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2022 Annual Meeting and Fall International
Conference of the Korean Society of Crop Science

2022 한국작물학회 정기총회 및 추계 국제 학술대회

# Innovative Direction of Crop Science Research for Food Security

## 식량안보강화를 위한 작물학연구 혁신방향

**2022.10.13(Thu) ~ 14(Fri) | Korea University, KU**

공동주최

The Korean Society of Crop Science
한 국 작 물 학 회

KOICA Korea International Cooperation Agency

IRRI International Rice Research Institute

Rural Development Administration

주관

고려대학교 생명자원연구소
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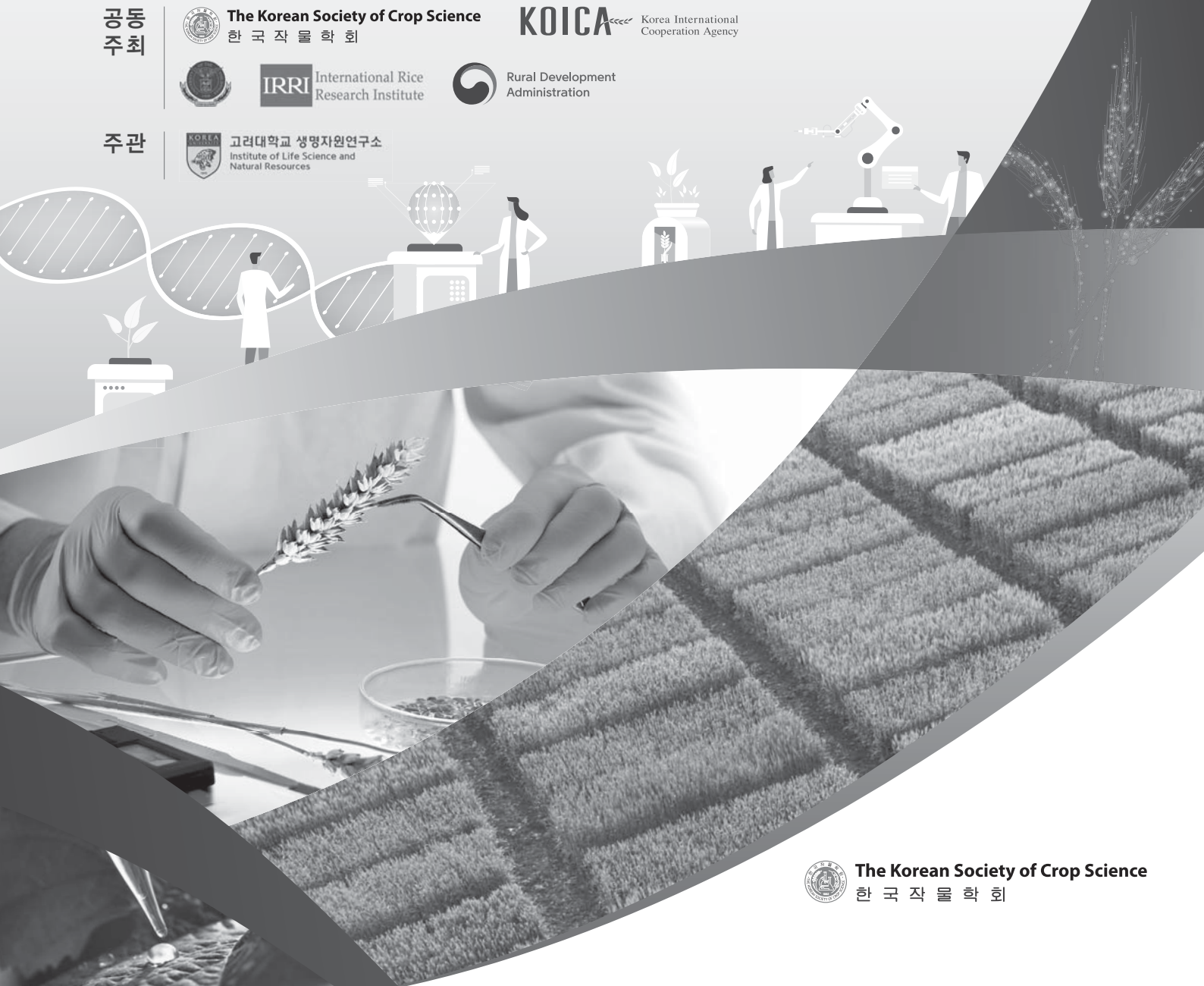

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# 사단법인 한국작물학회

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"본 사업은 기획재정부의 복권기금 및 과학기술정보통신부의 과학기술진흥기금으로 추진되어
사회적 가치 실현과 국가 과학기술 발전에 기여합니다."

# Opening address

Dear honorable members of the Korean Society of Crop Science, and distinguished guests joining us from all around the world for this Autumn Annual Conference. I am pleased to welcome you. My name is Jinwoong, Cho. I am the chairman of the Korean Crop Society and a professor at Chungnam National University.

In celebrating the 60th anniversary of our establishment, I would like to share our incredible journey of 60 years. The Korean Society of Crop Science has contributed significantly to the advancement of Korea's agricultural industry. We had created a foundation and tried to become self-sufficient in food production in the 1960s, the so-called green revolution increased crop yield in the 70s, year-round production in the 80s, improvement and enhancement of agricultural products in the 90s, and increased safety and functional products in 2000s and climate change adaptation and customized crops and advanced crop breeding in 2010.

Despite these achievements, we are facing difficulties securing food in Korea due to the spread of the COVID-19 pandemic that has lasted for about three years, the outbreak of local wars, financial crises, and instability of food productivity caused by climate change. Accordingly, The Korean Society of Crop Science has held an academic conference under the theme 'Innovative Directions for Crop Science Research for Food Security Strengthened" to solve these difficulties.

I do not know how to express my gratitude to Dr. Ajay Kohli from the International Rice Research Institute, Director Kim Bo-ram of the Ministry of Agriculture, Food and Rural Affairs, Dr. Cho Seungho from the Central Crop Department of the National Institute of Crop Science, Professor Koh Hee-Jong of Seoul University, Professor Yang Seung-Ryong of Korea University . I want to express my special thanks to Professor Meera Kwon from Busan National University. Also, I would like to express my thanks to all the researchers at home and abroad who will give presentations on each crop type tomorrow, as well as the members presenting the posters.

I believe that these various presentations, which are academic brainstorming, could be a strong strategy for strengthening Korea's food security. To achieve an economic balance between farmers who are producers and citizens who are consumers, the government should be actively involved in the cultivation and production of some crops, including rice, as a public concept, so it takes part in storage, purchase, and spread of consumption. I am sure that The Korean Society of Crop Science can play a crucial role in establishing a comprehensive plan for this and implementing it.

Lastly, I would like to express my deepest gratitude to the President of Korea University and related persons, the Korean Federation of Science and Technology Societies, the President of KOICA, the Rural Development Administration, and the speakers and members of the Society for their tremendous effort in hosting the Autumn Annual Conference 2022 of The Korean Society of Crop Science.

October 13, 2022
The Korean Society of Crop Science
**Cho Jin-Woong**, Chairman

# Welcome speech

안녕하십니까, 고려대학교 총장 정진택입니다.

완연한 가을의 정취가 느껴지는 오늘 한국작물학회의 2022년 추계학술대회 개최를 진심으로 축하드립니다.

먼저 바쁘신 와중에도 오늘의 행사를 위하여 고려대학교를 찾아주신 한국작물학회 회원 여러분께 환영의 인사를 드리며, 조진웅 회장님을 비롯한 관계자 여러분의 노고에 감사의 말씀을 드립니다.

또한, 이번 추계작물학회는 국제학회로서 이윤영 코이카 이사님, 우선희 한국과총 부회장님, 젠밸리 국제미작연구소 부소장님, 호세 까마초 필리핀대학 총장님이 참석하시여 자리를 빛내주시고 있습니다.

최근 4차 산업혁명이라는 새로운 변화의 화두 속에 급격한 기후변화의 위기가 공존하고 있는 현실에 비추어 식량안보에 대한 중요성은 더욱 강조되며 식량자급률은 우리나라의 중요한 이슈라고 생각합니다.

이와 같은 상황에서 "식량안보강화를 위한 작물학연구 혁신방향"이라는 주제로 국가 및 국민생활의 근간인 식량자급률 제고와 나아가 식량안보에 대한 깊이 있는 논의와 해결책 모색을 위한 중요한 자리를 고려대학교에서 가지게 되어 큰 의미가 있다고 생각합니다.

오늘의 학술대회는 단순한 학술교류에 그치지 않고, 우리나라의 미래 농업 정책 마련을 위한 뜻 깊은 장이 되리라 믿어 의심치 않습니다.

여러 분야 중 농업은 우리나라의 역사와 같이 발전되어 왔다고 생각합니다. 아무도 부인할 수 없는 먹거리의 중요성은 아무리 강조해도 지나치지 않습니다. 국가의 지속가능한 발전을 위해서 우리는 농업에 관심을 보다 더 가져야 한다고 생각합니다.

고려대학교는 시대의 변곡점마다 우리 사회에 필요한 새로운 가치를 제시하며 민족과 나라의 앞날을 이끌어 왔으며, 농업 및 작물생명공학 등 21세기에 요구되는 교육 및 기술발전에 많은 기여를 하고 있습니다.

민족 사학으로 대한민국의 역사를 이끌어온 고려대학교 총장으로서 우리 역사에 큰 족적을 남기고 있는 한국작물학회의 학술대회를 안암벌에서 개최하게 되어 영광스럽게 생각합니다.

다시 한번, 오늘의 학술대회에 함께 해주신 한국작물학회 회원 및 관계자 여러분께 감사의 말씀을 드리며, 한국작물학회의 무한한 성장과 발전을 기원합니다. 감사합니다.

2022년 10월 13일

고려대학교 총장 **정 진 택**

# Welcome speech

안녕하십니까, 코이카 이윤영 이사입니다.

먼저, 정진택 고려대학교 총장님, 우선희 한국과학기술단체총연합회 부회장님, 젠밸리(Jean Balie) 국제미작연구소(IRRI) 연구원장님, 호세 까마초(Jose Camacho Jr.) 필리핀대학 총장님, 그리고 개회사를 해주신 조진웅 한국작물학회장님 그리고 각 세션의 좌장과 연사님들, 각 분야 전문가 여러분께 감사드립니다. 특히, 멀리 필리핀에서 참석해주신 국제미작연구소 및 필리핀 국립대 여러분께 깊은 감사의 인사를 드립니다.

먼저 우리나라 농업발전과 식량안보에 기초를 제공한 한국작물학회의 설립 60주년을 다시 한번 축하드립니다. 이번 국제학술대회는 특별히 한국작물학회, 농진청, 고려대학교, 그리고 국제미작연구소 및 KOICA가 공동으로 '식량안보강화를 위한 작물학연구 혁신방향'이라는 주제로 주최하게 된 점 매우 뜻깊게 생각합니다.

이번 국제학술대회는 국내외 작물 전문가들의 네트워크를 통해 응용 연구의 협력을 촉진하기 위해 공공부문과 민간부문의 파트너십에 기초하여 국제 농업 식량 분야의 혁신적 역량 육성을 위한 다양한 방안을 제안하여 주실 것으로 기대합니다.

오늘 귀중한 시간을 내주신 모든 분께 다시 한번 감사드립니다.

**〈식량안보를 위한 코이카 개발전략 및 필리핀 사업 소개〉**

여러분, 우리는 3년째로 접어든 코로나19(Covid 19) 팬데믹을 비롯하여, 우크라이나 전쟁으로 인한 세계적 식량 공급망 위기, 기후 변화로 인한 홍수, 지진 등 자연재해 등 전례 없는 위기를 겪고 있습니다.

UN이 발간한 2022년 지속가능발전(SDGs) 보고서에 따르면, 코로나19로 인해 빈곤인구는 최대 9,500만 명이 증가하고 4년 이상의 빈곤감소 성과가 후퇴하였으며, 분쟁 확대와 기후변화, 증가하는 불평등과 맞물리며 식량과 기아 문제도 심각해지고 있습니다.

이와 같이 전 세계 위기 상황에서 그간 다양한 학술활동을 통하여 우리나라의 식량자급 및 국민 식품건강 발전에 기여해온 작물학회가 우리나라를 넘어 전 세계 식량안보강화를 위한 작물학 연구 혁신 방향을 논의하는 오늘 이 자리가 매우 중요한 의미가 있다고 생각합니다.

기후위기, 분쟁, 코로나19와 같은 전지구적인 위협은 전세계 발전의 문제를 더욱 복합화(Complex)하고 있습니다.

식량안보 역시 마찬가지입니다. 식량안보에 대한 전 세계적인 위협에 효과적으로 대응하기 위해서는 다양한 주체들이 포괄적(Comprehensive)이고, 통합적(Integrated)으로 접근하는 것이 중요합니다.

이러한 지형의 변화 속에서 우리 정부는 '글로벌 중추국가 실현'이라는 비전아래, 지속가능발전목표(SDGs) 및 글로벌 가치 실현과 개방적·포용적 국제질서를 구축하고 강화하는데 동참하고자 ODA 규모 확대를 천명하였고 코이카는 이러한 정부 정책을 선도적으로 이행하고 있습니다.

농림수산 분야는 코이카의 중점 지원분야 중 하나입니다. 안정적이고 풍요로운 농촌주민의 삶 실현이라는

비전하에 포용적이고 지속가능한 농촌개발, 지속가능한 농림수산업 생산 증대 및 시장성 강화, 그리고 기후변화 대응을 위한 농산어촌 생산체계 구축 및 자연자원 보전이라는 3대 전략을 수립하고, 종자개발지원, 영농 역량강화 지원 프로그램 등 매년 약 6천만불, 전체 사업비의 약 10%를 농림수산분야 프로그램에 지원하고 있습니다.

특히 필리핀, 베트남, 인도네시아 등 아세안 지역 국가를 대상으로 식량안보를 위한 다양한 프로그램을 파트너국가와 함께 기획하여 집중적으로 지원하고 있습니다.

필리핀 국립대학교 첨단 농업연구센터 설립 및 고등교육 역량강화 사업 역시 이러한 프로그램의 일환으로 지원하고 있습니다. 2021년부터 2026년까지 총 1,495만불을 지원, 필리핀 국립대학교 내에 첨단 농업 유전체연구소를 설립하고 국제미작연구소(IRRI) 및 한국대학과 협업하여 동 연구소 운영 역량 강화, 필리핀 대학의 농업 유전체 관련 커리큘럼 개발, 그리고 유전체 연구 관련 석박사 학위 프로그램을 제공하는 사업입니다. 금번 국제학술대회도 동 사업의 농업유전체 연구 역량강화 프로그램의 일환으로 공동 개최하게 되었습니다. 한국의 작물 연구 관련의 경험을 필리핀과 공유함으로써 양국의 식량안보 증진을 위한 다양한 방안을 고민해 보고자 합니다. 참석자 여러분, 오늘날 식량안보의 문제는 더 이상 몇몇 개발도상국의 문제가 아닌 인류 공동의 보편적인(universal) 문제가 되었습니다. 이러한 상황에서 일방적 수혜자와 공여자로 나뉘는 이분법적 접근으로는 기후변화와 식량안보의 문제를 해결할 수 없습니다.

전 세계 정부, 국제기구, 학계, 민간 모두의 역량과 발전 경험을 공유하고 더 나아가 지역 및 글로벌 공동번영에 기여하는 새로운 형태의 개발협력 파트너십만이 이러한 문제를 해결할 수 있습니다.

오늘 국제학술대회가 아시아 지역의 식량안보를 강화하고 지속가능한 농업과 농산물의 안정적 공급에 대한 혁신적이고도 풍성한 논의가 이루어지길 기대합니다.

참석자 여러분, 옛 경서인 논어에서는 사람의 나이 60세를 이순(耳順)이라고 하여, 경륜이 쌓이고 사려와 판단이 성숙하여 남의 말을 부드럽게 받아들이는 시기라고 합니다.

〈한국작물학회 60주년 국제 학술대회〉가 서로의 경험과 전문성을 존중하고 경청함으로써 현재 세계가 직면한 식량 위기에 대응하고 해결해 가는 방법을 찾아가는 하나의 계기가 될 것이라 확신합니다.

오늘 이 자리에서 풍성한 발표와 토론이 있기를 기대하며, 들판의 씨앗이 자라 곡식이 되고 나무로 크듯이 금일의 논의가 하루의 회의에 그치지 않고, 논의의 장이 이어지며 그 결실을 볼 수 있도록, KOICA 역시 지속적으로 노력해 나가겠습니다.

감사합니다.

2022년 10월 13일

KOICA 이사 **이 윤 영**

# Congratulatory address

Dear honorable members of the Korean Society of Crop Science.

At first, sincerely I would like to congratulate you on the 60th anniversary of the birth of the Korean Society of Crop Science and the holding of the 2022 fall international academic conference in the bountiful season of bearing fruit. It is a meaningful year to celebrate the 60th anniversary of the Korean Society of Crop Science, which has been leading the way to food solutions worldwide through crop production research and commercialization. I would like to congratulate honorable President Cho Jin-Woong and other academic management officials who have a long history and tradition in the agricultural field of Korea and the Federation of Korean Trade Unions for their endless efforts to develop the society.

This international symposium will be held under the main theme of **'Innovative direction of crop science research for food security'**. Securing a stable supply of safe food is the most important thing for humans to live regardless of the times. In recent years, rice production in Korea has experienced a decline in rice prices due to an accumulation of inventories due to a good harvest for several years. Although the main grain supply and demand situation has succeeded in self-sufficiency of rice, the staple food, due to productivity improvement, etc., it is facing a structural oversupply of rice due to reduced consumption and the burden of mandatory imports. Despite the policy, the level of self-sufficiency shows a stagnant limit.

The lack of confidence in policy continuity and consistency, production-oriented policy design without sufficient consideration of the characteristics of demand, and very low price competitiveness compared to imported products were the main factors behind the stable expansion of grain production.

Particularly, in order to improve wheat self-sufficiency, efforts to improve the quality of wheat varieties should be prioritized. Research and development in the field of crop production should be continuously carried out at the national level.

The global food security crisis occurred due to COVID-19 and the Russia-Ukraine war, and the recent simultaneous droughts and heat waves threaten table prices in developing countries as well as advanced countries, so discussions on global food security are needed. In addition, strategic crops such as wheat and corn are expected to deteriorate globally this year, and the international community is in dire need of a response, with more than 2.3 billion people suffering from food security threats worldwide.

Once again, I hope that through this international conference, comprehensive R&D and countermeasures will be prepared for the innovation direction of agronomic research for the reinforcement of food security.

I hope that this academic activity will serve as an opportunity to gather wisdom on sustainable food security in the future. I will do my best to actively review the support for the activities of academic societies related to this trend at the Korean Federation of Science & Technology Societies, to which I belong.

I hope today and tomorrow will be an opportunity for useful information and research exchange through the fall international symposium of the Korean Society of Crop Science. And it is said that rivers and mountains will change in every 10 years. I hope that the 60th anniversary celebration of the Korean Society of Crop Science, which is celebrating the age of sixty, will be a stepping stone to become a representative society of Korean academic organizations for the next 100 years.

I wish the Korean Society of Crop Science good luck and endless development.

Thank you very much.

October 13, 2022

**Woo Sun-Hee**, Vice-President of the Korean Federation of Science and Technology Societies (KOFST)

# Program

- Date : October 13. 2022 (Thu.) ~ 14. 2022. (Fri.)
- Place : Korea University (Inchon Hall & SK Future Hall)
- Subject : Innovative Direction of Crop Science Research for Food Security

■ October 13, 2022 (Thu.) Inchon Hall

| Date | Announcement |
|---|---|
| 12:00-13:00 | Registration |
| 13:00-13:30 | Directorate meeting |
| | Inchon Hall |
| 13:30-14:00 | Opening Ceremony<br>Jae Yoon Kim (Kongju National University)<br>1. Opening address<br>Jin-Woong Cho (President, Korean Society of Crop Science)<br>2. Welcome speech<br>Jin Taek Chung (President, Korea University)<br>Yun-young Lee (Vice President, KOICA)<br>3. Congratulatory address<br>Sun-Hee Woo (Vice President, KOFST)<br>Jean Balie (Director General, International Rice Research Institute)<br>Jose V. Camacho, Jr (Chancellor, University of the Philippines Los Baños) |
| | Plenary Session 1 Chairman : Prof. Yong Weon Seo (Korea University) |
| 14:00-14:20 | Plenary Lecture 1<br>The Integrative Research Paradigm of IRRI and the One CGIAR<br>Ajay Kohli (Deputy Director General for Research, IRRI, Philippines) |
| 14:20-14:50 | Plenary Lecture 2<br>Mid-to Long-term Food Policy Direction<br>Bo-ram Kim (Director, Food Grain Industry Division, Food Grain Industry Div., Ministry of Agriculture and Food) |
| 14:50-15:20 | Plenary Lecture 3<br>National Food Security Improved by Crop Value Chain Enhancement<br>Seungho Cho (National Institute of Crop Science, Rural Development Administration) |
| 15:20-15:40 | Coffee Break |
| | Plenary Session 2 Chairman : Prof. Sun-Hee Woo (Chungbuk National University) |
| 15:40-16:10 | Plenary Lecture 4<br>Crop Science Approaches to Alleviate the Food Security Concerns in Korea<br>Hee-Jong Koh (Seoul National University) |
| 16:10-16:40 | Plenary Lecture 5<br>Strengthening Food Security through Food Quality Improvement - Focus on Grain Quality and Self-Sufficiency Rate<br>Meera Kweon (Pusan National University) |
| 16:40-17:10 | Plenary Lecture 6<br>An Economic Perspective on Food Security<br>Seung-Ryong Yang (Korea University) |
| 17:10-17:20 | Coffee Break |
| 17:20-17:40 | Annual Meeting of the Korean Society of Crop Science |

■ October 14, 2022 (Fri.) SK Future Hall

| Date | Announcement |
|---|---|
| 09:00-11:40 | Oral presentation by division |
| | Division 1: Rice (Choi Jonghyun Hall) — Chairman: Prof. Soonwook Kwon (Pusan National University) |
| | 1. Improvement of Abiotic Stress Resilience for Stable Rice Production<br>Dongjin Shin (National Institute of Crop Science, RDA)<br>2. The Variation of Yield-Related Traits of the QTL Pyramiding Lines for Climate-resilience and Nutrition Uptake in Rice<br>Joong Hyoun Chin (Sejong University)<br>3. Organ- and Time-Specific Soluble Carbohydrates and Primary Metabolites Profiling in Rice Plants at Different Growth Stage<br>Young Tae Shin (Chungbuk National University)<br>4. Fine-Mapping for Identification of Genes on Pre-Harvest Sprouting in Rice (*Oryza sativa* L.)<br>Seong-Gyu Jang (Department of Plant Bioscience, Pusan National University)<br>5. Single-trait GWAS of Leaf Rolling Index with the Korean Rice Germplasm<br>Byeong Yong Jeong (Department of Crop Science, Konkuk University) |
| | Division 2: Barley, Wheat, and Other Crops (Room 513) — Chairman: Prof. Seong Woo Cho (Gyeongsang National University) |
| | 1. Impact of Korean Malting Barley Varieties on Malt Quality<br>Young-mi Yoon (National Institute of Crop Science)<br>2. Production and Quality Parameters of Oat Grown in Conventional/Organic Farming<br>Petr Konvalina (University of South Bohemia)<br>3. Development and Application of Speed Vernalization System for Practical Speed Breeding in Wheat (*Triticum aestivum* L.)<br>Jin-Kyung Cha (National Institute of Crop Science)<br>4. Glutathione-Mediated Modulation of Cadmium Stress Responses in Oilseed Rape Plants: Oxidative Stress, Redox Status, and Hormone Balance<br>Ha-il Jung (National Academy of Agricultural Sciences)<br>5. The Growth and Quantity of Potatoes by Fertilizer in the High-altitude Areas<br>Gun Ho Jung (National Institute of Crop Science) |
| 09:00-11:40 (Division 3) | Division 3: Legumes (Room 522) — Chairman: Prof. Taehwan Jun (Pusan National University) |
| | 1. Breeding and Production Research Direction for Soybean Self-Sufficiency Improvement in Korea<br>Jee-Yeon Ko (National Institue of Crop Science)<br>2. Identification of a Potential Gene for Elevating $\omega$ -3 Concentration and its Efficiency for Improving $\omega$ -6/$\omega$ -3 Ratio in Soybean<br>Hyun Jo (Kyungpook National University)<br>3. QTL Identification for Slow Wilting and High Moisture Contents in Soybean (*Glycine max* [L.]) and Arduino-Based High-Throughput Phenotyping for Drought Tolerance<br>Hakyung Kwon (Seoul National University)<br>4. Genome Wide Association Study for Agronomic Traits in Wild Soybean (*Glycine soja*)<br>Woon Ji Kim (Chonnam National University)<br>5. Selective Allele Stacking of a Novel Quantitative Trait Locus Facilitates the Enhancement of Seed Epicatechin Contents in Soybean (*Glycine max* (L.) Merr.)<br>Sewon Park (Seoul National University) |
| 10:00-11:45 (Division 4) | Division 4: KOICA-UPLB-IRRI Consortium for International Agricultural Genomics Research (Room 504) — Chairman: Prof. Changsoo Kim (Chungnam National University) & Jorge Gil C. Angeles (University of the Philippines Los Baños) |
| | 1. Status of Philippine Mango Genomics: Enriching Molecular Genomics Towards a Globally Competitive Philippine Mango Industry<br>Eureka Teresa M. Ocampo (University of the Philippines Los Baños)<br>2. Sophora Genomes Provide Insight into the Evolution of Alkaloid Metabolites Along with Small-scale Gene Duplication<br>Yang Jae Kang (Gyeongsang National University)<br>3. The Philippines Coconut Genomics Initiatives: Updates and Opportunities for Capacity Building and Genomics Research Collaboration<br>Hayde Flandez-Galvez (University of the Philippines Los Baños)<br>4. Leveraging Rice Genetic Diversity: Connecting the Genebank to Mainstream Breeding<br>Damien Platten (International Rice Research Institute)<br>5. Whole Genome Sequencing of Two *Musa* Species Towards Disease Resistance and Fiber Quality Improvement<br>Maria Genaleen Diaz (University of the Philippines Los Baños)<br>6. Genetic Insights into Domestication Loci Associated with Awn Development in Rice<br>Ngoc Ha Luong (Chungnam National University)<br>7. Development of Bioinformatics Capacity in Support of the KOICA-UPLB-IRRI Agricultural Genomics Research Center<br>Ramil P. Mauleon (International Rice Research Institute) |
| 11:40-12:00 | Giveaway event & Closing ceremony (Choi Jonghyun Hall) |
| 12:00-16:00 | Temperate Rice Research Consortium Steering Committee Meeting (Room 504) |

# Contents

## Plenary Session



## Division Session

## 포스터발표

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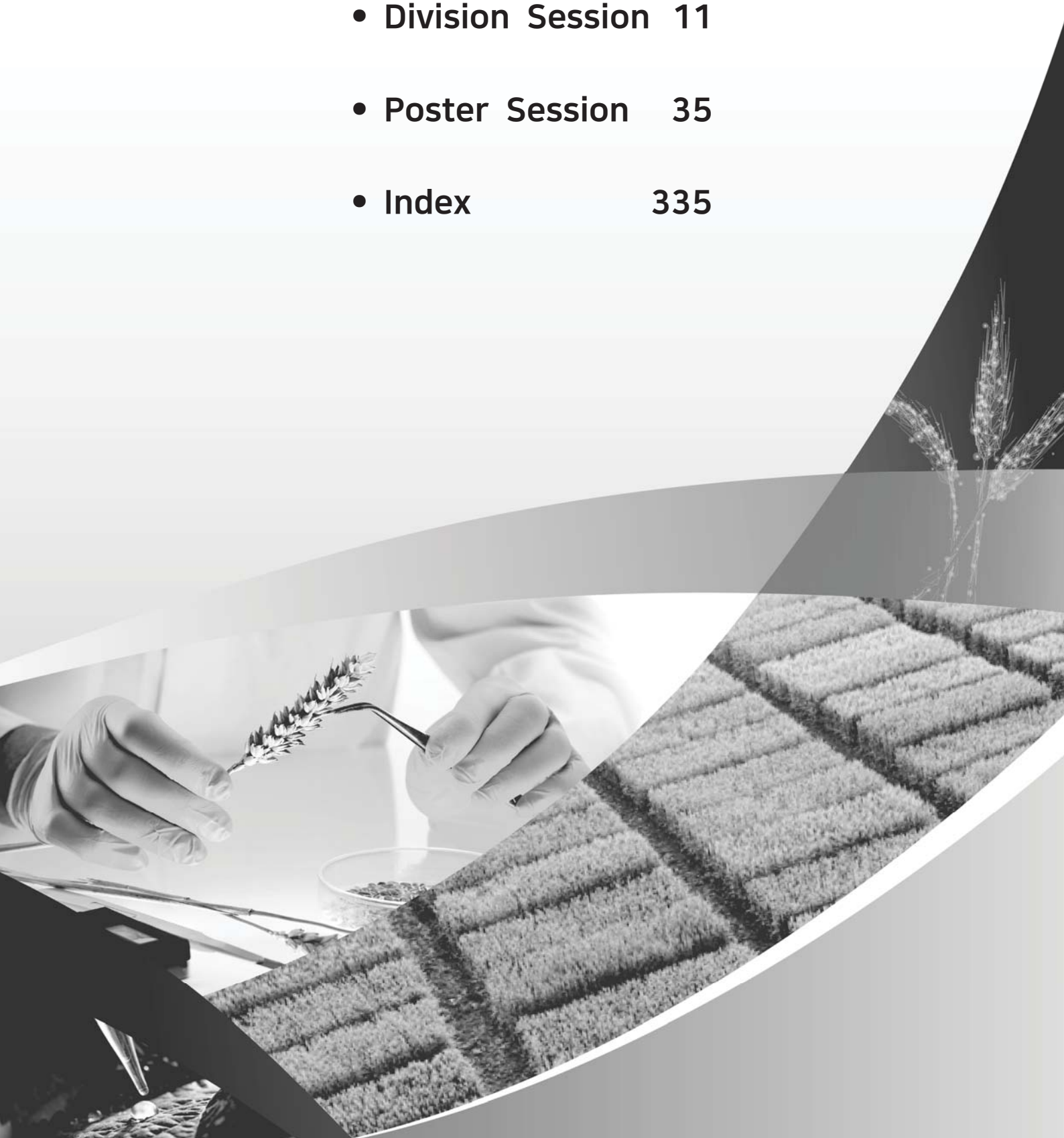
## PC



# Plenary Session

**Plenary-01**

# The Integrative Research Paradigm of IRRI and the OneCGIAR

Ajay Kohli[1]*

[1]Deputy Director General Research, International Rice Research Institute, Pili Drive, UPLB, Los Banos Laguna, 4030, Philippines.

**[Abstract]**

A little more than a decade ago, the International Rice Research Institute (IRRI) started on a journey of revitalization through adopting the concept of systems research. Instead of being just a rice breeding and affiliated sciences research center, it expanded its vision of impact on the rice-based food systems. In almost the same vein the OneCGIAR has also attempted to aggregate the commodity-based research into food systems-based research that critically caters to specific overarching 'Impact and Action Areas'. Incidentally, IRRI's structure and operations map on to these Impact and Action areas very well. Hence, IRRI's research directly caters to societal, economic and environmental sustainability. It does so through a coherent pipeline that spans the upstream discovery component all the way to product delivery, dissemination, and impact assessment. While a circular 5D-pipeline of demand, discovery, development, deployment and distinction attend to the ground-level realities of demand, development and acceptance of a product, the Four Flagships attend to proximal deliverables under challenging conditions of change brought about by the CGIAR restructuring and COVID-19. Prioritizing specific products under the flagships ensures that institutional support is available to fast-track the deliverables. Clear examples now highlight the potential of such approaches. Thus, despite the challenges of climate change, political unrest of war and global medical encumbrances, the stable partners of IRRI like Korea have helped to come close to deliverables.

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**Plenary-02**

# Mid- to Long-term Food Policy Direction

Bo-ram Kim[1]*

[1]Food Grain Industry Division, Ministry of Agriculture, Food and Rural Affairs

**[Abstract]**

Prolonged Russia-Ukraine war, and unstable situation of supply and demand of global crops including the COVID-19 pandemic have raised awareness regarding food crisis, and in addition to this situation, export restriction measures imposed by some countries have accelerated the rise in the prices. Since the Republic of Korea depends annual crop consumption (21.32 million tons) mostly on the imports (food self-sufficiency rate in 2020 was 45.8%, crop self-sufficiency rate was 20.2%), our main task is to stably secure food. Now we need to put focus on building capacity to secure stable food supply, and actively manage and respond to risks.

To overcome this condition, the Korean government set robust food sovereignty as its policy task, and has been focusing on the policy capacity by providing financial and policy support in parallel. We need to implement mid- to long-term measures to strengthen food security as well as to ensure domestic price stability.

While increasing the domestic capacity to supply food in the mid- to long-term perspective, we are implementing projects to bring in crops which are inevitable to be imported by private companies. Specifically, we are making efforts to expand infrastructure for the public reserve and domestic production of wheat and beans which have low self-sufficiency rate, and to secure food sovereignty by providing support to secure global crop supply chain to private companies. The Ministry of Agriculture, Food and Rural Affairs plans to set a target for food self-sufficiency rate and prepare a policy to strengthen mid- to long-term food security by establishing a task force to strengthen mid- to long-term food security in the Ministry.

Especially, although wheat is the second staple food, domestic wheat production and the foundation for the industry is poor. Compared to the wheat imports, domestic production of wheat is 30 thousand tons (self-sufficiency rate of 1%), leading to a vulnerable status against internal and external shocks. Through the establishment of the Wheat Industry Promotion Act (Feb. 2020) and the First Master Plan for Wheat Industry Promotion (Nov. 2020), the Korean government has developed a policy basis, and has been providing financial support in overall across the production, distribution and consumption process.

In addition, the government established a production complex for Korean wheat and beans in order to supply affordable government-supplied commodities, provide education and consulting services, and create a high-quality stable production system, including facilities and equipment. We are also continuing to increase the public reserve for wheat and beans with the purpose of stable supply and demand as well as food security.

The Korean government will establish and implement mid- to long-term measures to strengthen the foundation for domestic production across production, distribution and consumption process, and to stably secure global supply chain including through diversified import channels.

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**Plenary-03**

## National Food Security Improved by Crop Value Chain Enhancement

Seungho Cho1*

[1]National Institute of Crop Science

Goal of national food security is to improve crop productivity and substantiality. More comprehensive and expanded concept of food security including food safety, quality, nutrition and value-added new applications is need for futuristic smart society. The entire process of breeding-seed production-seedling preparation-cultivation-harvest-distribution-consumption which used to be independently managed will need to be organized into one integrated management procedure. Advancement of the agro-food industry through technology integration, networking and expansion has been slow because these technological elements are still fragmented and independently operated. It is necessary to develop G, E, M, and P data management process and high-level decision-making protocols first. Sustainable high value supply chain for domestic food crops is expected to be secured by GxExMxP technologies.

**Plenary-04**

# Crop Science Approaches to Alleviate the Food Security Concerns in Korea

Hee-Jong Koh[1]*

[1]Department of Agriculture, Forestry and Bioresources, Seoul National University

**[Abstract]**

Unstable crop production and distribution affected by climate change and COVID-19 pandemic has raised the food security concerns worldwide. In particular, Russia's invasion to Ukraine has blocked the grain trade such as wheat and corn to importing countries, which has aggravated the situation. Korea has relied on foreign imports for about 80% of domestic grain demand, raising great concerns on food security. Considering situations related to Korea's food security, some points in view of a crop scientist are suggested and discussed as follows; 1) Domestic production of major grain crops should be increased through encouraging farmers by appropriate governmental subsidy programs 2) International corporation should be strengthened and diversified for sustainable overseas agricultural development and for stable import even in case of food crisis and emergency. 3) Self-sufficiency target should be specified by law so that more budget investments could be put to alleviate the food security concerns. 4) Technologies for climate smart agriculture and for competitive agricultural products should be developed aided by social and governmental support.

**Plenary-05**

# An Economic Perspective on Food Security

Seung-Ryong Yang[1]*

[1]Department of Food and Resource Economics, College of Life Science and Biotechnology, Korea University

**[Abstract]**

The concept of food security has gained increasing attention during the food crisis period between 2006 and 2011. According to the FAO, food security is defined as an access by all people at all times to the food needed for healthy and active life. Achieving food security means that sufficient food is available, food supply is relatively stable, and those in need of food can afford food at a reasonable cost. After a short period of stable food prices the world is facing another food crisis due mainly to the COVID-19 pandemic and the Russian invasion over Ukraine. Food security has re-emerged as an urgent problem to the world.

There have been two conflicting opinions about how to achieve food security. Agricultural exporting countries insist diversification of food sources and freer trade on the top of domestic self-reliance. On the other hand, food importing countries emphasize self-sufficiency of major food crops.

This study investigates whether domestic agricultural production contributes to strengthening food security. The panel data analysis shows that the increase in food self-sufficiency raises the Global Food Security Index and lessens the probability of food riots, while lower import tariffs (implying freer trade) do not. Some related issues are discussed accordingly.

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Plenary-06

# Strengthening Food Security through Food Quality Improvement - Focus on Grain Quality and Self-Sufficiency Rate

Meera Kweon[1]*

[1]Department of Food Science and Nutrition, College of Human Ecology, Pusan National University

**[Abstract]**

The concern about food security is rising as the unstable situation of food supply and demand due to the Covid-19 pandemic, climate change, and turbulent political situation. Korea's global food security index (GFSI), analyzed by the Economist Group, is considered good, but the level continuously decreases in comparing food security levels by country. In particular, Korea is highly dependent on food imports, and food and grain self-sufficiency rates continuously decrease. Therefore, increasing those rates to strengthen food security is urgent. Among the major grains, the self-sufficiency of wheat, corn, and soybeans, except rice, is relatively low. Unlike the decrease in the annual rice consumption, the annual wheat consumption has been continuously maintained or increased, which is required public-private efforts to increase the self-sufficiency rate of wheat. Applying the government's policies implemented to increase the self-sufficiency rate of rice in the past will help increase the self-sufficiency rate of wheat. In other words, expanding wheat production and infrastructure, stabilizing supply and demand, and establishing a distribution system can be applied. However, the processing capability of wheat and rice is different, which is necessary to improve wheat quality and processing technology to produce consumer-preferred wheat-based products. The wheat and flour quality can be improved through breeding, cultivation, post-harvest management, and milling. In addition, research on formulation, processes, packaging, and storage to improve the quality of wheat-based products should be done continuously. Overall, food security could be strengthened by expanding wheat production and consumption, improving wheat quality, and increasing wheat self-sufficiency.

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# Division Session

Division-1-01

# Improvement of Abiotic Stress Resilience for Stable Rice Production

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[1]Dep. of Southern Area Crop Science, National Institute of Crop Science, RDA, Miryang-si, Gyeongnam-do 50424, Korea

**[Abstract]**

Recently, stable crop production is threatened by the effects of climate change. In particular, it is difficult to consistently maintain agricultural policies due to large price fluctuations depending on the difference in total domestic rice production from year to year. For stable rice production amid changes in the crop growing environment, development of varieties with improved disease resistance and abiotic stress stability is becoming more important. In here, drought and cold tolerant trait have been studied. First, for the development of drought tolerant varieties, we analyzed which agricultural traits are mainly affected by domestic drought conditions. As a result, it was observed that drought caused by the lack of water during transplanting season inhibits the development of the number of tiller and reduces the yield. 'Samgang' was selected as a useful genetic resource with strong drought tolerant and stable tiller number development even under drought conditions by phenotype screening. Three of drought tolerant QTLs were identified using doubled haploid (DH) population derived from a cross between Nacdong and Samgang, a drought sensitive and a tolerant, respectively. Among these QTLs, when *qVDT2* and *qVDT11* were integrated, it was investigated that the tiller number development was relatively stable in the rainfed paddy field conditions.

It is known that the high-yielding Tongil-type cultivars are severely affected by cold stress throughout the entire growth stage. In this study, we established conditions that can test the cold tolerance phenotype with alternate temperature to treat low temperatures in indoor growth conditions similar to those in field conditions at seedling stage. Three cold tolerant QTLs were explored using population derived from a cross between Hanareum2 (cold sensitive variety, Tongil-type) and Unkwang (cold tolerant variety, Japonica). Among these QTLs, *qSCT12* showed strong cold tolerant phenotype. and when all of three QTLs were integrated, it was investigated that cold tolerant score was relatively similar to its donor parent, Unkwang, in our experimental conditions. We are performing that development of new variety with improved cold tolerant through the introduction of these QTLs.

**[Acknowledgement]**

This research was supported by the Research Program for Agricultural Science and Technology Development (PJ014774052022 ), Rural Development and Administration

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Division-1-02

# The Variation of Yield-Related Traits of the QTL Pyramiding Lines for Climate-resilience and Nutrition Uptake in Rice

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**[Abstract]**
Greenhouse gas emissions are one of the critical factors that drive change in rice cropping systems. Within this changing system, less water irrigation and chemical fertilizer are seriously considered, as well combining precision farming technologies with irrigation control. Water and phosphorus (P) fertilizer are two of the most critical inputs in rice cultivation. Due to the lack of water availability in the system, P fertilizer is not available, especially in acidic soil conditions. Moreover, the various types of abiotic stresses, such as drought, high temperature, salinity, submergence, and limited fertilizer result in significant yield loss in the system. Even in the late stage of growth, the waves caused by diseases and insects make the field more unfruitful. Therefore, agronomists and breeders need to identify the secondary phenotypes to estimate the yield loss of when stress appears. The prediction will be clearer if we have a set of markers tagging the causal variation and the associated precise phenotype indices. Although there have been various studies for abiotic stress tolerance, we still lack functional molecular markers and phenotype indices. This is due to the underlying challenges caused by environmental factors in highly unpredictable regional and yearly environmental conditions in the field system. *Pup1(phosphorus uptake 1)* is still known as the first QTL associated with phosphorus uptake and have been validated in different field crops. Interestingly, some pyramiding lines of *Pup1* and other QTLs for other stress tolerances showed preferable phenotypes in the yield. Precise physiological studies with the help of genomics are on-going and some results will be discussed.

**[Acknowledgement]**
This work was supported by a grant from the BioGreen (No. PJ0159162022), Rural Development Administration, Republic of Korea. This work was supported under the framework of international cooperation program managed by National Research Foundation of Korea(NRF-2021K1A3A1A61002988).

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Division-1-03

# Organ- and Time-Specific Soluble Carbohydrates and Primary Metabolites Profiling in Rice Plants at Different Growth Stage

Young Tae Shin[1], Jwakyung Sung[1]*

[1]Department of Crop Science, Chungbuk National Univ, Chungbuk Cheongju 28644, Korea

**[Introduction]**

Plants including rice extremely depend on solar energy, photosynthesis, to synthesize carbon compounds and to implement growth and reproduction. Due to the contribution of carbohydrates on rice growth, the allocation and partitioning of assimilation products between source and sink organs is a major factor in determining plant yield. In general, rice abundantly accumulates soluble carbohydrates; relatively large portion of sucrose in leaf vacuoles during the day and less amounts of starch in chloroplasts. Therefore, understanding organ-, time- and growth stage-dependent carbohydrate metabolism could be one of clues to ensure suitable growth and grain yield against a variety of environmental stresses derived from climate change. Accordingly, the objective of this study was to investigate a variation of primary metabolites including soluble carbohydrates, and, to achieve our goal, we employed the high throughput technology (metabolomics) by GC-TOFMS.

**[Materials and Methods]**

The seeds of *Oryza sativa* L. cv. Ungwangbyeo were germinated, and the selected seedlings were grown in a greenhouse located in Chungbuk National University. The overall management for rice cultivation was followed by RDA standard manual. To analyze soluble carbohydrate, the shoots, roots and grains are carefully taken at the tillering, heading, days after flowering (DAF) 20 and DAF 40, respectively. Soluble carbohydrates including starch were extracted and measured at 630 nm using a UV-spectrophotometer (UV-1900i, Shimadzu, Japan). Metabolomic analysis from leaf blades, roots, and grains harvested with every 12-hour intervals (noon and midnight) at the tillering and heading stage, respectively. Analysis of hydrophilic compounds (e.g., amino acids, sugars, organic acids, and sugar alcohols) Samples were analyzed on an Agilent 7890A GC (Agilent Technologies, Santa Clara, CA, USA) equipped with a Pegasus TOF-MS ((Leco, St. Joseph)., Michigan, USA)

**[Results and Discussion]**

The level of total soluble sugars and starch tended to increase at the heading stage. At DAF 20, total sugar showed a tendency of decrease in all parts, whereas starch was significantly accumulated in grains. As a result of metabolite profiling, all primary metabolites such as organic acids, amino acids and sugars from leaf sheaths and roots decreased at midnight compared to noon at the heading stage. In contrast, during the heading stage, the grains showed higher amino acids and sugars compared to other parts both time points, noon and midnight. Shikimate acid, a precursor to produce phenolic compounds, showed a tendency of decrease at midnight at the tillering stage although the level was higher than at the heading stage.

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Division-1-04

# Fine-Mapping for Identification of Genes on Pre-Harvest Sprouting in Rice (*Oryza sativa* L.)

Seong-Gyu Jang[1], Da-Eun Im[1], Hongjia Zhang[1], Ah-Rim Lee[1], Fang-Yuan Cao[1], Yuting Zeng[1], Sang-Cheol Kim[1], Jeong-hyeon Gong[1], Soon-Wook Kwon[1]*

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**[Introduction]**

Rice (*Oryza sativa* L.) is one of the most important food crops as it is the main staple food for more than half of the world's population. Climate change entails higher temperatures, and the predicted above-average temperatures will diminish rice crop yields. Pre-harvest sprouting (PHS), one of the adverse effects of climate change on crops, was reported to become a serious threat to rice production. In this study, we identified candidate genes associated with PHS using segregation populations.

**[Materials and Methods]**

To analyze quantitative trait loci (QTLs) and fine-mapping for PHS tolerance, we evaluated PHS under field and growth chamber conditions of $F_{2:3}$, $F_{3:4}$ populations, and their parental lines. Genotypic analyses were performed using single nucleotide polymorphisms (SNPs) and InDel (Insertion & deletion) markers detected in re-sequencing data.

**[Results and Discussion]**

*qPHS1*$^{FC}$ and *qPHS1*$^{GC}$ were detected on chromosome 1, and the QTL regions were narrowed down from 237 Kbp to 50 Kbp. The five candidate genes *Os01g0111200, Os01g0111300, Os01g0111400, Os01g0111500*, and *Os01g0111600* were detected in this 50 Kbp region, and *Os01g0111400* and *Os01g0111600* were confirmed to contain SNP and an InDel region between PHS-S and PHS-T.

**[Acknowledgement]**

This research was funded by the Rural Development Administration, Republic of Korea (PJ01579403).

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Division-1-05

# Single-trait GWAS of Leaf Rolling Index with the Korean Rice Germplasm

ByeongYong Jeong[1], Muhyun Kim[1], Tae-Ho Ham[3], Seong-Gyu Jang[2], Ah-Rim Lee[2], Min young Song[1], Soon-Wook Kwon[2], Joohyun Lee[1]*

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**[Abstract]**
Leaves are an important organism for photosynthesis and transpiration. The shape of leaf is crucial factor affecting plant architecture. V-shape leaf rolling is enhancing canopy photosynthesis by increasing the $CO_2$ penetration and the light capture by reducing the shadow between the leaves. Therefore, moderate leaf rolling is thought to more high grain yield per area than flat leaf. We investigated 278 KRICE_CORE accession's Adaxial Leaf Rolling Index (LRI) in first heading using the following equation.
For each accession, genomic DNA was used for sequencing. We sequenced the genomics with ~8 X coverage to detect SNPS. Raw reads were aligned against the rice reference (IRGSP 1.0) for SNP identification and genotype calling. To generate genotype data for GWAS, SNPs were filtered with minor allele frequency 0.05. Finally, 841,134 high-quality SNPs were used for our GWAS.
The significant threshold was -log10(P) > 7.23. From the results, 2 significance SNP were detected. Considering the LD block of 250kbp, 60 candidate gene were selected including Hypothetical gene and Conserved gene. In this poster, we analyzed candidate gene affecting adaxial Leaf Rolling through single-trait GWAS.

**[Acknowledgement]**
This study was supported by a grant from "improvement of green rice plant type using genetic information" Program (No. PJ01707303), Rural Development Administration, Republic of Korea.

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Division-2-01

# Impact of Korean Malting Barley Varieties on Malt Quality

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**[Abstract]**
Barley has been used for the production of malt in the brewing industry. Malting is the process of preparing barley through partial germination. Malt extract is the most important quality parameter for malt quality. The grain and malt quality parameters of ten Korean malting barley varieties were studied. Malts was prepared using Phoeix automated micro malting system(Phoenix Bio, Australia). Quality analysis of Barley and malt was determined according to European brewery convention(EBC, 1998) and American society of brewing chemists(ASBC, 1997) method. And the hordeins of barley and malt were extracted with 50% isopropyl alcohol(IPA, 2-propanol) of 1% dithiothreitol(DTT). The analysis of hordeins was carried out by ultra-performance liquid chromatography(UPLC). The mean values of 1000-grains weight, assortment rate, protein content, starch content, beta-glucan content, husk rate, germination energy, germination capacity and water sensitivity of grain were 45.8g, 86.8%, 11.9%, 58.0%, 3.8%, 14.0%, 96.2%, 97.2%, 10.0%, respectively. The mean values of protein content, friability, diastatic power, extract, soluble protein, Kolbach index, beta-glucan of malt and wort were 11.3%, 87.6%, 201WK(Windish Kolbach), 79.3%, 4.6%, 41%, 85mg/L, respectively. UPLC analysis of grain and malt hordeins revealed that the amount of hordeins significantly degraded during malting. Also, we could successfully be used to compare hordein polypeptide patterns with malt quality.

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Division-2-02

# Production and Quality Parameters of Oat Grown in Conventional/Organic Farming

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**[Abstract]**
Hulled and naked oat is a perspective crop for the low input production systems due to its low requirements for soil quality and nutrition. Oats have good competitive ability against weeds and can provide appropriate yield in organic farming in comparison with other cereal species such as wheat or barley. It is a perspective crop from the point of view of use in the food industry too. The aim of our study was to compare the production and quality parameters of naked and hulled oat grown in both organic (OF) and conventional fields (CF). Small plot trials were conducted in two locations in the Czech Republic (České Budějovice, Prague) for four years (2018-2021) in two production systems (OF, and CF). We used four varieties of hulled oat (Korok, Kertag, Raven, Seldon) and one variety of naked oat (Patrik). During the vegetation, agronomically important data were recorded. After harvest samples were processed in the laboratory and analyzed selected quality parameters of grain dry matter (the protein content was determined by the Kjeldahl method, starch content in grain according to Ewers, fat content in grain dry matter by the modified method according to Soxhlet, and ash content in grain dry matter). The data were evaluated using the program STATISTICA version 13.2, StatSoft, Inc., California, USA. It is clear from the results that the number of panicles before the harvest was influenced by the location, cultivation system, year, and, to a lesser extent, the influence of the variety. The number of panicles in OF averaged 340 per square meter, which was 90% of the value of CF. For thousand grain weight (TGW), a significantly predominant effect of year was found. The independent effect of location on TGW was statistically not significant. Grain yield was predominantly influenced by cultivation system and location. In OF, it reached an average of 3.97 $t.ha^{-1}$, which was 75% of the yield of CF. As part of the evaluation of the basic grain quality indicators, the content of protein, starch, fat, and ash in the dry matter of the grain was evaluated. The content of protein in the dry matter of the grain was predominantly influenced by year, followed by the influence of the variety and a fairly comparable influence of the cultivation system and locality. On average, it achieved 16.05% in OF and 17.01% in CF. The starch content was then related to the protein content, where as a result of the lower protein content in the grain of OF oats, the content of starch and fat was on the contrary increased. The year turned out to be the most significant factor, affecting both the starch content in the dry matter of the grain and the fat content. This was followed again by a fairly comparable influence on the cultivation system and locality. The influence of the cultivation system and location was not statistically significantly applied in the case of ash content in dry matter. Based on our results we can propose both types of oat (hulled and naked) as perspective crops for OF. An organic farmer can expect to achieve stable yields which, in less favorable conditions for the production of cereals in the OF, may be close to the level of conventional yields. In the future, it will be important to change agrotechnology in OF and increase oat yield because this crop has a good potential to grow in areas with low nitrogen input or less fertile soil.

**Keywords:** hulled oat, naked oat, organic farming, conventional farming, yield

Division-2-03

# Development and Application of Speed Vernalization System for Practical Speed Breeding in Wheat (*Triticum aestivum* L.)

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**[Abstract]**

A traditional wheat breeding program needs more than 12-13 years to develop a new cultivar. In recent years, 'Speed breeding (SB)' system, which uses extremely extended photoperiod (22 h), enabled up to 4-6 generations of spring wheat per year. However, since almost 70% of wheat cultivars are winter type, and over 95% of total cultivation area is for winter wheat in Korea, optimized vernalization treatment was essential for improving the SB system. Several vernalization temperatures and durations were tested with various genotypes, and the 4 weeks of 8-10 ºC vernalization treatment was the most effective to develop 4 generations per year, for both spring and winter type wheat cultivars. This 'Speed vernalization (SV)' system followed by SB, allowed developing a new $F_6$ recombinant inbred lines (RILs) within 2 years. Among the 184 RILs, which derived from a cross between Jokoyung and Joongmo2008, two outstanding lines were selected for yield trial test, and then named Milyang52 and Milyang53. Compared to the traditional wheat breeding program, over 60% of the time was saved to develop these two lines. Marker-assisted selection and backcross were also combined with the SV system. YW3215-2B-1 (Jokoyung*3/Garnet), which has similar agronomic traits with Jokyoung and the same *Glu-B1* allele with Garnet, was developed within 2.5 years. Thus, the SV system combined with molecular breeding technology would help breeders to make a new cultivar with less time and high efficiency.

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Division-2-04

# Glutathione-Mediated Modulation of Cadmium Stress Responses in Oilseed Rape Plants: Oxidative Stress, Redox Status, and Hormone Balance

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**[Introduction]**

The antioxidant glutathione (GSH) alleviates adverse physio-metabolic effects and defends against abiotic stresses including cadmium (Cd) stress. However, its function and role in resisting Cd phytotoxicity by leveraging plant antioxidant-scavenging, redox-regulating, and hormone-balancing systems have not been comprehensively and systematically demonstrated in the Cd-hyperaccumulating plant *Brassica napus* L. cv. Tammi (oilseed rape).

**[Materials and Methods]**

The hydroponically cultivated *B. napus* seedlings were grown in a greenhouse (National Institute of Agricultural Science, Wanju, Republic of Korea) with natural sunlight, day/night temperatures of 30°C/25°C, and also day/night relative humidity of 60%/80%. Four-leaf seedlings were then grown in hydroponics treated with 10 μM of Cd ($CdCl_2$) and were simultaneously sprayed with GSH (50 and 100 mg $kg^{-1}$) and 2 ml $L^{-1}$ of commercial surfactant (10% polyoxyethylene alkyl aryl ether and 20% sodium lignosulfonate). Ten days after treatment, fresh samples of roots and leaves were frozen in liquid nitrogen and stored at -80°C until further analyses of the reactive oxygen species (ROS), redox, and hormone levels.

**[Results and Discussion]**

Cd stress alone significantly inhibited growth and increased the levels of ROS and the bioaccumulation of Cd in the seedlings compared with those in unstressed controls. Furthermore, Cd stress induced an imbalance in plant stress hormone levels and decreases in endogenous GSH levels and GSH redox ratios, which were correlated with reductions in ascorbate (AsA) and/or nicotinamide adenine dinucleotide phosphate (NADPH) redox states. However, the exogenous application of GSH to Cd-stressed *B. napus* seedlings reduced Cd-induced ROS levels and enhanced antioxidant-scavenging defenses and redox regulation by both increasing AsA, GSH, and NADPH concentrations and rebalancing stress hormones, thereby enhancing Cd uptake and accumulation. These results demonstrate that GSH improved plant redox status by upregulating the AsA-GSH-NADPH cycle and reestablishing normal hormonal balance. This indicates that exogenously applied GSH can mitigate Cd phytotoxicity in *B. napus* and possibly other plants. Therefore, antioxidant GSH can potentially be applied to Cd-polluted soil for plant remediation.

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Division-2-05

# The Growth and Quantity of Potatoes by Fertilizer in the High-altitude Areas

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**[Introduction]**

In high latitudes, the free period for growing crops is very short, on average, about 130 days, so it is preferred to cultivate a variety of potatoes with a high number of premature ripening. For spring cultivation, potatoes are used for the crops in front of two crops, and early ripening varieties are cultivated because the cultivation period is short. The recently fostered potato varieties are mainly selected from soil with high nutrient content, and it is necessary to review the adaptability of cultivation in barren soil. This study was conducted to investigate the growth and quantity of potatoes according to the fertilizer amount in high-altitude barren land.

**[Materials and Methods]**

This experiment was sown on May 12, 2022 at the test bed of the Highland Agricultural Research Institute in Daegwallyeong, Pyeongchang, and harvested on August 12, 2022. Potato varieties were cultivated in Sumi, Seohong, Jopung, and Dami. The test tool was treated with no fertilizer, 0.5 times, 1 times, 1.5 times, and 2 times the test fertilizer, and compost was treated with 2,000kg/10a. The catabolic properties of test-tube soil (ph, EC, OM, $AvP^2O^5$, etc.) was analyzed. During the growth period, the average temperature, solar radiation, and sunlight time were investigated, and the growth and water quality of each fertilizer specific amount were tested.

**[Results and Discussion]**

Until the cultivation period (May-August), the average temperature is 17.9°C, the precipitation is 658.6mm, the sunlight time is 718.4 hours, and the solar radiation amount is 1982.9 (MJ/㎡). The results of the catabolic characteristics of the test soil show that pH 7.7, EC 0.3dS/m, OM 11g/kg, $AvP^2O^5$ 97 mg/kg, Ca 15.3cmol (+)/kg, Mg 2.7cmol (+)/kg K 0.2cmol (+)/kg. It is estimated that PH and EC are high due to the high salt content due to the mass spraying of calcium chloride in winter. The flowering season is June 20 for morning winds, July 1 for Sumi, July 5 for Seohong, and July 9 for Dami. The quantity of potatoes per 10a is 6 tons without treatment, 32.5 tons for 0.5 times treatment, 38 tons for 1 times treatment, 37.1 tons for 1.5 times treatment, and 35.6 tons for 2 times the amount of fertilizer. When fertilizer was treated twice, it was 6 times higher than when it was untreated. The quantity of potato products is 0.9 tons without processing, 23.3 tons for 0.5 times processing, 30.9 tons for 1 times processing, 31.4 tons for 1.5 times processing, and 30.6 tons for 2 times processing, which is 30 times higher. According to the test results, potatoes are multi-crops, and there is a large difference in quantity depending on the amount of fertilizer. When growing potatoes, if the amount of fertilizer exceeds the standard ratio, the amount of growth on the ground increases, but the amount of potatoes increases to a certain level.

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Division-3-01

# Breeding and Production Research Direction for Soybean Self-Sufficiency Improvement in Korea

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**[Abstract]**

Recently, soybean production and market price are unstable, even if demand of soybean is maintained. Diverse conditions such as climate change, a decrease in rural population, and consuming affect food industry. In this situation, food security is soaring as important key-word again, and MAFRA is promoting policies for improving soybean self-sufficiency with the goal of 40% until 2030. The point of policy is to extend a production and stabilize a demand for soybean with supporting large-scale soybean paddy-field complex. According to the background, soybean breeding and production research in NICS are proceeded with three parts. First, production improvement with soybean cultivation land enlargement and high-yield cultivar development. Various growth period soybean cultivars for double cropping, irrigation management technologies in paddy field, and hyper-yield and specific-region adaptable cultivar development. Second, reduction of production expense with mechanized cultivation and digital-based field management technologies. Third, consumer-friendly and high quality soybeans with high protein cultivar for alternative protein usage and high food process-ability for soy milk, tofu, soybean sprouts, and grain usage. Each part need to be combined and advanced to improve soybean industry and soybean self-sufficiency.

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Division-3-02

# Identification of a Potential Gene for Elevating ω-3 Concentration and its Efficiency for Improving ω-6/ω-3 Ratio in Soybean

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**[Abstract]**
This present study was to identify a novel candidate gene that contribute to the elevated α-linolenic acid (ALA, ω-3) concentration in PE2166 from mutagenesis of Pungsannamul. Major loci *qALA5_1* and *qALA5_2* were detected on chromosome 5 of soybean through quantitative trait loci mapping analyses of recombinant inbred lines. With next generation sequencing of parental lines and Pungsannamul, and recombinant analyses, a potential gene, *Glyma.05g221500* (*HD*) controlling elevated ALA concentration was identified. *HD* is a homeodomain-like transcriptional regulator that may regulate the expression level of microsomal ω-3 fatty acid desaturase (*FAD3*) genes responsible for the conversion of linoleic acid into ALA in the fatty acid biosynthetic pathway. In addition, we hypothesized that combination of mutant alleles, *HD* and either of microsomal delta-12 fatty acid desaturase 2-1 (*FAD2-1*), could reduce the ω-6/ω-3 ratio. In populations where *HD*, and *FAD2-1A* and *FAD2-1B* genes were segregated, combination of a *hd* allele from PE2166 and either of the variant *FAD2-1* alleles were sufficient to reduce the ω-6/ω-3 ratio in seeds.

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Division-3-03

# QTL Identification for Slow Wilting and High Moisture Contents in Soybean (*Glycine max* [L.]) and Arduino-Based High-Throughput Phenotyping for Drought Tolerance

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**[Abstract]**
Drought becomes frequent and severe because of continuous global warming, leading to a significant loss of crop yield. In soybean (*Glycine max* [L.]), most of quantitative trait loci (QTLs) analyses for drought tolerance have conducted by investigating yield changes under water-restricted conditions at the reproductive stages. More recently, the necessity of QTL studies to use physiological indices responding to drought at the early growth stages besides the reproductive ones has arisen due to the unpredictable and prevalent occurrence of drought throughout the soybean growing season. In this study, we thus identified QTLs conferring wilting scores and moisture contents of soybean subjected to drought stress in the early vegetative stage using an recombinant inbred line (RIL) population derived from a cross between Taekwang (drought-sensitive) and SS2-2 (drought-tolerant). For the two traits, the same major QTL was located on chromosome 10, accounting for up to 11.5 % of phenotypic variance explained with LOD score of 12.5. This QTL overlaps with a reported QTL for the limited transpiration trait in soybean and harbors an ortholog of the Arabidopsis ABA and drought-induced *RING-DUF1117* gene. Meanwhile, one of important features of plant drought tolerance is their ability to limit transpiration rates under high vapor pressure deficiency in response to mitigate water loss. However, monitoring their transpiration rates is time-consuming and laborious. Therefore, only a few population-level studies regarding transpiration rates under the drought condition have been reported so far. Via employing an Arduino-based platform, for the reasons addressed, we are measuring and recording total pot weights of soybean plants every hour from the 1$^{st}$ day after water restriction to the days when the half of the RILs exhibited permanent tissue damage in at least one trifoliate. Gradual decrease in moisture of soil in pots as time passes refers increase in the severity of drought stress. By tracking changes in the total pot weights of soybean plants, we will infer transpiration rates of the mapping parents and their RILs according to different levels of VPD and drought stress. The profile of transpiration rates from different levels of severity in the stresses facilitates a better understanding of relationship between transpiration-related features, such as limited maximum transpiration rates, to water saving performances, as well as those to other drought-responsive phenotypes. Our findings will provide primary insights on drought tolerance mechanisms in soybean and useful resources for improvement of soybean varieties tolerant to drought stress.

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Division-3-04

# Genome Wide Association Study for Agronomic Traits in Wild Soybean (*Glycine soja*)

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**[Introduction]**

Soybeans (*Glycine max*) are one of the most important crops in the world because they are not only high in protein and oil content, but also contain all of the essential amino acids. Wild soybean (*Glycine soja*) is the wild ancestor of cultivated soybean and preserve valuable gene pool for improving agronomic traits in soybean. Advances in high-throughput genotyping techniques have facilitated approach to SNP genotyping. Genome wide association study (GWAS) is being used as a powerful tool to discover and validate QTLs and candidate genes associated with variety of agricultural traits.

**[Materials and Methods]**

The 203 wild soybean accessions were planted in the experimental field of Chonnam National University, 2015 and 2016. The agronomic traits including days to flowering (DtF), days to maturity (DtM), number of pods (NoP) and one-hundred seed weight (100SW) were investigated. Also, the protein, oil and amino acid contents were analyzed using Kjeldahl, Soxhlet method and amino acid auto-analyzer (S433-H, SYKAM), respectively. All accessions were genotyped using 180K Axiom® Soya SNP array. GWAS was performed with linear mixed model using restricted maximum likelihood algorithm in QTLmaxV2.

**[Results and Discussion]**

The 203 wild soybean accessions were divided into 4 clusters by ADMIXTURE, principal component analysis and neighbor-joined cluster. GWAS identified 18 SNPs linked to DtF, 32 SNPs to DtM, and 41 SNPs to 100SW. Through the detected SNP marker few genes governing specific traits were selected as candidate genes. Among them, Glyma.06g119400 and Glyma.11g251500 were related to DtF, Glyma.12g210900 was commonly related to DtF and DtM, and Glyma.14g205200 was related to 100SW. In addition, we identified two genes, Glyma.11g015500 and Glyma.20g050300, responsible for protein and oil content respectively. In amino acids, we identified that Glyma.01g053200 and Glyma.03g241600 genes were related to 9 amino acids (Ala, Asp, Glu, Gly, Leu, Lys, Pro, Ser, Thr). The identification of SNP markers associated with agronomic traits are expected to be helpful for the development of molecular markers that can be used for soybean breeding.

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Division-3-05

# Selective Allele Stacking of a Novel Quantitative Trait Locus Facilitates the Enhancement of Seed Epicatechin Contents in Soybean (*Glycine max* (L.) Merr.)

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**[Abstract]**
(-)-Epicatechin (EC), a primary form of flavan-3ol and a building block of proanthocyanidins, has health benefits as it is a potent antioxidant. So far, no quantitative trait loci (QTLs) associated with EC have yet been identified in soybean. In this study, QTLs for EC and hilum color were identified in recombinant inbred lines (RILs) derived from the varieties Jinpung and IT109098 using high-resolution single nucleotide polymorphism linkage mapping. This revealed two major QTLs for EC content, *qEC06* and *qEC08*. *qEC06* spanned the *T* Locus encoding flavonoid 3′-hydroxylase. *qEC08*, located near the *I* locus on Chr08, was also a major QTL for hilum color; however, allelic stacking of *qEC08* and *I* revealed no relationship between *I* and EC content. RILs with IT109098 alleles at both *qEC06* and *qEC08* had higher EC content than other lines. These results will enable the production of soybean varieties with high EC content *via* marker-assisted selection.

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Division-4-01

# Status of Philippine Mango Genomics: Enriching Molecular Genomics Towards a Globally Competitive Philippine Mango Industry

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**[Abstract]**
This paper presents the first genome assemblies of Philippine mangoes that provide valuable reference for varietal improvement and genomic studies on mango and related fruit crops. WE sequenced whole genomes of 3 species, *Mangifera odorata* (Huani), *Mangifera altissima* (Paho), and Mangifera indica 'Carabao' (Sweet Elena). 'Carabao' is the major export variety of the Philippines; Paho is identified as vulnerable by the IUCN Red List of Threatened Species; Huani has fruit sap acrid which is the primary defense mechanism against insects and birds. We used Falcon, a diploid aware – *de novo* assembler to assemble SMRT generated long-read sequences. Falcon-unzip was employed to phase the output assembly producing larger contig sets (primary contigs) and shorter contigs corresponding to haplotypes (haplotigs). Assembly statistics were generated by comparing the assembly to a reference genome, Tommy Atkins, using Quality Assessment Tool (QUAST). Moreover, the extent of duplication and completeness of gene content was measured using Benchmarking Universal Single-Copy Orthologs (BUSCO). Draft assemblies with high duplications were processed using Purge Haplotigs and Purge Dups to lessen duplications with minimal impact on genome completeness. *De novo* assemblies of Huani, Paho and 'Carabao' were then generated with primary contig sizes of 463.64 Mb, 508.95 Mb and 401.51 Mb respectively. These draft assemblies of Huani, Paho and 'Carabao' showed 96.90%, 95.17% and 99.07% complete BUSCOs respectively which is comparable to 'Tommy Atkins' genome (98.6%). Using two mango transcriptome data (pooled RNA-seq from different mango varieties and tissues), 91-96% or 24-30 million reads were successfully mapped back for each generated assembly indicating high degree of completeness. The results obtained demonstrated the highly contiguous, phased, and near complete genome assembly of three Philippine mango species for structural and functional annotation of gene units, especially those with economic importance.

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Division-4-02

# Sophora Genomes Provide Insight into the Evolution of Alkaloid Metabolites Along with Small-scale Gene Duplication

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**[Introduction]**

The genus Sophora (Fabaceae) is one of the most famous medicinal plants traditionally used in East Asian countries for a long time. Krishna et al. have found that sophora plants can be used for sedative, depressant, analgesic, hypothermic, antitumor, antipyretic, and cardiotonic activities. The genus Sophora includes approximately 70 species, distributed widely in tropical and temperate regions. Among them, *S. flavescens* is a perennial herb, native to China, India, Japan, Korea, and Russia, and its dried roots show anti-oxidant, anti-inflammatory, anti-bacterial, apoptosis modulation, and anti-tumor activities. The sister species of *S. flavescens*, *Echinosophora koreensis*, a deciduous shrub, is endemic to Korea, and its ethnopharmacological effectiveness has not been well known, possibly due to its rarity and protection by the law in South Korea. The *E. koreensis* genome, which is phylogenetically related to *S. flavescens* but is more than 50% smaller, can help with the assembly and validation of *S. flavescens*'s much larger genome. Also, the phylogenetic closeness between *S. flavescens* and *E. koreensis* enables genome comparison, which would show recent evolutional divergence with respect to their polymorphic phenotypes.

**[Materials and Methods]**

NextDenovo and Falcon are utilized in the process of assembling PacBio long reads into contigs. Using quickMerge, the assembled contigs were combined into a single assemble set. The short reads that were generated by Illumina were utilized to correct the assemblies by nextPolish. Additionally, PurgeHaplotig was used to remove redundant assemblies that may be allelic variants.

**[Results and Discussion]**

Here, we used the PacBio sequencing platform to sequence and assemble the *E. koreensis* and *S. flavescens* genomes. The *E. koreensis* genome assembly confirmed the expected size of the genome and predicted almost all of the possible genes. The genome and gene catalog were profiled based on various bioinformatics pipelines. The expected genome size was also obtained from the assembly of the *S. flavescens* genome and a gene catalog was prepared. Based on the genome and gene content of the sister species, the evolution of gene families was observed, and especially transporter gene families showed distinct evolution among legume species. Moreover, based on Kegg analysis, we found pathways that may control pharmaceutical metabolites in *S. flavescens* and *E. koreensis*. The Sophora species' genome assembly would further be used for comparative genomics and knowledge mining for drug development.

**[Acknowledgement]**

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Division-4-03

# The Philippines Coconut Genomics Initiatives: Updates and Opportunities for Capacity Building and Genomics Research Collaboration

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**[Abstract]**
Philippines is the second world supplier of coconut by-products. As its first major genomics project, the Philippine Genome Center program for Agriculture (PGC-Agriculture) took the challenge to sequence and assemble the whole coconut genome. The project aims to provide advance genetics tools for our collaborating coconut researchers while taking the opportunity to initiate local capacity. Combination of different NGS platforms was explored and the Philippine 'Catigan Green Dwarf' (CATD) variety was selected with the breeders to be the crop's reference genome. A high quality genome assembly of CATD was generated and used to characterize important genes of coconut towards the development of resilient and outstanding varieties especially for added high-value traits.
The talk will present the significant results of the project as published in various papers including the first report of whole genome sequence of a dwarf coconut variety. Updates will include the challenges hurdled and specific applications such as gene mining for host insect resistance and screening for least damaged coconuts (thus potentially insect resistant varieties). Genome-wide DNA markers as published and genes related to coconut oil qualitative/quantitative traits will also be presented, including initial molecular/biochemical studies that support nutritional and medicinal claims. A web-based genome database is currently built for ease access and wider utility of these genomics tools. Indeed, a major milestone accomplished by the coconut genomics research team, which was facilitated with the all-out government support and strong collaboration among multidisciplinary experts and partnership with advance research institutes.

**[Acknowledgement]**
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Division-4-04

# Leveraging Rice Genetic Diversity: Connecting the Genebank to Mainstream Breeding

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**[Abstract]**

Rice contains a wealth of genetic diversity, both within *Oryza sativa* and in related A-genome species. Decades of genetic research into this diversity have identified dozens of major genes contributing to a wide variety of important traits, including disease resistance, abiotic stress tolerance (drought, salinity, submergence, heat, cold etc.), grain quality, flowering date and maturity and plant architecture. Yet despite these opportunities, very few of the major genes and QTLs known have been successfully applied through rice breeding programs to produce sustained changes in farmer's fields. This presentation will briefly examine some of the factors limiting application of major genes in the mainstream breeding programs, and steps that have been taken to alleviate those limitations. As a result of these interventions, dozens of major genes that were previously unavailable to breeders are now being used confidently in the variety development process. Case studies will be discussed of genes critical for blast resistance worldwide, rice yellow mottle virus for Africa, and new validated QTLs for salinity tolerance.

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Division-4-05

# Whole Genome Sequencing of Two *Musa* Species Towards Disease Resistance and Fiber Quality Improvement

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**[Abstract]**
Abaca (*Musa textilis* L. Nee) is a native Musa species from the Philippines known for its natural fiber. Abaca fiber a.k.a. Manila hemp extracted from its pseudostems is considered one of the strongest fibers in the world. This is used for commodities such as ropes, papers, and money bills. Abaca is vulnerable to pests and diseases such as the Abaca Bunchy Top Disease (ABTD) caused by Abaca Bunchy Top Virus (ABTV) and Banana Bunchy Top Virus (BBTV). Inosa, one of the varieties of abaca utilized in the Philippines, is highly susceptible to ABTD. In contrast, Pacol (*Musa balbisiana* L.), a close relative of abaca, is highly resistant to the same disease. Here, we report the sequencing and *de novo* genome assembly of both abaca var. Inosa and banana var. Pacol. A total of ~16 Gb and ~21 Gb raw reads for Inosa and Pacol, respectively, were generated using Pacbio Hifi sequencing method and assembled with Hifiasm. High-quality *de novo* assemblies of both *Musa* species with 99% recovered as per BUSCO analysis were obtained. The assembled Inosa genome has a total length of ~654 Mb and N50 of 7 Mb while Pacol has a total length of 527 Mb and N50 of 3 Mb which are close to their estimated genome size of ~638 Mb and ~503 Mb, respectively. The information that can be derived from the *de novo* assembled genomes would provide a solid foundation for further research in disease resistance and fiber quality improvement in abaca.

**[Acknowledgement]**
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**Division-4-06**

## Genetic Insights into Domestication Loci Associated with Awn Development in Rice

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**[Abstract]**
Rice (*Oryza sativa* L.) is a widely studied domesticated model plant. Seed awning is an unfavorable trait during rice harvesting and processing. Hence, awn was one of the target characters selected during domestication. However, the genetic mechanisms underlying awn development in rice are not well understood. In this study, we analyzed the genes for awn development using a mapping population derived from a cross between the Korean *indica* cultivar 'Milyang23' and NIL4/9 (derived from a cross between 'Hwaseong' and *O. minuta*). Two quantitative trait loci (QTLs), *qAwn4* and *qAwn9* were mapped on chromosome 4 and 9, respectively, increased awn length in an additive manner. Through comparative sequencing analyses parental lines, *LABA1* was determined as the causal gene underlying *qAwn4. qAwn9* was mapped to a 199-kb physical region between markers RM24663 and RM24679. Within this interval, 27 annotated genes were identified, and five genes, including a basic leucine zipper transcription factor 76 (*OsbZIP76*), were considered candidate genes for *qAwn9* based on their functional annotations and sequence variations. Haplotype analysis using the candidate genes revealed tropical *japonica* specific sequence variants in the *qAwn9* region, which partly explains the non-detection of *qAwn9* in previous studies that used progenies from interspecific crosses. This provides further evidence that *OsbZIP76* is possibly a causal gene for *qAwn9*. The *O. minuta qAwn9* allele was identified as a major QTL associated with awn development in rice, providing an important molecular target for basic genetic research and domestication studies. Our results lay the foundation for further cloning of the awn gene underlying *qAwn9*.

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Division-4-07

# Development of Bioinformatics Capacity in Support of the KOICA-UPLB-IRRI Agricultural Genomics Research Center

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**[Abstract]**
Capacity building for bioinformatics could be achieved with the systematic training of research staff and higher degree students in the current best practices for analysis of data from 'omic-type experiments. It is anticipated that the KOICA-University of the Philippines Los Baños – International Rice Research Insitute Agricultural Genomics Research Center activities will focus on the use of next generation sequencing technology for genome sequencing and annotation, genome variant discovery for use in GWAS and QTL mapping, and transcriptome analysis of organisms important to agriculture and food security. Such activities require that researchers have high levels of knowledge and skills in bioinformatics in order to gain insights from the results of the experiments performed. In this talk the bioinformatic tools/solutions and online training materials already available will be presented, as well the upcoming resources under development in support of the project.

**[Acknowledgement]**
The bioinformatics tools, portal development and support for training is supported through the KOICA project.

**[Short Biographical Sketch]**
Dr Ramil Mauleon is a Senior Scientist for bioinformatics at the International Rice Research Institute. He is a geneticist by training, with minors in Computer Science and Molecular Biology & Biotechnology from the University of the Philippines Los Baños (UPLB). His research interests include adoption, creation, and implementation of integrative analyses methods for genomics, transcriptomics, proteomics, metabolomics, and digital phenotyping in agricultural crops, leading to candidate gene discovery and marker development for breeding applications. On the biocomputing/IT side, he is involved in projects such as the development and adoption of re-usable analysis software workflows for large datasets with high computational resource demand, and exploration and implementation of FAIR (Findable, Accessible, interoperable, Reusable) -compliant technologies for biological databases and web applications (such as Rice SNP-Seek and Crop Galaxy). He is adjunct faculty at the UPLB and Southern Cross University in Australia.

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# Poster Session

PA-1

# Effect of Tillering on Heading Response of Rice by Temperature and Day-length Conditions

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**[Introduction]**

In rice, tillering is known to have a large coefficient of variation, depending on the environment as well as genetic factors. The day-length for increased tillering is opposite to the condition in which the flowering is accelerated and the vegetative growth period is shortened. Because tillering mainly occurs during the vegetative growth period, it is strongly influenced by developmental processes such as floral induction. florigen-activation-complex has been reported to affect growth such as tillering in addition to floral-induction, many related studies have been conducted However, the mechanism and functions of this interaction have not yet been fully elucidated and report contradictory results.

**[Methods and Materials]**

In this study, we subjected rice plants (‘Saenuri’ and ‘Odae’) with tillers removed to short and long day-length regimes and observed the growth and flowering responses. Light intensity, temperature, and humidity can be artificially controlled. The light turned on at 7:30 AM regardless of day-length treatment, thus day-length was adjusted by the off time. The day-length conditions after removing the tiller were matched between short (12 hour light/12 hour dark) and long (14 hour 30 minute light/9 hour 30 minute dark) day-length conditions, and the temperature was set to 28 °C (maximum 33 °C/minimum 23 °C).

**[Results and Discussion]**

In the long day-length condition, plant height tended to increase in the tiller removed treatment group compared to that in the control in both cultivars. However, in the short day length condition, which was considered to promote flowering, plant height decreased in the tiller removed treatment group. The number of growing days from sowing to heading in the short day-lengths decreased in the tiller removed treatment group compared to that in the control group. Conversely, for long day-length, the number of growing days from sowing to heading was longer in the tiller removed treatment group than that in the control group. In short day-length condition, the expression levels of the florigen genes (Hd3a, RFT1) increased with treatment time. The expression levels of both the florigens in the main stem, from which the tiller was removed, increased compared to those in the control, under short day-length condition.

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PA-2

# 발아조건 및 휴면타파 처리에 따른 수단그라스(*Sorghum sudanense(Piper.) Stapf*) 품종별 발아검정

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**[Abstract]**
녹비작물은 천연비료로서 화학비료 사용량을 감소시키고 이산화탄소를 흡수해 농업분야에서 온실가스 저감을 위해 사용하고 있다. 녹비작물을 이용하여 지속가능한 친환경 농업의 필요성이 증대되고 있는 실정이다. 화본과 녹비작물은 두과 녹비작물에 비해 탄소 물질의 함량과 biomass가 상대적으로 높아 토양 내 유기물 증진을 위한 재배에 적합하다. 이에 화본과 녹비작물 중 하나인 수단그라스의 발아 및 휴면특성 검정을 진행하여 발아 적정조건을 찾아 유기종자 생산기술 개발을 위한 자료로 활용하고자 한다.
본 연구에서는 수단그라스 4품종(GW104G, Cadan99B, TE-Evergreen, Sweet home)을 공시품종으로 사용하였다. 표준발아검사에 따라 각 품종별 종자를 100립씩 3반복 치상하여 10일간 발아검정 진행 후 발아율, 발아세, 평균발아일수, 발아속도를 조사하였다. 첫 번째 실험은 침종시간 및 치상온도별 실험으로 시간별(무처리/5/10/15/20/25hr)로 침종한 후, 생장상(10/20/30/40°C)에 보관하여 정상아 개수를 파악하였다. 두 번째 실험은 휴면타파 실험으로 1~5일 동안 종자를 예냉(무처리/5/10/15°C)과 고온(50°C) 처리한 후, 첫 번째 실험 결과에 따라 발아 최적 조건(침종 20hr, 치상온도 20°C)에서 발아시킨 후 정상아 개수를 파악하였다.
수단그라스 4품종의 치상온도별 발아율은 20°C에서 평균 92±6.9%로 가장 높았으며, TE-evergreen의 경우 치상온도 10°C에서 10시간, 20°C에서 20시간, 30와 40°C에서 15시간 침종한 값이 유의적으로 높은 발아율을 보였다. 수단그라스 4품종의 평균발아일수(MGT)는 침종 20시간과 치상온도 30°C일 때 평균 1.21±1.14일로 가장 빨랐으며 발아속도(GR)는 침종 20시간과 치상온도 20°C의 조건일 때 89.9±5.92로 가장 빨랐다. 수단그라스 4품종의 휴면타파 온도별 발아율은 10°C에서 평균 92±9.3%로 가장 높았다. TE-evergreen의 경우 휴면타파 온도 5, 10, 15°C에서 4~5일 동안 처리한 값이 무처리와 50°C처리에 비해 유의적으로 높은 발아율을 보였다.
수단그라스 발아검사 결과, 20시간 침종 후 20~40°C에서 2~3일간 발아시킬 경우 90%이상의 발아율을 보이므로 파종을 위한 종자 전처리를 할 경우 이와 같은 조건에서 진행하는 것이 바람직 할 것으로 사료된다.

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PA-3

# Processing and Shipping Status of Buckwheat Company in the Jeju Region of Korean Peninsula

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**[Introduction]**
Buckwheat cultivation area in Jeju region is the largest in Korea. In 2020, the buckwheat cultivation area was 728ha. So buckwheat has been treated as a specialized crop in Jeju. There is not basic information about processing and sales of buckwheat manufacturers so, this study was carried out to obtain basic datas for policies for industrialization through a survey including questions for Jeju region buckwheat specialization.

**[Materials and Methods]**
Interview using survey were performed for 10 companies related with buckwheat in Jeju region. The survey included the present situation and processing status such as facility size, number of employees, and equipment owned. In the addition, the distribution status and profitability of buckwheat companies in Jeju region were investigated.

**[Results and Discussion]**
There were total 10 companies related to buckwheat in Jeju region, with 7 farming association corporations, 1 agricultural company corporation, and 1 village community. The average facility size was 488 ㎡. On average, there were 4 employees and the companies generally had 5 equipments with production equipment such as tractor and combine and, processing equipment. All of them were growing buckwheat and 70% of companies were processing the buckwheat. They have commonly made 3 or 4 production.. The average annual trading volume of raw cereals was 150 tons and the trading period was in both spring and autumn. The companies sold the buckwheat through direct sales of consumer sites. To promote the sale of processed products, they mainly used both online and offline store. The average profitability per buckwheat company was 659 million won in sales and operating profit was 63 million won.

**[Acknowledgement]**
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PA-4

# Buckwheat Cultivation and Shipping Status of Farmers in the Jeju Region of Korean Peninsula

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**[Introduction]**
There is not basic information about cultivation technic and shipping status of buckwheat in Jeju region. Therefore, this study was carried out to acquire basic information to develope the cultivation technic of buckwheat in Jeju region.

**[Materials and Methods]**
Interview using survey were performed for 30 buckwheat farms in Jeju region. The survey examined cultivation season, Number of days of growth and methods to sow and harvest time.

**[Results and Discussion]**
The average cultivation area per farm was 15.1 ha. And the most cultivation season of buckwheat was in both spring and autumn. Sowing was mainly done as broadcast seeding(70%) and the other method was strip-seeding(30%). The number of growing days from buckwheat sowing to harvesting in autumn season were about six days earlier than in summer season. when famers havested buckwheat, all of them used combine. Harvested buckwheat was shipped out from farming corporations where grew buckwheat.

**[Acknowledgement]**
This study was supported by a grant from Agenda Program (Project No: PJ016174), Rural Development Administration. Korea.

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PA-5

# Effects of Different Levels of Nitrogen and Planting Density on Growth of Rice

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**[Introduction]**

Although rice transplantation occupies most of Korea, it is the cultivation method that requires a lot of labor for nursing the seedlings and transplanting. Recently, 'Low-density transplanting cultivation(LDT)' had been expanding due to the decrease in the labor force in rural areas, as this can reduce the burden of transplanting. LDT is a technique to increase the seeding amount per a seedling tray and reduce the planting density in order to transplant with the minimum number of seedling trays in the same area. Studies of LDT has been conducted in Korea, resulting in the development of suitable seedling methods and planting density. It is recommended that the planting density is 50 to 60 hills per 3.3㎡ with small decrease in yield. But, a fertilization method suitable for this new technology has not been studied. Therefore, the purpose of this study is to analyze the growth under the different levels of nitrogen and planting density in order to set the appropriate nitrogen fertilizer level.

**[Materials and Methods]**

This study was conducted at the National Institute of Crop Science(NICS) in 2022. As for the variety, Sindongjin with many tillers and Hopyeong with few tillers were selected. During nursery, controls were sown with 130 g per tray and nursed for 30 days, and in LDT, 300 to 350 g per tray were sown and nursed for 15 days. The planting density was set to 80 hills per 3.3㎡ (30×14cm) for the control group and 50 hills(30×22cm) for LDT. Seedlings were transplanted into large stainless steel pots with a size of 110×70cm and treated with different nitrogen fertilization levels of 5, 9(standard), 13, 15kg per 10a in each pot. The nitrogen split rate of 50-20-30% was applied and the other management was followed the standard cultivation method in rice.

**[Results and Discussion]**

The research of growth was conducted at 3 day after heading. Culm length increased as nitrogen level increased. Compared to the standard N level(9kg/10a), they were 2 to 3% longer in 13kg, 15kg and 5% shorter in 5kg. As for panicle length, there was no change under different N levels, and panicle of Sindongjin was 2.1cm longer on average than that of the Hopyeong. The factor with the biggest change under N fertilization was the number of panicles. The number of panicle per hill increased by an average of 22% in 13kg and 34% in 15kg compared to the standard(9kg). The ratio of the number of panicle per ㎡ of 50 hills(LDT) compared to 80 hills(control) was 82% in standard N level(9kg). but, it increased by 92% in 13kg, and then decreased by 86% in 15kg. This tendency was greater in Hopyeong than Sindongjin. Hopyeong was secured 81% in standard N level(9kg), but in 13kg and 15kg, 94% and 90% secured, and the fertilization effects of Hopyeong was analyzed to be greater. On the other hand, in order to analyze the appropriate N fertilizeration in LDT, the control group(standard fertilization(9kg) + conventional planting density(80 hills)) and LDT group(50 hills) by N levels were compared. In both varieties, the number of panicles as many as the control group was secured in 13kg. Therefore, if 13kg of N ferilizer is applied at LDT, panicle number is secured and the yield is expected to increase. However, the final optimal N fertilizer level should be determined through yield and quality analysis later.

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PA-6

# Double Cropping System Using Summer Eco-Type Buckwheat and Soybean for Soy-Sprout in the Jeju Region of Korean Peninsula

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**[Introduction]**

The buckwheat cultivation area in Jeju region is 728 ha (2020), accounting for 45.5% of Korea. The buckwheat called a pseudo-cereal is a short-season crop. Recently, there has been a problem of decreasing yield and income due to weather disasters during autumn buckwheat cultivation. With the introduction of summer eco-type buckwheat varieties that can be cultivated in spring, research on crop and income improvement to replace buckwheat autumn cultivation was required. Thus, This study was carried out to suggest the effect of stabilizing production and increasing income-according to spring cultivation of buckwheat and a double cropping system using soybeans.

**[Materials and Methods]**

A field experiment was conducted in buckwheat field, located in Jeju region Andeok-meon, Seogwipo-si, Jeju, during the 2021 cultivated season. Buckwheat seeds of the cultivar "Yangjeol" was scattered to be sown (6kg/10a) on April 22. After buckwheat harvest(June 22), 'Aram' soybean were sown in the same field with 5kg/10a on July 8, and harvested on October 24. As a control, autumn buckwheat was harvested on November 2 by rowing 6kg/10a on September 3. Cultivation management was in accordance with the Rural Development Administration standard cultivation method. The buckwheat-soybean crop system and the growth characteristics, yield, and income of autumn buckwheat were compared and analyzed.

**[Results and Discussion]**

The yield of buckwheat sown in spring was 176.2kg/10a, and the yield of buckwheat sown in autumn was 139.3kg/10a, which was 27% higher when sown in spring. And, the soybean crop was 214.kg/10a. As a result of income analysis by crop unit price (buckwheat 4,225 won/kg, soybean 6,815 won/kg), it was 1,363,000 won/10a in the case of double-cropping of buckwheat, and 2,234 thousand won/10a in the case of buckwheat-soybean crop. Therefore, it was investigated that the crude income increased by 63% if the cultivation of buckwheat was changed to spring sowing buckwheat and-soybean. However, the slack period between the harvest of spring buckwheat and sowing of kidney soybeans was judged to be less than 2 weeks, and it is thought that early varieties of both buckwheat and soybean will be selected to secure slack and sufficient number of growing days.

**[Acknowledgement]**

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PA-7

# Comparison of Yield Potential According to Planting Density for Use of Small Potatoes in Greenhouse Cultivation

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**[Abstract]**

This study was carried out to investigate planting density suitable for technology that can produce a lot of small seed potatoes to machine sowing. the test material was made of less than 3 g of seed potatoes, and planting density was 75×10, 75×15, 75×20cm. the results of the test study were as follows. number of potatoes per 10a and number of potatoes under 50 g were the most 75×10cm in 2sowing methods. In view of these results, planting density suitable for technology that can produce a lot of small seed potatoes to machine sowing is judged 75×10cm in 2sowing methods. In order for this study to be applied in the agricultural field, cultivation management such as adequate water supply will be required.

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PA-8

# Growth Characteristics of Tongil-Type Cultivars under Wet Direct Seeded Rice in Yeongnam Plain

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**[Introduction]**

Rice consumption continues to decrease, but the processed rice market continues to increase. Therefore, cultivation practice for reducing production cost of high yield rice is required to secure price competitiveness of raw material grains. Direct seeded rice cultivation is about 2~3% of the total rice cultivation area, but wet-hill seeding, direct seeding practice using drone are gradually increasing. The Tongil type rice has a different growth suitable temperature from japonica rice, and the setting of the growth period is different for transplanted rice and direct seeding, but the adaptability test of direct-seeded cultivation practice of Tongil type rice is very insufficient. Therefore, this test was conducted to review the growth characteristics of high yielding Tongil-type rice cultivars under wet direct seeded condition for establishing direct-seeding cultivation practices.

**[Material and Methods]**

This test was conducted in the paddy field of the Southern Area Crop Department in Miryang, Gyeongnam in 2022. 3 Tongil type rice cultivars, Saemimyoen, Hanareum 4, Mirchal were wet direct seeded in April 26$^{th}$, May 2$^{th}$, 9$^{th}$ and 16$^{th}$. Seeding amounts was 5kg/10a, and amount of fertilization was 18, 9, and 11kg per 10a of nitrogen-phosphate-potassium, respectively. The no. of seedling, emergence rate, heading stage, lodging index were investigated in accordance with Agricultural Science and Technology Survey Standards of the Rural Development Administration.

**[Result and Conclusion]**

The emergence rate of all three cultivars showed a tendency to increase because the temperature rose as the seeding time was delayed. Emergence rate on April 25$^{th}$, May 2$^{th}$, 9$^{th}$, 16$^{th}$ was 60, 63.8, 68.3, 73.1%, respectively, it increased by 6%, 14%, and 22%, respectively, compared to seeding on the April 25$^{th}$. The days to emergence was shortened by the seeding time was delayed, the days to emergence on April 25$^{th}$, May 2$^{th}$, 9$^{th}$, 16$^{th}$ was 21, 20, 18, 13, respectively. The number of seedling per ㎡ on April 25$^{th}$, May 2$^{th}$, 9$^{th}$, 16$^{th}$ was 110, 116, 125, 134, respectively, it was higher than the optimum number of 80 to 120/㎡. Heading date was almost the same as for seeding date on April 25$^{th}$ and May 2$^{th}$., but when seeding on May 16$^{th}$, heading date was delayed by 5 to 6days. Field lodging and lodging index were decreased as the seeding date was delayed. This is because the heading time of each cultivar was different for each seeding time, and thus the growth status of rice after heading was greatly affected.

**[Acknowledgement]**

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PA-9

# Early Growth Development and Heading Characteristics of Rice for Extremely Early Rice Cultivation in the Yeongnam Plain

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**[Introduction]**

In the southern region, the temperature is high and the rice cultivation period is long, so various cropping systems linked with rice are being implemented, such as double-cropping of rice and wheat. In particular, early cultivation to produce rice before Chuseok increases in the year when Chuseok comes early. In general, since there are no connected crops after early cultivation, most of them fall into fallow. Therefore, rice should be planted earlier than normal early cultivation for planting crops that can be continuously linked after rice. Therefore, this study was conducted to find out the heading characteristics of rice varieties suitable for the establishment of a double-cropping system in which other crops are grown in late August after cultivating rice.

**[Materials and Methods]**

This study was conducted from 2020 to 2021 in the rice paddies of the Department of Southern Area Crop Science of the National Institute of Crop Science. For the experimental varieties, 14 varieties of early maturing cultivar such as Baekilmi, Jinok and Junamjoseang were grown for 30 days in an unheated greenhouse. Transplantation was carred out on April 7$^{th}$, 14$^{th}$, 21$^{st}$ and 28$^{th}$, and the planting distnace was 30x12cm, and number of planted hills was 5. The amount of fertilization was 9, 4.5 and 5.7 kg per 10a, respectively, as components of nitrogen, phosphate and potassium, and other cultivation management followed standard cultivation method of the Rural Development Administration. The yield and quality of rice were investigated in accordance with Agricultural Science and Technology Survey Standards of the Rural Development Administration.

**[Results and Discussion]**

35 days after transplanting, the dry weight of rice hill was very low in those transplanted on April 7$^{th}$ and 14$^{th}$ compared to these transplanted on April 21$^{st}$ and 28$^{th}$. The daily Crop Growth Rate(CGR) for 35 days after transplanting was 8 times, 4 times, and 2 times higher in the case of transplanting on April 28$^{th}$ compared to the transplanting on April 7$^{th}$, 14$^{th}$ and 21$^{st}$, respectively, and the same trend was observed among dry weight. However, as the growth progressed thereafter, there was little difference in the distinct trends among dry weight according to the transplanting period at the heading stage. The heading stage period of the experimental varieties ranged from June 30 to July 19, and there was a large difference according to the varieties and transplanting period. In general, the earlier transplanting period, the faster heading stage. When trasnplanting on April 7$^{th}$, 14$^{th}$, 21$^{st}$ and 28$^{th}$, the average heading stage date was July 8$^{th}$, 9$^{th}$, 11$^{st}$ and 14$^{th}$, respectively. Compared to the transplant on April 28$^{th}$, when transplanting April 7$^{th}$, 14$^{th}$ and 21$^{st}$, the heading was faster by 6, 5 and 3 days, respecively. However, ther were some varieties whose heading was delayed when the transplanting date was early, which is thought to be due to the delay in growth because of damage from low temperatures in the early growth stage. In order to double-cropping system after harvesting rice, the crops after rice must be sown in the last August, so it is necessary to be able to harvest rice before August 20$^{th}$. In this study, if Beakilmi, Junamjoseang, Jungmo1032 and Jinok are transplanted in mid-late April to avoid low-temperature damage, it is possible to take heading before July 10$^{th}$ and harvest before August 20. Therefore, those varieties will be advantageous for crop connectivity with other crops planted in late August after rice cultivation.

**[Acknowledgement]**

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PA-10

# Characteristics of Rice Yields and Quality under Extremely Early Rice Cultivation in the Yeongnam Plain

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**[Introduction]**

Recently, early cultivation of rice is gradually increasing to produce rice before Korean Thanksgiving Day(Chuseok) in the southern plains of Korea. In addition, when Chuseok comes early, rice is planted earlier than regular early cultivation in order to produce rice before Chuseok. Early or extremely early rice cultivation not only increases income by producing new rice before Chuseok, but also disperses the agricultural labor periods in June when rice transplanting is concentrated and October when harvest is concentrated, and avoids natural disasters such as typhoons that can cause damage in August and September. However, early cultivation is a high risk of deterioration in rice quality or yield because the ripening period of the rice is July to August when the temperature is high. Therefore, it is very important to select the optimum variety for extremely early rice cultivation. Accordingly, this study was conducted to use it as basic data for the development of adaptive rice varieties by investigating the yield and quality characteristics of each variety during the extremely early cultivation.

**[Materials and Methods]**

This study was conducted from 2020 to 2021 in the rice paddies of the Department of Southern Area Crop Science of the National Institute of Crop Science. For the experimental varieties, 14 varieties of early maturing cultivar such as Baekilmi, Jinok and Junamjoseang were grown for 30 days in an unheated greenhouse. Transplantation was carried out on April 7$^{th}$, 14$^{th}$, 21$^{st}$ and 28$^{th}$, and the planting distance was 30x12cm, and number of planted hills was 5. The amount of fertilization was 9, 4.5 and 5.7 kg per 10a, respectively, as components of nitrogen, phosphate and potassium, and other cultivation management followed standard cultivation method of the Rural Development Administration. The yield and quality of rice were investigated in accordance with Agricultural Science and Technology Survey Standards of the Rural Development Administration.

**[Results and Discussion]**

When cultivated extremely early, the yield of rice tended to increase as the transplanting period was delayed, compared to April 7th, but the rate of increase was modest, about 1-3%. As the heading stage was delayed, the yield increased significantly. Compared to the heading stage before July 5th, when heading on July 5-9, July 10-14, July 15-19 and after July 20, the yield increased by 14%, 32%, 39% and 33%, respectively. When combining the tested variety and the transplanting period, the distribution of heading stage was 39.3% on July 10-14, and 23.2% on July 5-9, July 15-19, and about 62.5% of all combinations were heading on early or mid-July. The varieties with high rice yields were Ungwang, Haedamssal and Haedeul, and their heading stage was in the early or mid-July range. As the transplanting period was delayed, the number of panicle increased and the spikelet number per panicle, percent ripened grains and 1000 grains weight tended to decrease. Thousands of weights had the least tendency compared to other yield component. The head rice ratio increased as the transplanting period was delayed, and there was little difference between April 21$^{th}$ and 28$^{th}$, and the yield of head rice increased by 3, 4, and 7%, respectively, when transplanting on April 14$^{th}$, 21$^{st}$ and 28$^{th}$ compared to April 7$^{th}$. By cultivar, Ungwang, Haedeul and Haedamssal were high yield, so the varieties with relatively late heading stage and high yields also tended to have high quantity of head rice. The protein content was the highest in rice transplanting on the April 28$^{th}$, and by cultivar, Baekilmi, Jungmo1032 and Joun, which had an early heading stage, were high. Contrary to the head rice ratio, the protein content decrease as the heading stage was delayed.

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PA-11

# Lidar Utilization for Real-Time Confirmation of the Growth Status of *Sorghum Bicolor* in Field

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**[Introduction]**
Recently, the agricultural system is expanding into the 6th industrial era. All over the World, the core technologies of the 4th industrial revolution are being grafted to make automated agricultural works with unmanned and intelligent technologies. In this automation, construction and research of phenomics facilities that convert non-destructive plant phenotypic information into DB based on images are being actively conducted. Although the use of phenomics and canopy systems is increasing for the measurement of growth information on open field crops, which account for 85.6% of the total agricultural land area, however it is difficult to apply to domestic field crops due to the high cost of equipment and operation. In particular, it is urgent to establish a growth information-based technology optimized for measuring the growth information of field crops. To measure the growth status, we introduced the real-time growth measurement technology using LiDAR for *S. bicolor*.

**[Materials and Methods]**
LiDAR was measured at a height of 2-3 m to obtain the object information of *S. bicolor*. For the measurement, *S. bicolor* was labeled individually, and then LiDAR imaging and measurements were performed at weekly basis. LiDAR image data was subjected to image pre-processing such as visualization of point cloud data and noise removal. The pre-processed data were labeled for stems, leaves, and ears, followed by learning and segmentation. Various deep learning models (PointNet, PointNet++, Dynamic Graph CNN, PointCNN, ShellNet, RIConv) were used to compare the performance of each model. For the deep learning model, actual measurement information (5,880 pieces) and LiDAR image data (360GB) were used.

**[Results and Discussion]**
The results of measuring plant length, culm length, stem diameter, ear length, and ear width of *S. bicolor* with image data are as follows. The average error of 87% of the plant length was 1.9 cm. The culm length had an average error rate of 2.04 cm with an accuracy of 84%. The stem diameter had an accuracy of 81% and an average error rate of 1.93 mm. The ear length had an accuracy of 86% and an average error rate of 66 mm. The ear width had an accuracy of 89% and an average error rate of 6.86 mm. The average measurement took 2.7 hours for three people, but it took about 47 minutes unmanned when acquiring image data, so the possibility was confirmed as a means to replace the growth survey with minimal time requirement.

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PA-12

# Characteristics of Growth and Yield by Varieties of Sweetpotato(*Ipomoea Batatas* L.) Cultivated in Paddy Field

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**[ABSTRACT]**

In recent, a demand for sweetpotato cultivation technology to expand the cultivated area of field crops in paddy fields is increasing. This research was carried out to establish suitable varieties and cultivation techniques for mass production of sweetpotato for processing raw materials. For the selection of varieties suitable for cultivation in rice fields for each processing purpose, 12 varieties in 2018 (8 varieties for starch, 4 as dried, chips and beverages), and 6 varieties in 2019 (4 varieties for starch including 'Daeyumi'; chips, semi-dried 'Pungwonmi'; beverage and coloring 'Shinjami') were used. Sweetpotato stems were planted in mid-May and harvested after 120 days to investigate the yield. Results revealed that the yield of sweetpotato (2019) for starch production, varied with variety as 'Gogeonmi' 3,926 > 'Jinhongmi' 3,428 > 'Daeyumi' 2,873 > 'Singeonmi' 2,752 kg/10a. The starch content was 20.2% in 'Daeyumi', 18.2 in 'Gogeonmi', 21.2 in 'Singeonmi', and 20.6% in 'Jinghongmi'. The total amount of starch was higher in 'Daeyumi' (730 kg/10a) and 'Gogeonmi' (731 kg/10a). The yield of chips and edible varieties 'Pungwonmi' was 4,688 kg/10a. The yield of 'Shinjami' of purple variety such as beverages and powder was 3,139 kg/10a. Aa a result of evaluation sweetpotato yield by waterlogging treatments on different growing stages in paddy fields, the yields of 'Daeyumi' and 'Jinhongmi' varieties treated with waterlogging at the storage root formation stage decreased by 11.8% and 11.7%, respectively, compared to the control. In the case of waterlogging treatment at storage root swelling stage, Both varieties showed the lowest yield reduction at 7.0% and 4.8%, respectively. Based on these results, stable production and substitution effect of processing raw materials can be expected by cultivating sweetpotato varieties suitable for paddy cultivation.

**[Acknowledgement]**

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PA-13

# Effect of Different Irrigation Levels on the Fiber Content of Sweetpotato Root

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**[ABSTRACT]**

One of the major problems with sweetpotato (*Ipomoea batats* Lam.) is the tough thread tissue that occurs in the storage root, which has a negative impact on the sales of sweet potato because it impairs the texture during cooking and the processing quality. The fiber contents in storage roots of sweetpotato is affected by cultivation conditions and environment. To investigate the effect of fiber generation at different levels of irrigation, the sweetpoatoto “Hogammi” was transplanted in greenhouse. Sweetpotato was grown in styrofoam beds(W1605*D330*H300mm) to block moisture flowing from the outside. The irrigation was carried out as 3 levels (5, 10, and 20 mm through drip irrigation facilities) at 20-day intervals. Five plants were harvested per plot at 90, 100 and 120 days after transplanting (DAT). The size of the storage root was large in the order of irrigation conditions 10mm>20mm>5mm treatment. And the longer cultivation period, the larger size of the storage root was observed. As a result of the analysis of the fiber content, it showed a tendency to decrease as the cultivation period increased (90days→120days). In addition, the fiber contents of sweetpotato harvested at 90, 100 and 120 DAT in the level of 5 mm irrigation plot were 351, 324 and 207 mg/100g, respectively, which were higher than those of other irrigation level plots. During all cultivation periods, the 10mm treatment group showed the lowest fiber content of 280, 228 and 127 mg/100g. At 20 mm irrigation level, the fiber content was less than that of 5mm irrigation level, but showed a tendency to increase compared to that of 10 mm irrigation level. These results suggested that drought stress or excessive-irrigation increases the fiber content of sweetpotato, which reduces their commercial value.

**[Acknowledgement]**

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PA-14

# Characteristics of Biodegradable Films and Their Effects on Soybean Growth

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**[Abstract]**
Recently, the use of mulching film has increased in soybean cultivation. Polyethylene (PE) films and biodegradable films (BF) have the advantages of improving soil moisture retention, geothermal maintenance, and $CO_2$ maintenance as well providing weed control. Furthermore, BFs are a material that can compensate for the shortcomings of PE because it has the ability to decompose naturally by soil microorganisms, sunlight, and geothermal heat. Many researches have been carrying out studies regarding the development of BFs for these very reasons. This study was conducted better understand which films are optimal for soybean cultivation after evaluations of soybean growth and film characteristics of various BFs. BFs Farmsbio (Farm Hannong), Heulgro Film (Sejin Bio), Vonto Film (Eco-Hansung), two unnamed biodegradable films (Seojin Bio and Taesung), and a PE film were used in this study. For the control plots, no mulching was used. Experimental fields were fertilized according to conventional cultivation methods, tilled, and then covered with either BFs or PE films. After 1 week, soybean (cv. Daechan) seeds were seeded. Germination rate and plant height were measured at weekly intervals after seeding. In addition, pH, EC, and decomposition and light transmittance levels of films were measured during the experimental period. Daily average temperatures and relative humidity in soils was measured during the experimental period. There was no significant difference in germination rates and plant height in both crops grown with BFs and PE films, but crops grown in the control plot had significantly lower germination rates and growth. Soil pH was not significantly different regardless of treatments (BF, PE, and non-mulching) at 14, 28, and 42 days after seeding. In general, the EC contents in the control plots was lower than in crops grown using BFs and PE films. With the exception of some BFs, light transmittance and decomposition levels of films did not, in general, increase up to 70 days after soybean seeding. Since this study is ongoing, we are continually investigating these parameters. The average daily moisture in soil was higher in crops grown with BFs and PE films than in the control plot. However, the daily average soil temperature was not consistent regardless of treatments. Therefore, the BFs used in this study can be used without negative impacts on soybean growth.

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PA-15

# Difference in Fiber Content Between Soil Characteristics of Cultivation Sites and Sweetpotato Varieties

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**[Introduction]**
Sweetpotato varieties with high fiber content in the storage root have poor texture when steamed or roasted. This study was conducted to investigate the difference in fiber content among the sweetpotato varieties and soil characteristics of cultivation sites.

**[Material and Methods]**
Cultivation varieties were orange fleshed sweetpotato (Hogammi, Pungwonmi, Sodammi), light yellow fleshed sweetpotato (Jinuylmi), and purple fleshed sweetpotato (Danjami). Collection of storage roots (Hogammi) and soil sample of growing regions were 19 sites. The fiber content of cultivars, the degree of visual fibrousness, and the relationship between soil characteristics and fiber content were investigated.

**[Results and Discussion]**
The average fiber content of 'Hogammi', 'Sodammi', 'Pungwonmi', 'Danjami', 'Jinyulmi' cultivars was 95.71, 66.73, 44.55, 40.55, and 38.53 mg/100g FW, respectively, from the samples collected at the farms in Haenam, Muan, and Unbong, Korea. There was no significant difference between site-specific conditions and varieties. Based on the degree of visual fibrousness, 'Hogammi' has an average of 3.6 ~4.0 with lots of thick stringy fibers. The fiber content of 'Hogammi' cultivar was measured at across 19 sites representing the main sweetpotato growing regions of Korea. The fiber content of 'Hogammi' at 19 sites were from 115.82 and 114.6 mg/100g in Haenam 2 and Boryeong 1, to 87.46 mg/100g in Hamyang. However, the fiber content at the rest of 16 sites was within the range of 94.63 ~108.52 mg/100g, although there were some site-level differences. The fiber content of sweetpotato storage roots were positively correlated with soil phosphorus ($R^2 = 0.58^{**}$), and also with organic matter ($R^2 = 0.52^{*}$), and pH ($R^2 = 0.51^{*}$), respectively, which were significant at 1% and 5% levels. We found that the fiber content of sweetpotato storage roots increased with increasing phosphorus content, organic matter and pH in the soil.

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PA-16

# Biodegradable Film Decomposition Levels and Their Effects on Growth and Yield of Corn Crops

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**[Abstract]**
Recently, PE (polyethylene) film has been used increasingly in corn cultivation. However, PE films often cause soil and environment contamination. In order to reduce this problem, many researches have been carrying out studies on biodegradable films (BF) that are easily decomposed by soil microorganisms. Therefore, this study was conducted to determine which BF is optimal for growth and yield of corn crops while also having the highest rates of film decomposition. BFs Farmsbio (Farm Hannong), Heulgro Film (Sejin Bio), Vonto Film (Eco-Hansung) as well as a selected PE film were used in this study. For the control, we used crops grown without any kind of mulching. Experimental fields were fertilized according to conventional cultivation methods, tilled, and then covered by either BF or PE. After 1 week, corn (cv. MIBECK2ho) at the 3-leaf stage (16 days after seeding) was transplanted. Plant height was measured at 18 and 32 days after transplanting and heading stages. Yield components and yield were also measured at harvest. In addition, pH, EC, and decomposition and light transmittance levels of films were investigated during the experimental period. Daily average temperature, relative humidity and organic matter in soils were also measured during the experimental period. There was no significant difference in plant height, heading date, and silking between crops with BFs and PE, but the crops grown with BFs and PE films reached higher growth parameters in a shorter amount of time than the crops in the non-mulching control. Additionally, there were no significant differences in yield components such as length of ears, ear width, ear weight, and yield in crops that were grown using films or crops in the control plot. Light transmittance and decomposition levels of films generally increased with time after transplanting, and was highest in the Heulgro film than other BFs. Soil pH and organic matter in crops using BFs and PE films were significantly higher than in the control plot at 99 and 113 days after transplanting. In general, the EC contents in the control plot was lower than in crops using BFs and PE films. The average daily moisture in soil was higher when BFs and PE films were used than in the control plot. However, the daily average soil temperature was higher in crops using BFs and PE films than in the control plots at the beginning of the experimental period, but there was no consistent difference in soil temperature towards the later part of the experimental period. Therefore, the BFs used in this study were shown to be helpful without causing negative impacts on the growth and yield of corn.

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PA-17

# Rice (*Oryza sativa* L.) Growth Promotion by Various Plant Extracts Produced Using Different Extraction Methods

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**[Abstract]**

Modern agricultural production needs to provide sustainable management practices that are eco-friendly and low cost. Plant extracts are a cost-effective and environmentally friendly alternative to synthetic plant growth regulators. This study was therefore carried out to investigate the effects of various plant extracts produced using different extraction methods on the vegetative growth of rice under laboratory and greenhouse conditions. For this study, seventeen plant extracts were made from plant species such as leaves of *M. arvense*, *C. asiatica*, *M. oleifera*, *V. radiata*, *V. unguiculate*, *P. guajava*, *A. vera*, and *A. tuberosum*, aboveground plant parts of *C. rotundus*, *M. sativa*, and *P. frutescens,* roots of *R. undulatum,* tubers of *A. sativum,* leaves and stems of *G. max* (cv. Taegwang) as well as rice straw and hulls (cv. Hopyeong). As a test crop, we applied these extracts to rice plants. For the purpose of making our extracts, some plant materials and species were collected in fields and others were purchased from Chonnam Hanyaknonghyup Cooperation (South Korea). Leaves, roots, and aboveground plant parts of plant species were dried, ground, extracted (water, boiling water and ethanol) and fermented. Rice growth promotion effects were determined using plant extracts at 0, 0.05, 0.1, 0.5, and 1% concentrations under petri dish conditions. Seven selected plant extracts were applied to rice seeds with soil drench application or seedling at 3-4 leaf stages with soil and foliar applications under greenhouse conditions. For comparison with extracts, we used urea at 0.6%. Of the 17 water extracts used in this study, 10 extracts reduced rice growth, but the other 7 extracts (*P. guajava*, *A. vera*, *A. tuberosum, M. sativa, A. sativum,* and *G. max*) increased growth by 40-60% on compared to the control in Petri dish bioassay. Thus, these 7 extracts were selected for further study. Under greenhouse conditions, rice growth also increased by 20-40% when the same 7 extracts were applied to rice seeds using soil drench application. Furthermore, at the 3-4 leaf stage rice growth also increased 30-80% or 30-60% when the same 7 extracts were applied using soil and foliar applications. Overall, the 7 extracts produced higher rates of growth promotion when soil drench application was used than when foliar application was used. In the case of boiling water and ethanol extracts, rice growth increased only 20% in response to both soil drench and foliar application of the same 7 extracts. Rice growth promotion was greater when extracts were produced using water extraction method than boiling water and ethanol extraction methods. Most notably, the 7 water extracts used in this study produced higher rates of growth promotion than urea at 0.6% which is typically used for crop growth promotion. Overall, the 7 water extracts when applied using soil drenching method can be used as effective growth promotors of rice in organic agriculture.

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PA-18

# Evaluation of Fiber Content According to the Cultivation Period of New Sweetpotato Varieties

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**[Abstract]**
Recently, as one of the major problems in the quality of sweetpotato, occurrence of thin and long fibrous tissues in storage root acts as a negative factor when consumers eat sweetpotato. In this study, the fiber content was compared according to the cultivation period in storage roots of 'Sodammi' and 'Hopungmi', which were newly bred and developed, and in that of 'Hogammi', which contains a lot of fibrous tissues. To isolate of fiber from storage root, the Association Official Analytical Chemists (AOAC) method was applied for quantifying fiber present in storage root of sweetpotato. The fiber contents isolated by this method is calculated by converting the weight of the storage root. The fiber content was measured every 20 days from 60 to 120 days after planting. As a result of this study, the lowest amount of fiber was 'Hopungmi' (70~140 mg/100 g), and the highest amount of fiber was observed in 'Hogammi' (115~223 mg/100 g). 'Sodammi' showed an intermediate level (104~149 mg/100 g) between the fiber content of 'Hopungmi' and 'Hogammi'. The fiber contents of 'Hopungmi' was 39% lower than that of 'Hogammi'. As the increased cultivation periods, the fiber contents showed a tendency to decrease. In the future research, the length, thickness, and fiber contents will be investigated to compare the degree of taste inhibition.

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PA-19

# Effect of Sowing Date and Planting Density on Growth, Yield and Anthocyanin Content of Purple Corn 'sakso 1'

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**[Abstract]**
Purple corn Saekso 1 was developed by Maize Research Institute (Hongcheon, Gangwon, Korea) and registered in 2011. Saekso 1 is a anthocyanin-rich hybrid variety that is yellow grain, purple husk and cob. Purple husk and cob of Saekso 1 is as a resource for the bioactive material by health food. In order to investigate optimum sowing date and planting density of Saekso 1. Agronomic characteristics were compared by sowing times April 25, May 15 and June 5. Husk dry weight were 68, 72 and 70kg·10a-1, respectively. Cob dry weight were 90, 92 and 92kg·10a-1, respectively. Content of cyanidin-3-glucoside in husk were 0.56, 0.62 and 0.56% and in cob were 0.19, 0.14 and 0.17%. Therefore, the sowing time to increase husk and cob weight and content of cyanidin-3-glucoside is appropriate for planting in mid-May. The number of plants in planting density trial was 9,400, 7,000, 5,700 and 4,700 plants in 10a area. Plant height at each trial were 249, 250, 246 and 248cm, respectively. Husk dry weight were 76, 67 and 63 and 60kg·10a-1, respectively. Cob dry weight were 112, 92, 87 and 81kg·10a-1, respectively. Content of cyanidin-3-glucoside in husk were 0.70, 0.71, 0.71 and 0.75% and in cob were 0.21, 0.28, 0.26 and 0.20%. Therefore, appropriate sowing time was in mid-May and planting density was 5,700 ~ 7,000 plants·10a-1 in order to increase the yield and content of cyanidin-3-glucoside of purple corn in South Korea.

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PA-20

# A Comparison of Growth and Yield of Wheat, Barley and Oat Sprouts in Saemangeum Reclaimed Land

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**[Introduction]**

Reclaimed land has a poor environment to grow crops due to many adverse factors such as low organic matter and high salt content. However, when crops are placed in a poor environment, certain substances are produced for self-defense, and these substances act as functional ingredients for people. If the functionality of crops grown in reclaimed land is increased, it will be a good alternative to compensate for the decrease in yield and improve added value. Recently, attempts have been made to use it as a functional material through sprout cultivation of crops. A consumer demands for sprout crops with high content of unique health functional substances such as sprouted barley. An attention of sprouted wheat has been on the rise since several years ago. Therefore, sprouts were taken using wheat, barley, and oats with high salt resistance, and a yield comparison was presented before selecting wheat varieties with improved functional components.

**[Materials and Methods]**

The test was carried out in the Saemangeum reclaimed area 5 in Gimje and upland in Iksan using wheat, barley, and oats. The fertilization amount followed the standard application amount of 9.1-7.4-3.8kg/10a ($N$-$P_2O_5$-$K_2O$). Sowing was carried out in reclaimed land on March 10th and upland on March 11th. The seeding amount was 120kg/10a for wheat and barley, and 140kg/10a for oats because the germination rate was low through the seed germination test. Harvesting was carried out when the average plant height reached around 15cm.

**[Results and Discussion]**

The plant heights of sprouts grown in reclaimed land and upland were compared on the 20th after sowing. “Saegeumgang” of wheat was 7.08±0.99cm, 10.45% higher than that of upland, and had the fastest initial growth rate. “Arijinheuk” of wheat with 7.12±0.90cm was 1.57% higher in reclaimed land. In reclaimed land, “Daeyang” and “Joyang” of oat were 5.71±0.81cm and 5.33±0.79cm, respectively, being similar to that of upland. “Keunalbori-1ho” of barley was 6.56±0.80cm, “Nurichal” of barley was 6.87±0.65cm, and “Highspeed” of oat was 6.94±0.63cm, which was 5.48%, 13.37%, 9.16% lower than that of upland. As for the fresh weight per 10a, “Saegeumgang” and “Arijinheuk” in reclaimed land were 678.0 and 729.3kg, which was decreased up to 45.1% and 36.7% compared to upland. “Keunalbori-1ho” and “Nurichal” were 938.3 and 1469.3, which was decreased by 43.7% and 26.3% compared to upland. Oat “Highspeed”, “Daeyang”, and “Joyang” were 1124.7, 564.0, and 546.3, which was decreased up to 18.1%, 35.2%, and 21.0%. Overall, the yield decreased compared to upland, and “Highspeed” and “Nurichal” were the best when considering the yield and the extent of decrease. On the other hand, “Saegeumgang” showed the largest difference in yield, which seems to be the effect of wet injury. From this result, it is necessary to drain well when it is cultivated for sprouts in the field. The drying of the harvest was carried out in hot air at 50°C. Based on the dry matter yield of sprouts grown in reclaimed land, “Nurichal” with 145.3, “Keunalbori-1ho” with 110.7 and “Highspeed” with 127.7kg/10a were significantly high than “Joyang” with 72.7 being the lowed.

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PA-21

# Reduction of Stress Caused by Drought and Salt in Rice (*Oryza sativa* L.) Crops through Applications of Selected Plant Extracts and the Physiological Response Mechanisms of Rice

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**[Abstract]**
In many areas of the world, salt damage and drought have had a negative impact on human survival due to a decrease in agricultural productivity. For instance, about 50% of agricultural land will be affected by salt damage by 2050. Biostimulants such as plant extracts can not only increase the nutrient utilization efficiency of plants, but also promote plant growth and increase resistance to abiotic or biotic stress. Therefore, the objective of this study was to determine how selected plant extracts might reduce levels of stress caused by drought and salt and to better understand the physiological response mechanisms of rice plants. In this study, we used Soybean leaves, Soybean stems and *Allium tuberosum*, *Allium cepa*, *Hizikia fusiforme*, and *Gracilaria verrucosa* extracts were used. These extracts had been used in previous studies and were found to be effective. The materials were dried in a dry oven at 50°C for 5 days and ground using a blender. Each 50 g of materials was put in 1 L of distilled water, stirred for 24 hours, filtered using 4 layers of mirocloth, and then concentrated using a concentrator. Rice (cv. Hopumbyeo) seeds were immersed and germinated, and then sown in seedbeds filled with commercial soil. In drought experiments, three rice seedlings at 1 week after seeding was transplanted into 100 ml cups filled with commercial soils and grown until the 4-leaf stage. For this experiment, the soil weight in a cup was equalized, and water was allowed to become 100% saturated and then drained for 24 hours. Thereafter, plant extracts at 3% concentrations were applied to the soils. For NaCl treatments, rice plants at 17 days after seeding were treated with either 100 mM NaCl or plant extracts at 1% + 100 mM NaCl combinations in the growth chamber. Leaf injury, relative water content, photosynthetic efficiency, and chlorophyll contents were measured at 3, 5, and 6 days after treatments. Shoot fresh weight of rice under drought conditions increased 28-37% in response to treatments of Soybean leaf, Soybean stem, *Allium tuberosum*, *Allium cepa*, *Hizikia fusiforme*, and *Gracilaria verrucosa* extracts at 3% when compared with control plants. Shoot fresh weight of rice subjected to 100 mM NaCl treatments also increased by 6-24% in response to Soybean leaf, Soybean stem, *Allium tuberosum*, *Allium cepa*, *Hizikia fusiforme*, and *Gracilaria verrucosa* extracts at 3% when compared with control plants. Compared to the control, rice plants treated with these six extracts and subjected to drought conditions had significantly higher relative water content, Fv/Fm, total chlorophyll and total carotenoids than control plants. With the exception of relative water contents, rice plants treated with the six extracts and subjected to salt stress (100 mM NaCl treatments) had significantly higher Fv/Fm, total chlorophyll and total carotenoids than control plants. However, the type of extract used did not produce significant difference in these parameters. Thus, all the plant extracts used in this study could mitigate drought and NaCl stresses and could also contribute substantially to sustainable crop production.

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PA-22

# Growth Monitoring for Soybean Smart Water Management and Production Prediction Model Development

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**[Abstract]**
With the development of advanced technology, automation of agricultural work is spreading. In association with the 4th industrial revolution-based technology, research on field smart farm technology is being actively conducted. A state-of-the-art unmanned automated agricultural production demonstration complex was established in Naju-si, Jeollanam-do. For the operation of the demonstration area platform, it is necessary to build a sophisticated, advanced, and intelligent field smart farming model. For the operation of the unmanned automated agricultural production demonstration area platform, we are building data on the growth of soybean for smart cultivated crops and conducting research to determine the optimal time for agricultural work. In order to operate an unmanned automation platform, data is collected to discover digital factors for water management immediately after planting, water management during the growing season, and determination of harvest time. A subsurface drip irrigation system was established for smart water management. Irrigation was carried out when the soil moisture was less than 20%. For effective water management, soil moisture was measured at the surface, 15cm, and 30cm depth. Vegetation indices were collected using drones to find key factors in soybean production prediction. In addition, major growth characteristics such as stem length, number of branches, number of nodes on the main stem, leaf area index, and dry weight were investigated. By discovering digital factors for effective decision-making through data construction, it is expected to greatly enhance the efficiency of the operation of the unmanned automated agricultural production demonstration area.

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PA-23

# Effect of Rice Transplanting Date and Optimal Transplanting Dates for Mid-Plain Area in South Korea

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**[Abstract]**
The transplanting date of rice affects grain yield and quality, and it is changed by the environment during cultivation. Thus, it is important to provide the optimal transplanting dates for rice growers under global warming environment. In this study, transplanting date experiments with thirty-day-old seedlings of three cultivars (early, mid, and mid-late maturity) were conducted at the National Institute of Crop Science in Suwon from 2018 to 2021 to determine the optimal transplanting dates for and quantify the effect of planting dates on yield and quality. Transplanting date was strongly associated with culitvar across every year. Clear relationships between transplanting date and head rice yield in early and mid-late maturing rice varieties were observed, and the highest head rice yields were observed during transplantings in mid and late June for early maturing cultivar and mid June for mid-late maturing cultivar. It is obvious that the optimal rice transplanting dates have been shifted and are better later than the optimal transplanting dates in 2002-2004. Days to heading was also strongly associated with the transplanting date and cultivar with 89% of the variation explained. Days to heading was reduced in the later transplanting dates. Grain yield was strongly associate with biomass production during ripening($R^2$=0.85), however translocated biomass from leaf and stem showed little association with grain yield. The results from this study reconfirmed the importance of shifting optimal transplanting dates to maximize head rice yield for the Mid-plain area in South Korea.

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PA-24

# Effect of Nitrogen Fertilizer Application on Yield and Quality of Korean Noodle Wheat

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**[Abstract]**

As various wheat variety for bread, all-purpose, and cake flour have been developed, suitable cultivation method for the end-use of the new variety need to be revised. This study was conducted to suggest an optimal nitrogen(N) fertilizer method for wheat Variety 'Saekeumgang' and 'Hojoong' with good noodle quality. In order to analyze the yield and quality changes of 'Saekeumgang' and 'Hojoong' as nitrogen fertilizer amount and timing, these varieties were sown on paddy soil in jeunju, Republic of Korea. The amount of N fertilizer was divided into 4 levels (7.1, 9.1 11.1, 13.1kg/10a). In each levels, N amount in sowing date fixed as 3.6kg/10a, N amount in 10 days after heading(DAH) were treated 0 or 2kg/10a, and the other N amount was treated in regrowing stage. As N amount in regrowing stage increased, culm length of 'Saekkeumgang' was increased, but culm length of 'Hojoong' was not affected. Spike number/㎡ was increased when N fertilizer amount in regrowing stage increased as 3.5 to 7.5kg/10a. But, spike number/㎡ wasn't increased compared N amount 7.1kg/10a conditions when N fertilizer amount 9.1kg/10a. When the N fertilization amount in regrowing stage was increased by 1kg/10a, grain yield increased by 45.7 kg/10a in 'Saegeumgang' and 21.4kg/10a in 'Hojoong', so the fertilizer effect of 'Saegeumgang' was higher. when N fertilizer amount was increased to 2kg/10a at 10DAH, 1000-grain weight increased, but spike number/m2 and grain yield were not affected by N fertilizer at 10 DAH. Protein content and SDS-sedimentation value were increased as increasing N fertilizer amount in regrowing stage and 10 DAH. Among them, N fertilizer amount in 10 DAH had higher impact on protein content and SDS-sedimentation value. As N fertilize in 10 DAH, hardness of noodle was increased and chewiness of noodle was decreased

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PA-25

# Optimal Nitrogen Fertilizer Application Method for High Quality Bread Wheat Production

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**[Abstract]**
For high quality bread wheat production in Korea, it is necessary to develop optimal nitrogen (N) fertilizer methods. For optimal N fertilizer, we evaluated the alteration of growth, yield, yield components and end-use qualities according to the treatment of N fertilizer amounts and timings at heading stages. Growth, yield, yield components, and end-use quality weren't altered by various timings of N fertilizer treatment conditions whereas, 1,000 grain weight and lodging degree was increased by increasing amounts of N fertilizer treatment conditions at 7 days after heading (7 DAH). Especially, lodging degree was significantly increased by 6kg/10a of N fertilizer treatment conditions at 7 DAH. The flour protein contents increased by various amounts of N fertilizer treatment conditions. However, SDS-sedimentation and bread loaf volumes were decreased by exceeding 6kg/10a of N fertilizer treatment conditions at 7 DAH. When considering the quality of bread, 6kg/10a N fertilizer treatment is best, but 3kg/10a N fertilizer treatment is more suitable for both quality and lodging at 7 DAH. Therefore, it is preferable to fertilize 3kg/10a of nitrogen at 7 DAH in addition to standard fertilizer when cultivate bread wheat.

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PA-26

# Effect of Soil Water Stress on Yield and Quality of Korean Wheat

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**[Abstract]**

Among annual precipitation in Korea (1306.3 mm), 54% of it falls intensively in summer, and only about 12.4% falls in April and May, when the water requirement of wheat is the highest. Korean wheat also could be damaged by soil water excess stress as frozen soil thaws after winter (late Feb~Mar). This study was conducted to evaluate effect of soil water stress on yield and quality of Korean wheat cultivar 'Saegeumgang'. Soil water treatments consisted of 4 treatments; water excess treatment in tilling stage (3.23~3.30), drought treatment in ripening stage (Apr~Jun), irrigation treatment in ripening stage (5.10) and standard condition. There was no significant difference between the treatment conditions for culm length, and the number of spike number was the highest in the order of irrigation in the ripening period (951)> standard cultivation (876)> excess water treatment in the tilling stage (752)> drought treatment in the ripening stage (767/㎡). Test weight and Thousand grain weight were 548g/L and 22.1g respectively, which were lower than other treatments, and there was no significant difference between the other treatments. Abortive grain was 5.4kg/10a which was lower than other treatment, and there was no significant difference between the other treatment than other treatments. In drought treatment, protein content was 11.9% which is the highest among all treatments, and SDS-sedimentation value was 27.2ml under drought treatment which was very low compared to other treatments. Therefore, wheat yield and spike number were decreased in excess water condition at tilling stage and drought condition at ripening stage. Furthermore, wheat quality became deteriorate in drought condition at ripening stage.

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PA-27

# Effect of Nitrogen Fertilizer Application on Yield and Quality of Korean Soft Wheat Cultivar 'Goso'

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**[Abstract]**

Wheat flour can be categorized into bread, all-purpose, cake flour according to its protein content. Since optimal wheat flour protein content is different for each end use, it is necessary to diversify the nitrogen fertilizer methods depending on the end use and cultivar. Optimal wheat flour protein content of soft wheat (for cake flour) is lowest (<=10%) among all end use, it is necessary to develop nitrogen fertilizer methods for high yield and low protein content. In order to analyze the yield and quality changes of soft wheat as nitrogen fertilizer amount and splitting timing, soft wheat cultivar 'goso' was sown on paddy soil in jeunju, Republic of Korea ('21.10). the amount of nitrogen fertilizer was divided into 4 levels by adjusting 2kg/10a increments from 5.1 to 11.1kg/10a, and in the N 7.1 and 9.1kg/10a(standard) treatment, N amount divided into sowing date:regrowing stage=3:7, 4:6(standard), 5:5. In regrowing stage, Tiller number and N fertilizer amount at sowing date showed a correlation; $y=-121.14x^2+792.66x-525.41$ ($R^2=0.77^*$, y: Tiller number/㎡, x: N amount at sowing date(kg/10a)). Tiller number in regrowing stage was the highest when the nitrogen fertilizer amount at sowing date was 3.23kg/10a. spike number per ㎡ was the highest when N fertilizer was divided into sowing date:regrowing stage=3:7(N amount: 9.1kg/10a). If N fertilizer amount was fixed, grain yield was also the highest when N fertilizer was divided into sowing date:regrowing stage=3:7. Also, N amount at sowing date and grain yield showed no correlation, but N amount at regrowing stage and grain yield showed significant correlation. As N amount increased, protein content also showed a tendency to increase.

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PA-28

# Changes of the Content and the Activity of Seed Antioxidants by Milling and the Ripening Stage of Finger Millet [*Eleusine coracana* (L.) Gaertn]

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**[Introduction]**
Finger millet [*Eleusine coracana* (L.) Gaertn] is a small grain millet that is useful for poor environments grown in semi-dry areas in Asia and Africa, and is reported as health supplement crop with high calcium and antioxidants of seeds. In particular, antioxidants are concentrated in the seed coat. This study is examined the changes of the content and the activity of seed calcium and antioxidants by milling and the ripening stage to evaluate the value as a nutraceutical crop of the finger millet

**[Materials and Methods]**
The finger millet cultivar used was 'Finger No. 1' developed by the Rural Development Administration, and the field experiments were tried in Hwacheon of Gangwon-do from 2020 to 2021. The planting was done at May 26 in 2020 and at May 15 in 2021. Spike samples were performed with three times at an interval of 2 weeks for maturity periods. The seed chemicals quantified were calcium and the antioxdants such as total polyphenol and flavonoids. The antioxidant activity were determined by DPPH and ABTS radical scavenging ability.

**[Results and Discussion]**
There was no significant difference in seed calcium content depending on whether or not the milling, and the average content was 236 mg/100g. On the other hand, the DPPH, ABTS radical scavenging ability, the total polyphenol and flavonoid content were significantly high in unmilled seeds. This suggested that calcium in the seeds was mainly accumulated in the endosperm, and total phenol and flavonoids were mainly accumulated in the seed coat. During the maturity period, the calcium content was increased, whereas the DPPH, ABTS radical scavenging ability, the total polyphenol and flavonoid content were slightly decreased. This indicated that calcium was accumulated continuously during the maturity period, and the total polyphenols and flavonoids was in the early stages of maturity. DPPH radical scavenging ability, total phenol and flavonoid content showed a highly positive correlation with the one spike dry weight. These results suggested that the accumulation of seed chemicals related to antioxidant function of finger millet was mainly affected by the one spike dry weight.

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PA-29

# Analysis of Crop Growth Characteristics, the Activity and Content of Seed Antioxidants of Finger Millet [*Eleusine coracana* (L.) Gaertn] Treated with Planting Times in Gangwon Province of Korea

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**[Introduction]**
Finger millet [*Eleusine coracana* (L.) Gaertn] is a small grain millet belonging to the Poaceae family, which is rich in calcium and has higher antioxidative activity than other millets. The growth and nutritional content of seed are affected by the planting time. This study investigated the crop growth characteristics, the activities and contents of seed antioxidants by treatment of planting time in order to find the changes in productivity and antioxidant components of the finger millet seed.

**[Materials and Methods]**
The finger millet varieties used was 'Finger No. 1' developed by the Rural Development Administration, and the field experiments were tried in Hwacheon and Inje of Gangwon-do from 2020 to 2021. The planting was 2 times at late-May and mid-June in Hwacheon, and 3 times at late-May, mid-June, and late-June in Inje. The crop growth characteristics determined were heading date, total growth period, plant height, one spike dry weight, and seed yield. The seed chemicals quantified were calcium, and total polyphenol and flavonoids as antioxdants. The antioxidant activity were determined by DPPH and ABTS radical scavenging ability.

**[Results and Discussion]**
As the planting time was delayed from late-May to late-June, the heading date was delayed from early-Aug. to late-Aug. The plant height and seed yield were the highest in late-May in all treatments. The one spike dry weight was high in mid-June. The calcium content of finger millet seed was ranged from 198.8 to 346.5 mg/100g in all treatments. It showed the highest of 306.6 mg/100g at late-June in Hwacheon, and 243.4 mg/100g at late-May in Inje. The DPPH, ABTS radicals scavenging ability, and the contents of total polyphenol and flavonoid were high at late-June in Hwacheon. The Pearson correlation analysis showed that there was a significant positive correlation among the one spike dry weight, the DPPH radical scavenging ability and the total phenol content. Therefore, seed production was the highest at late-May planting. On the other hand, the activity and content of antioxidants such as DPPH radical scavenging ability and total phenol content were the highest at mid-June planting, when the one spike dry weight was high.

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PA-30

# Evaluation of the Effect of Shading on Soybean Photochemical Characteristics

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**[Introduction]**
Shading reduces the light intensity received by the crop and changes the light quality. The limited light intensity and the changed light quality under shading condition affect the morphological and physiological characteristics of crops. The reaction is because the photoreceptor protein recognizes the light change in the leaf and the metabolism that transmits the signal through the hormone occurs. Characteristics related to photosynthetic capacity inside the leaf are also affected. This study aims to compare the light environments on control and shading; to investigate the change in leaf photochemical characteristics in the response to shading.

**[Materials and Methods]**
In this study, “Daewon”, “Haepum” and “Cheong ja No. 5” soybeans were grown in paddy fields of the National Institute of Crop Science on June 13, 2022. For the shading net, commercial 35% and 75% were made into a shading chamber (1.2m in width × 2m in length) and processed from the V3-V4 to harvest. Measurements were made by installing a thermo-hygrometer and a leaf thermometer in the shading chamber during the cultivation period. The vegetation index(PolyPen), chlorophyll fluorescence (FluorPen), and chlorophyll content(MC-100) were measured for each stage.

**[Results and Discussion]**
The actual average shading rates of the 35% and 75% shading chambers during the experiment period were 47% and 78%, respectively. The Red to Far Red transmittance ratio between the control and the shade treatments in post-flowering stage was significantly, while later period was not significantly changed. The lowest stomatal conductivity was observed in the 75% shading in all varieties. The chlorophyll content under the shading were higher than the control. On the post flowering stage, the chlorophyll content was increased in all group of the three cultivars. The $F_V/F_M$ of chlorophyll fluorescence under the shading was higher than the control. The $F_V/F_M$ difference became smaller in the post R4. The non-photochemical fluorescence quenching (NPQ) of R4 was the highest in the control and the lowest in the 75% treatment in all cultivars. These results suggested that soybeans recognized the changed light environments in different shading conditions and regulated the photochemical characteristics.

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PA-31

# Estimation of Crop Cultivation Models for Korean Foxtail Millets [*Setaria italica*] in the High Latitudes of Korean Peninsula

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**[Introduction]**
Crop models are a formal way to present quantitative knowledge about how a crop grows in interaction with its environment. In this research, the crop cultivation models are defined as a possible and/or a limiting planting and harvest times to obtain stable productivity of crop plants for a certain region. It is entirely determined by the local environments, especially as the accumulated temperature and the day-length. This research was conducted to estimate the crop cultivation models for Korean foxtail millets in the high latitudes of Korean Peninsula.

**[Materials and Methods]**
The crop cultivation models was developed by the combination of two factors, the meteorological ecotype of region and the agricultural ecotype of Korean foxtail millet. The meteorological ecotype of region was classified by the the maximum growth days from the possible sowing date to harvest and its accumulated temperature of region. The agricultural ecotype of Korean foxtail millet was determined with the days required to heading and harvest, and those accumulated temperatures. The meteorological data of the 27 weather stations in North Korea was 30 years from 1991 to 2020. The field experiment was conducted with the 2 early and 2 late maturity cultivars from 2020 to 2021 in ‘Hwacheon’ and ‘Inje’ provinces of South Korea.

**[Results and Discussion]**
The limiting sowing and harvest dates of Korean foxtail millet were shortened as the cultivated region move form the southeast and the southwest to the north and the mountainous area in North Korea. The limiting sowing dates of the early maturity cultivars were shortened from June 30 at the southwest and the southeast to May 25 at the north and the mountainous provinces. Those of the late maturity were from June 5 to May 20. The limiting harvest dates were also shortened from Oct. 25 to Sep. 20 in all cultivars. The minimum growth days to obtain the stable seed yield of the early maturity cultivars were estimated with about 110 to 120 days required to reach the accumulated temperature of 2,400 °C. For late maturity cultivars, the minimum growth days were about 130 to 140 days to reach 2,900 °C in the high latitudes of Korean Peninsula.

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PA-32

# Effect of Tiller Number, Temperature and Day-Length on the Heading Time Responce of Rice

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**[Introduction]**

The case of rice, the heading time depends on the daylength and temperature . The shorter a day and the higher the temperature, the faster the heading time. The assimilation products made according to the amount of insolation are distributed to each tiller. Therefore physiological response varies according to the number of tillers.. This study provides information on the relationship between the daylength and the temperature, which influences the heading time which the prediction of the change of heading time by the varieties.

**[Materials and Methods]**

The cultivars used in the test were Odae. After 9 days after transplanting, the tillers were removed and the temperature treatment was performed at 22(17/27)°C and 28(23/33). After removing the tillering, the days were treated for 12 hours (short-days) and 14 hours 30 minutes (long-days). Gene expression was analyzed by Quantitation Real-Time PCR.

**[Results and Discussion]**

When the tillering was removed, the heading time was accelerated due to the decrease in the expression of OsMFT1 in a short-day condition. OsMFT1 delays heading time in rice by suppressing Ehd1, FZP and SEPALLATA-like genes. A list of genes involved in tillering was prepared in order to find genes related delay heading time in long-day conditions. When tillering was removed, tillering relation gene was increased, but there was no trend according to day-length and temperature.

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PA-33

# Analysis of Agricultural Ecological Characteristics for the Korean Foxtail Millet [*Setaria italica*] in 'Kangwon-do' Area of Korea

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**[Introduction]**
Foxtail millet is a traditionally representative minor food crop in Korea. Recently it's demand has been gradually increased as a health supplement food of rice. However, its low productivity and high cost in domestic cultivation and the increase of cheap imports are the major challenges to overcome. This research was conducted to determine the agricultural ecological characteristics of Korean foxtail millet in order to cultivate in high latitudes of the Korean Peninsula.

**[Materials and Methods]**
The field experiment was conducted in 'Hwacheon' and 'Inje' provinces in 'Kangwon-do' area of South Korea, which are high latitudes in South Korea, for two years from 2020 to 2021. The 4 Korean foxtail millets included the 2 early and the 2 late maturity cultivars. The 4 planing times were done at the mid-May, the late May, the early June, and the late June to find the limiting dates of heading and harvest. The days required to heading and harvest, and those accumulated temperatures were determined for 2 regions, 4 cultivars and 4 planting times, respectively.

**[Results and Discussion]**
When the plantings were delayed from the mid-May to the late June, the heading dates of 2 early maturity cultivars were delayed from the early Aug. to the early Sep. which were 70 to 80 days required to heading from planting. Those of 2 late maturity cultivars were the mid-Aug. to the mid-Sep. with 80 and 100 days, respectively. The limiting date of harvest was the mid-Oct., which was the 50 days to harvest from heading, regardless of regions, cultivars and planting treatments. The accumulated temperatures required to heading from planting was about 1,500°C of the 2 early maturity and 2,000°C of the 2 late maturity cultivars. The accumulated temperatures to harvest from heading was about 900°C in all 4 cultivars. In summary, the limiting total growth days and its accumulated temperatures of Korean foxtail millet was 115 days with 2,400°C for early maturity and 135 days with 2,900°C for late maturity cultivar in 'Kangwon-do' area, which would be satisfied to cultivate the Korean foxtail millet in high latitudes of the Korean Peninsula.

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PA-34

# Analysis of Ozone Exposure Damage of Rice using RNA-Sequencing

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**[Introduction]**

Recently, the concentration of fine dust causative substances (NOx, VOC, etc.) in the atmosphere has increased, resulting in high concentrations of Tropospheric ozone (O3) and increased damage to crops. Tropospheric ozone causes amorphous reddish brown spots on rice leaves, leaf death in severe cases and reduces photosynthesis rate because of chlorophyll destruction. In China and Japan, various studies have been conducted on the damage and yield reduction of rice due to ozone concentration and exposure. This study was conducted to select ozone related mechanisms and related genes using RNA-sequencing.

**[Materials and Methods]**

The varieties used were ozone-sensitive Wandoaengmi and ozone-insensitive Hwayeong. 150ppb of ozone was sampled at intervals of 3, and 10 days after treatment for 4 days. RNA was extracted and analyzed By analyzing the RNA-sequencing results, related pathways were analyzed using KEGG.

**[Results and Discussion]**

The DEG analysis showed that the number of genes whose expression patterns change in ozone-sensitive Wandoaengmi, which is more than Hwayoung, during ozone exposure. Chlorophyll a is decomposed into pheophytin a due to increased expression of magnesium dechelatase gene.The expression of the stress response hormones, ABA and JA biosynthesis genes, was expressed earlier in Wandoaengmi than Hwayeong.

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PA-35

# Study of Anthocyanin Accumulation by Ozone Stress in Rice

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**[Introduction]**

Anthocyanins are water-soluble flavonoid compounds in plant vacuoles.Anthocyanins are involved in the coloring of the reproductive organs of plants, attract pollinators such as insects, promote pollination, and protect plants from environmental stress. The anthocyanin accumulation determined by the regulation of the expression of early biosynthetic genes (EBGs; CHS, CHI, F3H, F3'H) and late biosynthetic genes (LBGs; DFR, LDOX, UGT). Anthocyanins are induced during ROS production due to environmental stress. This study is directive is to determine the expression profile of anthocyanin biosynthesis genes in rice as a result of ROS production during ozone exposure.

**[Materials and Methods]**

15-day-old seedlings were treated with 150 ppb ozone in the chamber for 4 days. Anthocyanin was extracted with methanol acidified with 1%HCl (v/v). The anthocyanin yield was calculated by subtracting the A657 fromthe A530 as previously described. biosynthetic gene was selected by homology test between *Arabidopsis* and *Maize* genes. Gene expression was analyzed by Quantitation Real-Time PCR.

**[Results and Discussion]**

Ozone treatment increased the anthocyanin content in rice. Anthocyanin biosynthesis genes in rice were listed by selecting homologous genes from *Arabidopsis* and *Maize* . The expression of F3H2, FLS1 and LDOX3 was increased during ozone treatment. This result is expected to contribute to the study of the protection mechanism of plants from ozone damage.

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PA-36

# Estimation of Agricultural Meteorological Ecotype During the Summer Cropping Period of the High Latitudes of Korean Peninsula

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**[Introduction]**
Agricultural meteorological ecotype is the most important factor in selection of crop species and cultivars suitable for a crop cultivation region. Recently the global warming has been reported over the past decades in all over Korea Peninsula, and the agricultural meteorology of the region is also gradually changed in micro-climate level. This research was conducted to estimate the agricultural meteorological ecotype during the summer cropping period of the 27 weather station (WS) regions of North Korea.

**[Materials and Methods]**
The meteorological data was 30 years from 1991 to 2020 of the 27 WSs in North Korea, and 'Hwacheon' and 'Inje' province in 'Kangwon-do' area of South Korea as references. The meteorological ecotype is classified by the two sorts of agricultural characteristics, the maximum growth days from the possible sowing date to harvest date and its accumulated temperature. The possible sowing and harvest was determined at the date with 8°C of daily minimum temperature.

**[Results and Discussion]**
The agricultural meteorological ecotype during the summer period of the 27 regions of North Korea was classified by 8 groups based on the maximum growth days and its accumulated temperature. The growth day and the accumulated temperature were decreased with the higher ordering of group. Group I is the highest maximum growth days with 185～190 days and the accumulated temperature with 3,600～3,800 °C among the eight groups. It includes provinces located to the southwest and the southeast area of North Korea. Group Ⅷ showed the lowest growth day with about 130 days and the accumulated temperature with about 2,500 °C, which provinces located to the north and the mountainous area. The provinces with the higher ordering group are moved to inside and north side of North Korea. This result suggests that the 8 agricultural meteorological ecotypes would be used on the selection of summer crop species and cultivars for a certain region of North Korea.

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PA-37

## 밀 품종별 춘파재배 생육 및 수량성

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**[서론]**
최근 전라북도 서부 평야지를 중심으로 밀(*Triticum aestivum* L.)과 콩을 연계한 이모작 작부체계가 증가하고 있다. 그러나 10월 콩 수확기에 기상 및 노력사정으로 수확이 늦어.져 밀을 가을에 파종하지 못하고 이듬해 춘파재배를 하는 사례가 많이 발생하고 있다. 우리나라에서 재배되고 있는 밀은 파성이 Ⅱ~Ⅲ인 양절형으로 봄에 파종해도 출수가 가능하지만 성숙기가 늦어져 후작물 파종에 영향을 주고 추파대비 수량이 떨어지는 등 문제점이 있다. 따라서 본 연구는 최근 육종된 국내 밀 우량품종의 춘파재배 생육 및 수량을 구명하여 밀 춘파재배에 적합한 품종을 선발하고 기초자료로 활용하고자 수행하였다.

**[재료 및 방법]**
본 시험은 밀 '금강', '새금강', '고소', '황금알', '아리흑' 5품종를 대상으로 2021~2022년에 수행하였다. 파종은 전라북도농업기술원 내 시험포장에 휴폭 25cm, 파폭 5cm, 파종량 16kg·10a$^{-1}$로 2022년 2월 25일(추파: 2021년 11월 3일)에 휴립세조파하였다. 기상 및 토양 자료는 Data Logger(WatchDog 1000 Series_WaterScout SMEC 300 Soil & Solar Radiation sensor, Spectrum Technologies, USA)로 수집하였으며, 생육 및 수량 조사는 농업과학기술 연구조사분석기준(RDA, 2012)에 준하였다.

**[결과 및 고찰]**
재배기간 중 평균기온은 1월중순, 2월하순에 -2.5, 0.8°C로 평년대비 각각 -2.2, -2.6°C 낮았으며, 3월이후에는 평년보다 높은 경향을 보였다. 강수량은 340.6mm로 평년대비 101.7mm 적었으며, 특히 5월에 5.3mm로 평년대비 74.9mm 적었다. 이에 따라 5월 포장 토양수분함량이 1.2%로 가물었다. 춘파재배에서 출수기와 성숙기는 '황금알'이 5/11, 6/13로 가장 빨랐으나, 추파대비 각각 18일, 14일 늦었다. 춘파재배에서 간장은 '아리흑'이 84.0cm로 가장 높았으며, 도복지수도 가장 높았다. 수장과 1수립수는 '고소'가 11.3cm, 41.3개로 가장 길고 많았다. m$^2$수수는 '황금알'이 707개로 가장 많았으나, 추파대비 300개 적었다. 천립중은 '황금알'이 40.8g으로 가장 무거웠으나, 추파대비 6.1g 가벼웠다. 대체로모든 품종에서 추파대비 춘파재배에서 수장, 1수립수는 증가하였으나, m$^2$수수와 천립중은 감소하였다. 수량은 '황금알'이 340kg·10a$^{-1}$로 가장 많았으나, 추파대비 61%수준이였다. 따라서 밀 춘파재배시 '황금알'이 수확시기도 빠르고 수량도 많아 적합한 품종으로 판단되나 추파대비 감수를 예상하여 파종량을 늘려야 할 것으로 보인다.

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PA-38

# Citric Acid (CA) and Glutathione (GSH) Mediated Alleviation of Cadmium (Cd) Stress in *Brassica napus*

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**[Introduction]**

Cadmium (Cd), a kind of nonessential and toxic metal that is very much harmful for both human and animal. The accumulating capacity of Cd is significant for phytoremediation of Cd-polluted soil environment. Citric acid (CA) as an organic chelator plays a vital role in alleviating Cd stress through more uptake of Cd by plants whereas Glutathione (GSH) significantly decreased the translocation of Cd from root to shoot, ultimately decreased Cd accumulation in shoots. From many previous studies it has been established that the CA and GSH enhance phytoremediation of different heavy metals and working against metal-induced oxidative stress. In this study, we attempted to discover the capability of CA for increasing phytoextraction of Cd contaminated environments and to know the capability of GSH for retaining the Cd in the plant roots, and to examine the comparative effect of CA and GSH on growth and physiology of the seedlings of Cd-stressed *Brassica napus*.

**[Materials and Methods]**

Healthy seeds of *B. napus* L. were sterilized and placed in petri dishes containing two layers of filter papers and germinated in controlled conditions. Following germination, the morphologically uniform seedlings were transferred to plastic pots and hydroponically grown for 7-days containing Hoagland solution. After one weeks of transplanting, uniform plants were treated with $CdCl_2$ and Citric Acid as T1: Control, T2: Cd (30 μM), T3: Cd (30 μM) + CA (1.0 mM), and T4: CA (1.0 mM) and; $CdCl_2$ and Glutathione as T1: Control, T2: Cd (30 μM), T3: Cd (30 μM) + GSH (0.5 mM), and T4: GSH (0.5 mM) with three replications. The control plants were free from $CdCl_2$, CA and GSH.

**[Results and Discussion]**

The research was focused on studying the effects of revealing Brassica plants to $CdCl_2$. The metal ion, Cd affected growth parameters and caused morpho-physiological alterations. *Brassica napus* seedlings exposed to different concentrations of $CdCl_2$ for 7 days did not show any leaf chlorosis or withering symptoms. However, Cd stress significantly affects the plant growth characters and plants become more yellowish in CA treated plants than GSH treated plants. A considerable reduction in the shoot and root growth was observed compared with the control in both CA and GSH treated plants. The most significant growth inhibition was observed when plants are treated with $CdCl_2$ (30 μM). The plant height (Both shoot length and root length) exhibited the largest reduction (14.40 cm in CA treated plants and 15.30 cm in GSH treated plants) compared to control plants respectively. Number of leaves per plant and leaf area (size) was found to be decreased when the seedlings were exposed to Cd stress. However, the highest inhibition (5 and 10 $cm^2$ for CA treated and 5 and 12 $cm^2$ for GSH treated leaf number and leaf area respectively) was observed in 30 μM concentrations compared to the control plants. The reduction of shoot and root growth may be occurred due to metal uptake primarily through roots. From previous studies as the Cd is retained in the root of plants for application of GSH, so it may be the environment friendly and promising strategy to decrease Cd concentration in edible parts of plants that may helpful for reducing the health hazard for both human and animals.

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PA-39

# Utilization of UAV Remote Sensing in Small-scale Field Experiment : Case Study in Evaluation of Plat-based LAI for Sweetcorn Production

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**[Abstract]**
Traditional agriculture mostly focused on activity in the field, but current agriculture faces problems such as reduction of agricultural inputs, labor shortage and so on. Accordingly, traditional agricultural experiments generally considered the simple treatment effects, but current agricultural experiments need to consider the several and complicate treatment effects. To analyze such several and complicate treatment effects, data collection has the first priority. Remote sensing is a quite effective tool to collect information in agriculture, and recent easier availability of UAVs (Unmanned Aerial Vehicles) enhances the effectiveness. LAI (Leaf Area Index) is one of the most important information for evaluating the condition of crop growth. In this study, we utilized UAV with multispectral camera to evaluate plant-based LAI of sweetcorn in a small-scale field experiment and discussed the feasibility of a new experimental design to analyze the several and complicate treatment effects. The plant-based SR measured by UAV showed the highest correlation coefficient with LAI measured by a canopy analyzer in 2018 and 2019. Application of linear mix model showed that plant-based SR data had higher detection power due to its huge number of data although SR was inferior to evaluate LAI than the canopy analyzer. The distribution of plant-based data also statistically revealed the border effect in treatment plots in the traditional experimental design. These results suggest that remote sensing with UAVs has the advantage even in a small-scale experimental plot and has a possibility to provide a new experimental design if combined with various analytical applications such as plant size, shape, and color.

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PA-40

# Analysis of Growth Characteristics and Yield of Hulless Oat According to Sowing Time in the Central Region of Korea

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**[Introduction]**

Oats, which are rich in fat, protein, and β-glucan, have been approved for health claim for coronary heart disease risk reduction in the United States, Canada and Europe. Due to this influence, domestic consumption and cultivation have been expanding in recent years. However, it is known that cultivation limit area of hulless oats where the average temperature in January does not drop below zero or the minimum average temperature in January does not fall below -4°C. Despite the recent warming in winter season, hulless oats are damaged during the winter due to a sudden cold wave, so spring-planted oat is preferred. And it is known that mid-March is the optimal sowing time in the central region of Korea.

**[Materials and Methods]**

This study was conducted in the field of Department of Central Area Crop Science of National Institute of Crop Science (NICS), Suwon, Gyeonggi province, Korea. Two hulless oats cultivars(Choyang:CY, Daeyang: DY) were sown five times at 10-day intervals from February 25, 2022, and the change in growth and yield characteristics according to the sowing time were evaluated. The oat cultivars were sown with a ridge width of 25cm using a barley drill seeder. Cultivation management was performed according to the Rural Development Administration standard cultivation methods.

**[Results and Discussion]**

There was no difference of seedling emergence between varieties. The number of days from sowing to emergence were 24 days in the first sowing and 10 days in the fifth sowing. The number of days from sowing to heading(DSH) decreased as the sowing time was delayed and the range of DSH of CY and DY were 75.0~52.3 days and 77.7~56.0 days, respectively. The number of days from sowing to maturity(DSM) CY was 108.0 days in the first sowing, but was shortened to 84.0 days in the last sowing by 24 days, and it was possible to harvest until the end of June. However, DSM of DY was 114.3 days in the 1st sowing, but full ripening was not achieved in the 4th and 5th sowings. The grain yield DY was the highest at 301kg/10a in the 3rd sowing. But the yield of CY was the highest at 327kg/10a in the 1st sowing, and decreased as the sowing period was delayed.

**[Acknowledgement]**

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PA-41

# Analysis of Morphological Characteristics and Compositional Changes of Naked Oat Grains According to Harvest Time in the Central Region of Korea

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**[Introduction]**

Hulless oats are generally harvested 45 days after heading(DAH). It is known that 1000 grain weight, the grain yield, and the germination rate are high at that time. In the central region of Korea, hulless oats were sown in the spring, and the change in grain characteristics and composition were evaluated to examine the appropriate harvest time.

**[Materials and Methods]**

This study was conducted in the field of Department of Central Area Crop Science of National Institute of Crop Science (NICS), Suwon, Gyeonggi province, Korea. On February 25, 2021, the early-ripening(Joyang, JY) and late-ripening (Daeyang, DY) hulless oat cultivars were sown with a ridge width of 25cm using a barley drill seeder. Cultivation management was performed according to the Rural Development Administration standard cultivation methods. After harvesting at intervals of 5 days from 40 to 55 days after planting, the grains were threshed and stored in a low-temperature storage (temperature: 5°C, humidity: 45%) and used for testing. Seed size (length/width/thickness), changes in grain components, and germination rate were investigated.

**[Results and Discussion]**

The grain length, width, and thickness of DY were 8.53±0.82mm, 2.48±0.31mm, and 1.96±0.21mm, respectively. And the grain length, width, and thickness of JY were 8.97±0.84mm, 2.52±0.30mm, and 2.02±0.21mm, respectively. The grain characteristics of hulless oat according to harvesting time, the length was the largest at the 40 DAH(8.86±0.86mm) and the smallest at the 55 DAH(8.65±0.92mm). However, width and thickness did not show any distinct trends. The germination rate of DY showed the highest at 97.4±1.34% in the 55 DAH, and JY showed the lowest at 86.2±5.17% in the 40 DAH. The avenanthramides (AVNs), which are known as a functional component of oats, showed higher contents in DY. And the AVN contents were increased according to harvesting time delayed after 45 DAH.

**[Acknowledgement]**

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PA-42

# Adaptability Test on Low Organic Soil and Selection of Varieties of Soybean Cultivars

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**[ABSTRACT]**
Food productivity in North Korea is about 50% lower than in South Korea. In order to increase the productivity of major crops, it is necessary to develop early maturing, disease resistance, and high-yielding varieties and apply them early. Since the late 1990s, North Korea has been actively developing potatoes, rice and corn as major food crops, and soybeans are considered important as a protein-supplying crop. Domestic cultivated varieties, which are expected to be most adaptable eco-climatologically, are mainly selected from soil with high nutrient soil. It is necessary to test separately for adaptability in low organic soil. So it is very necessary to apply technology to improve soil improvement through rotational crop selection in the middle and long-term. Therefore, this study was conducted to test the adaptability to low organic soils of domestic cultivars and to select varieties. In 2021 there are twenty two (22) varieties of soybeans were grown in low organic soil at the field of Chungbuk National University. This year twenty two (22) varieties of soybeans were also grown in low organic soil at the field of Chungbuk National University. Sowing was done on June 10, the planting distance was 70cm x 15cm, after opening the cotyledons fully, the soybeans were thinned and leaving two plants per hole. In addition, various types of growth characteristics and quantitative components were investigated to evaluate the adaptability to low organic soil of domestic varieties.
This study was conducted to investigate the growth characteristics and quantitative components of soybean varieties grown in low organic soil. The flowering period of 22 varieties of soybeans was about 14 days from July 22 to August 4. The flowers of the beans were white, purple, light purple and the pubescence color was gray and brown where most of them were gray. The highest plant height was up to 130.4 cm and lowest was 20.3 cm, highest stem length was up to 119.5 cm and lowest was 15.3 cm. Highest first pod height (FPH) was up to 34.0 cm and lowest was 3.0 cm. Highest stem diameter was up to 15.76mm and lowest was 1.76 mm. Number of main stem nodes was up to 19 and at least 1. Number of branch was up to 10 and at least 0. The number of pod per plant was up to 121. Bacterial pustule has been spread in soybean field.

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PA-43

# Comparative Evaluation of Qualitative and Quantitative Traits of Common Buckwheat (*Fagopyrum esculentum*)

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**[ABSTRACT]**
Common Buckwheat is a crop with high nutritional value due to its high protein, magnesium, iron, and vitamin content, as well as excellent rutin and quercetin content. This study was conducted to investigate the main agricultural characteristics of common buckwheat genetic sources and use them as basic data for establishing cultivation technology and fostering new varieties. The seeds were planted in the research field of Chungbuk National University on 24th April, 2022 maintained at 15 × 20 cm planting spaces. To evaluate the genetic diversity and morphological traits of buckwheat, different kinds of qualitative and quantitative traits were investigated of the 50 varieties.
The germination percentage of common buckwheat showed more than 85% that also showed the uniform germination. During the flowering period, all varieties bloomed within six days from June 18 to 23. The leaves color of common buckwheat were all dark green, and most of the stem colors were mixed with light green, light red, red, and crimson. The leaves of common buckwheat were mainly heart-shaped, and most of the flowers were white. The leaf length was 65.78 to 40.53 mm, and the width was 74.42 mm to 39.74 mm. The stem thickness was between 3.5 and 3.76 mm and the length was between 97.3 cm and 40.24 cm.

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PA-44

# Estimation of Heading Date of Paddy Rice from Slanted View Images Using Deep Learning Classification Model

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**[Abstract]**
Estimation of heading date of paddy rice is laborious and time consuming. Therefore, automatic estimation of heading date of paddy rice is highly essential. In this experiment, deep learning classification models were used to classify two difference categories of rice (vegetative and reproductive stage) based on the panicle initiation of paddy field. Specifically, the dataset includes 444 slanted view images belonging to two categories and was then expanded to include 1,497 images via IMGAUG data augmentation technique. We adopt two transfer learning strategies: (First, used transferring model weights already trained on ImageNet to six classification network models: VGGNet, ResNet, DenseNet, InceptionV3, Xception and MobileNet, Second, fine-tuned some layers of the network according to our dataset). After training the CNN model, we used several evaluation metrics commonly used for classification tasks, including Accuracy, Precision, Recall, and F1-score. In addition, GradCAM was used to generate visual explanations for each image patch. Experimental results showed that the InceptionV3 is the best performing model in terms of the accuracy, average recall, precision, and F1-score. The fine-tuned InceptionV3 model achieved an overall classification accuracy of 0.95 with a high F1-score of 0.95. Our CNN model also represented the change of rice heading date under different date of transplanting. This study demonstrated that image based deep learning model can reliably be used as an automatic monitoring system to detect the heading date of rice crops using CCTV camera.

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PA-45

# Automatic Estimation of Tillers and Leaf Numbers in Rice Using Deep Learning for Object Detection

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**[Abstract]**
Recently, many studies on big data based smart farming have been conducted. Research to quantify morphological characteristics using image data from various crops in smart farming is underway. Rice is one of the most important food crops in the world. Much research has been done to predict and model rice crop yield production. The number of productive tillers per plant is one of the important agronomic traits associated with the grain yield of rice crop. However, modeling the basic growth characteristics of rice requires accurate data measurements. The existing method of measurement by humans is not only labor intensive but also prone to human error. Therefore, conversion to digital data is necessary to obtain accurate and phenotyping quickly. In this study, we present an image-based method to predict leaf number and evaluate tiller number of individual rice crop using YOLOv5 deep learning network. We performed using various network of the YOLOv5 model and compared them to determine higher prediction accuracy. We also performed data augmentation, a method we use to complement small datasets. Based on the number of leaves and tiller actually measured in rice crop, the number of leaves predicted by the model from the image data and the existing regression equation were used to evaluate the number of tillers using the image data.

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PA-46

# A Comparison of the Growth Characteristics of Potatoes Varieties in the Potato-Sprout Soybean Cropping System in the Central and Northern Region

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**[Introduction]**

Due to climate warming, the sprout-soybean plantation is gradually moving northward, sprout-soybean production is unstable due to weather changes in the main production area, and the supply and demand of raw materials is gradually becoming unstable due to the conversion of threshing crops due to a decrease in income of production farmers. Potatoes are crops sensitive to weather factors, and for the cultivation of two crops in the middle and northern regions, we tried to select potato varieties applicable to the soybean-centered crop system by comparing the growth characteristics and quantity of potatoes.

**[Materilas and Methods]**

This test was conducted in 2021 and 2022 at a farme in Jinchon-ri, Miyang-myeon, Anseong-si, and the area of the farm is 0.4ha. For potato varieties, Sumi, Chubaek, and Haryeong were used. Seed potatoes were sown on March 14, 2021 and April 3, 2022, and the harvest was harvested on June 23, 2021 and June 27, 2022, taking into account the sowing and rainy season. The seed potato sowing amount was 150kg/10a, and the planting distance was 40×30cm.

**[Results and Discussion]**

As a result of comparing the growth of the harvest period, the number of stems was the largest with 6.0 in the lower age, and 4.8 and 4.2 in the upper and lower regions, respectively, showed similar results. In 2021 and 2022, the annual difference between the number of potatoes and the total number of potatoes was very large. In 2021, the average marketable yield was 4498.2kg/10a and the total yield was 4629.8kg/10a, and in 2022, the marketable yield and the total yield were 2,612.0kg/10a and 2,888.7kg/10a, respectively. By cultivars, the decrease in the yield of 'Haryeong' was the largest, the marketable yield decreased by 68% compared to the previous year, 'Chubaek' had the least decrease in yield, and it decreased by 16% year-on-year. In 2022, the seedling period was delayed by about 16 days due to frequent rain during the seed potato sowing period, and average temperature during entire growing period was 15.3°C in 2021, 17.9°C in 2022, and the highest temperature was 21.6°C in 2022, 24.8°C in 2022, so the tuber necrosis may be reduced. In the potato-sprout soybean cropping syatem, iit can be said that the 'Chubaek' variety with the best growth is the most suitable, since there is little difference in yield between the years.

**[Acknowledgement]**

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## 기후변화에 대응한 강원도 동해안지 차나무 재배적응성 검토

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**[서론]**
최근 기후 온난화로 인한 작물의 재배한계지가 북쪽으로 이동하고 있다. 강원도 동해안 지역은 기온상승과 해양성기후를 갖고 있어 차나무의 재배가능성 연구 필요성이 제기되고 있다. 지난 30년 연평균 기온이 전국 0.7°C, 강원권 0.9°C 상승하였고, 차나무 재배한계지도 전남 보성에서 강원도 고성으로 북상하였다. 선행연구로는 강원도에서 '04~'10년까지 한지적응「차」의 재배적지 및 품종선발을 하였고, 본 연구는 강원도 동해안지(강릉)에서 차나무 재배가능성을 검토하였다.

**[재료 및 방법]**
시험재배지는 지형, 재배시설 유무 등을 고려하여 강릉 4개소(연곡면 송림리, 연곡면 신왕리, 성산면, 사천면)를 선정하였다. 시험재료는 2020~2021년 동해안(고성), 보성 차산업연구소 등에서 종자, 삽목묘 형태로 6품종(하동 재래종, 야부기다 혼계, 보향, 참녹, 상녹, 명녹)을 수집하였다. 재배방법은 줄 간격 60㎝, 주간거리 30㎝ 두 줄 엇갈려 심기로 식재하였고, 초기 생육특성과 미세기상환경을 조사하여 재배적응성을 검토 하였다.

**[결과 및 고찰]**
차나무 식재 후 묘 활착률 95%이상, 최아종자 출현율 88%이상을 보였다. 차나무 재배적지는 연평균 기온 13~16°C, 겨울 최저평균온도는 -5 ~ -6°C이상인 지역으로 월동기 기상과 생육이 매우 중요하다. 강릉 4개소의 평균기온은 비슷하였으나, 최저기온은 지역별로 차이가 커 연곡면 신왕리에서는 대부분 월동 이후 고사하였다. 저온에 의한 동해피해로 적고 및 청고현상이 나타났고, 향후 월동기 저온에 대한 보온방법 등 재배법이 필요하다고 판단된다. 월동기 비닐 및 차광망 설치시 보온·방풍·습도 유지 등으로 생육이 양호하였고, 지역별·품종별 차이는 있으나 90%의 생존율을 보였다. 결론으로 월동기 방풍·보온 관리 시 재배 가능성은 있으나, 월동기 동해의 위험성이 커 추후 재배적지 탐색, 월동기 재배방법 등에 대한 추가적 연구가 필요하다. 이번 연구 결과는, 기후변화 대응 신작목 선택에 대한 기초자료로 이용될 수 있을 것이다.

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PA-48

# Growth Characteristics And Yield of Corn(*Zea mays* L.) for Grain by Early Sowing Date in the Central Region of South Korea

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**[ABSTRACT]**
The limit of crop cultivation is moving northward due to the temperature rise by climate change. There is a problem with crop growth if early sowing is performed at a time when the temperature is low. It is difficult to secure crop productivity and cultivation stability due to the low temperature and short cultivation period. Therefore, this study was conducted to analyze the change in growth characteristics and yield of corn for grain when early sowing is performed in central region of South Korea.
This experiment was conducted at experimental field of Suwon in 2021. Three varieties of corn for grain such as Kwangpyeongok, Sinhwangok, and Hwangdaok were sown at intervals of 5 days from 20 March to 15 April. The planting density at this time was sown with a row interval of 70 cm and a plant interval of 25 cm. Nitrogen, phosphoric acid, and potassium fertilizers were applied at 17.4 kg, 3.0 kg, and 6.9 kg per 10a, respectively. Phosphoric acid and potassium fertilizers were all applied before sowing and nitrogen fertilizer was applied 50% before sowing and 50% in the fifth leaf period. The corn growth characteristics and yield components were investigated.
The seedling establishment rate by sowing date was in the range of 68.5~88.5%, and it showed a difference depending on the variety. The range of days from sowing to tassel and silk emergence by sowing date was 79.9~98.4 and 81.0~98.9 days, respectively. As the sowing date was delayed, the days from sowing to tassel and silk emergence decreased. The growth characteristics and yield of corn by sowing date are as follows. Plant height was the highest at 241.3 cm at the sowing on 25 March, and Stalk diameter was the thickest at 25.6 mm at the sowing on 31 March. The fresh weight per plant was the highest at 728 g at the sowing on 25 March, and the dry weight per plant was the highest at 185 g at the sowing on 31 March. Corn growth characteristics did not show a certain trend depending on the sowing date, and corn growth was more vigorous at the sowing on March 25 and 31 than the others. In the case of ear weight, it was the heaviest with 344 g at the sowing on 25 March, and filled ear length ratio showed a tendency to decrease as the sowing time was delayed. The weight of 100 grains and grain yield per 10a of maize were the highest at 36.0g and 878.7kg/10a, respectively at the sowing on 25 March. Although the growth and yield of corn for grain were good during early sowing in the central region of South Korea, it is necessary to investigate the limit temperature for early sowing of corn by examining the annual variation according to weather conditions.

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PA-49

# A Comparison of Yield and Quality by Ecotype according to the Rice Transplantation Period in Central Plain and Eastern Coast in Gangwon

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**[Introduction]**
Due to recent climate change, the temperature in Korea has risen by 1.5°C over the past 100 years, twice the global average. Accordingly, as the cultivation period of rice increases, the possibility of changing the ecological type suitable for each region is raised. It is necessary to develop an appropriate transplantation period for stable, high-quality rice production by ecology type suitable for each region. Therefore, this study was conducted to find a suitable transplanting period for the central plains and eastern coast by comparing the yield and quality according to the transplanting date.

**[Materials and Methods]**
For the test varieties, early maturing 'Odae', middle maturing 'Cheongpum', and mid-late maturing 'Samgwang' were used for each ecotypes. The location was carried out in three areas: Chuncheon, Cheorwon, and Gangneung, which are the central plains and eastern coast. This study was conducted for two years in 2020 and 2021. As for the transplanting period for each region, Transplanting was carried out 5 times from May 20 to June 30 in Chuncheon and from May 10 to June 20 in Cheorwon and Gangneung at 10-day intervals. After harvesting, the yield and the head rice ratio of brown rice were comparatively analyzed.

**[Results and Discussion]**
In all regions and ecotypes, yields tend to decrease as the transplanting season is delayed. In Chuncheon, the earlier the transplanting period, the better the yield and the head rice ratio of brown rice in early maturing variety. For middle and mid-late maturing varieties are appropriate around June 10. In Gangneung, it is best to transplant the middle maturing variety around May 20. Lastly, in case of early maturing variety in Cheorwon, too early transplantation should be avoided as the rice yield and head rice ratio of brown rice will decrease. In case of middle and mid-late maturing varieties, better results were obtained the faster the transplanting was done. The results of this study are thought to be helpful in setting the transplantation period according to the ecological type of the central plain and eastern coast in Gangwon.

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PA-50

# Compatibility and Yield of Fall Crops After Extremely Early Rice Cultivation in Southern Plains

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**[Introduction]**

In southern plains, The number of farmers who use the extremely early rice cultivation method for making freshly harvested rice before Chuseok is increasing to improve income. However, There is a disadvantage that the utilization efficiency of use of arable land is lowered because land is not used for about 240 days from middle ten days-August, the rice harvest season, to middle ten days-April, the rice planting season of the next year. Since winter crops are harvested in May or June and due to climate warming, the temperature is higher until late compared to before. So, it is necessary to develop cropping system introduced fall crops using warm climate for increasing utilization efficiency of use of arable land. Accordingly, in this study, the crop connectivity and yield of buckwheat, potato, and Kimch cabbage were investigated after cultivating rice in paddy fields in southern region.

**[Materials and Methods]**

The study was conducted at paddy-land area in Department of Southern Area Crop Science of National Institute of Crop Science located in Miryang, Gyeongsangnam-do in 2021. Each variety of rice, buckwheat, potato, and Kimch cabbage were Junamjosaeng, Yangjeol, Geumseon and Whiparamgold. Junamjosaeng sown in March 21$^{st}$, transplanted on April 21$^{st}$ and harvested on August 19$^{th}$. Fall crops were seedling or setting on September 13$^{th}$, Yangjeol was harvested on November 19$^{th}$, and Geumseon and Whiparamgold were harvested on December 14$^{th}$.

**[Results and Discussion]**

Duration from sowing(or transplanting or setting) to harvest is 121 days, 67 days, and 92 days, respectly, for Junamjosaeng, Yangjeol and Geumseon and Whiparamgold. Junamjoseang yield is about 525 kg/10a. Yangjeol quantity came out 122 kg/10a, decreasing 43% compared to the previous year when it was sown on August 31$^{st}$. As a result of investigate Geumseon which is each tuber weighs more than 51 g among all tubers, the number of heavy potatoes was similar to 2020 sowing on September 1$^{st}$, but the weight decreased by 68% compared to 2020. Whiparamgold's weight, which was setting on September 9$^{th}$, 2020, was 2.93 kg per plant, but the Kimch cabbage harvested in 2021 was 1.19 kg per plant and failed to formed bulbing. There was no problem in terms of crop connectivity in extremely rice cultivation, buckwheat, potato, and napa cabbage in extreme early rice cropping system. However there was a large difference in growth and development according to the planting date depending on the weather from the last ten days of August to leading ten days of September. In addition, frost and low temperatures in November greatly affect the yield of buckwheat and potatoes, it is necessary to prepare to prevent damage in order to use them as income crops.

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# The Growth Response of Soybeans by Integrated Subsurface Drip Irrigation and Drainage System

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**[Introduction]**
Soybean has a great water requirement while it is more vulnerable to drought and wet injury than other upland crops. Therefore irrigation and drainage management is very important and it is a critical environmental factor in soybean cultivation and yield. Therefore, this study investigated growth and yield changes of soybean under an integration technology of irrigation and drainage.

**[Materials and Methods]**
This study tested three water management methods (i) Subsurface Drip Irrigation (SDI), (ii) Trenchless Subsurface Drainage method (TSDM) and (iii) Intergration of Irrigation and Drainage (IID). SDI pipes had 20cm of a drip space, 2.3L/hr of dischage properties, and the SDI pipes were burried at 40cm deep and 1.2m apart. TSDM pipes(Ø50mm) wrapped with felt were burried at 80cm and 2.4m apart. IID was installed by laying SDI pipes and TSDM pipes in an intersecting direction. Irrigation efficiency, water productivity, growth and yield if soybean were analyzed by effects of different water management methods.

**[Results and Discussion]**
Water effeciencies from three water management methods showed that SDI had 126.3% and IID had 80.7%. Results of water productivities were 1.26 from SDI and 0.81 from IID, respectively. Leaf indexes at a flowering period were 1.94 from soybeans with no irrigation treatment, 3.06 from TSDM, 3.35 from SDI and 4.12 from IID which was the greatest value than other water management methods. After comparing yield charateristics, pod numbers per plant, results of seed numbers per pod and 100 seed weight showed statistical differences across treatments. Especially, soybeans from IID had greater 100 seed weights than SDI and TSDM and the ratio of large seed(>7.1mm) was 83.4% from no irrigation treatment and 96.4% from IID. This results represent that IID improved the quality of soybena seeds. Soyeban yields were 284.0kg/10a from no irrigation treatment, 329.9kg/10a from TSDM, 384.2kg/10a from SDI and 409.3kg/10a from IID. Compared to the yield of no water treatment, the yield from TSDM increased by 16%, SDI 35% and IID 44%.

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PA-52

# The evaluation of Spectral Vegetation Indices for Classification of Nutritional Deficiency in Rice Using Machine Learning Method

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**[Abstract]**
Detection of stress responses in crops is important to diagnose crop growth and evaluate yield. Also, the multi-spectral sensor is effectively known to evaluate stress caused by nutrient and moisture in crops or biological agents such as weeds or diseases. Therefore, in this experiment, multispectral images were taken by an unmanned aerial vehicle(UAV) under field condition. The experiment was conducted in the long-term fertilizer field in the National Institute of Crop Science, and experiment area was divided into different status of NPK(Control, N-deficiency, P-deficiency, K-deficiency, Non-fertilizer). Total 11 vegetation indices were created with RGB and NIR reflectance values using python. Variations in nutrient content in plants affect the amount of light reflected or absorbed for each wavelength band. Therefore, the objective of this experiment was to evaluate vegetation indices derived from multispectral reflectance data as input into machine learning algorithm for the classification of nutritional deficiency in rice. RandomForest model was used as a representative ensemble model, and parameters were adjusted through hyperparameter tuning such as RandomSearchCV. As a result, training accuracy was 0.95 and test accuracy was 0.80, and IPCA, NDRE, and EVI were included in the top three indices for feature importance. Also, precision, recall, and f1-score, which are indicators for evaluating the performance of the classification model, showed a distribution of 0.7-0.9 for each class.

**[Acknowledgement]**
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PA-53

# Object Detection Based on Deep Learning Model for Two Stage Tracking with Pest Behavior Patterns in Soybean (*Glycine max* (L.) Merr.).

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**[Abstract]**
Soybean (Glycine max (L.) Merr.) is a representative food resource. To preserve the integrity of soybean, it is necessary to protect soybean yield and seed quality from threats of various pests and diseases.
*Riptortus pedestris* is a well-known insect pest that causes the greatest loss of soybean yield in South Korea. This pest not only directly reduces yields but also causes disorders and diseases in plant growth. Unfortunately, no resistant soybean resources have been reported. Therefore, it is necessary to identify the distribution and movement of *Riptortus pedestris* at an early stage to reduce the damage caused by insect pests.
Conventionally, the human eye has performed the diagnosis of agronomic traits related to pest outbreaks. However, due to human vision's subjectivity and impermanence, it is time-consuming, requires the assistance of specialists, and is labor-intensive. Therefore, the responses and behavior patterns of *Riptortus pedestris* to the scent of mixture R were visualized with a 3D model through the perspective of artificial intelligence. The movement patterns of *Riptortus pedestris* was analyzed by using time-series image data. In addition, classification was performed through visual analysis based on a deep learning model.
In the object tracking, implemented using the YOLO series model, the path of the movement of pests shows a negative reaction to a mixture R in a video scene. As a result of 3D modeling using the x, y, and z-axis of the tracked objects, 80% of the subjects showed behavioral patterns consistent with the treatment of mixture R.
In addition, these studies are being conducted in the soybean field and it will be possible to preserve the yield of soybeans through the application of a pest control platform to the early stage of soybeans.

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PA-54

# An Analysis of the Rice Situation in Nicaragua for Improving National Production.

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**[Abstract]**
Nicaragua is located in Central America, climatic conditions are considered tropical dry forest. Statistics reflex that in Nicaragua exits 24,000 rice farmers. National rice production only covers 73% of the national consumption. It exists two sowing system: irrigation and rainfed. Varieties used in both systems are mid-late maturity (120-135 days), there are 14 released varieties for irrigation, eight for rainfed, and eight landraces used in rainfed. The current breeding system (introduction of lines from Colombia) has increased the national production, however, has some limitation due to the lack of enough variability, reducing the proability of finding good genotypes and therefore the possibility of satisfying 100% of the demand. The purpose of this study was to analyze the problems that must be resolved in the short and long term to improve rice productivity in Nicaragua. In this paper we explain some proposal for an improvement plan. The selection of varieties with high adaptability to various cultivation environmental conditions it is necessary, also to thoroughly manage seed purity to supply certified seeds. In rice cultivation technology, it needs to improve seedling standing and weeding effect by improving soil leveling and water-saving cultivation technology. Also, proper fertilization and planting density must be established in irrigated and rain-fed areas. Furthermore, capacity must be strengthened by collecting and training with the most recent agricultural technology information, as well as by revitalizing the union rather than the individual farmer. It is necessary to develop varieties highly adaptable to the Nicaraguan cultivation environment, as well as to expand irrigation facilities and cultivation technology suitable for weather conditions in rain-fed areas. Last, it is necessary to maintain the consistency of agricultural policy for continuous and stable rice production in response to climate change events such as drought or intermittent heavy rain.

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PA-55

# Appropriate Sowing Time and Planting Density to Improve Popcorn Production

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**[Abstract]**
Popcorn grains are consumed around 10,000 tons per year, in South Korea. It is consumed in amusement parks, movie theaters and snacks. The size of the popcorn processed market in Korea is estimated to be 3.6 billon won per year. So, the popcorn grain market has good prospects. On the other hand, domestic grain is at the level of 1 %, which is less domestic production than the size of the market. Maize Research Institute has developed domestic varieties in order to increase the use of domestically produced grains. The Oyrunpopcorn variety which was commonly distributed is a preferred cultivar because it has a good popping rate compared to imported grains. In addition, 'G-Popcorn', 'Oyrun #2' and 'Kichan Popcorn' were developed, which diversified the choice of the farmers. Yield per unit area is important to improve farmers' income. At present, domestic grain production is traded at 5,000 won/kg, so if the yield improves, a high farmer's income is expected. Therefore, this study compared the growth characteristics and yield according to the appropriate sowing time and plant density to improve the yield of domestically grown popcorn. We used 'Oryunpopcorn' for this research. Agronomic characteristics were compared by sowing times April 23, May 22 and June 22. The 100 seeds weight were 15.9g, 17.7g and 15.0g, respectively. Kernel weight planted in May 22 is the highest value. Yield per 10a were 414kg, 434kg and 296kg, respectively. It shows the yield planted in May 22 was higher than other trials. Therefore, the sowing time to increase the kernel weight and yield is appropriate for planting in mid-May. The number of plants in planting density trial was 5,700 plants, 4,700 plants and 4,000 plants in 10a area. Plant height at each trial were 221cm, 214cm and 218cm, respectively. It was the highest height in 5,700 plants trials. The 100 kernel weight were 14.8g, 15.9g and 16.5g, respectively. Low planting density trial indicated high kernel weight. Yield per 10a was 415kg, 357kg and 314kg, respectively. It was higher at high density trial than other experimental plots. Therefore, appropriate sowing time was in mid-May and planting density was 5,700 plants/10a in order to increase the yield of popcorn in South Korea. This study will be useful for farmer's income to use the domestic cultivars.

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# Evaluation and Comparison Yield and Feed Value of Pasture Species and Varieties by Spring Sowing in High-Latitude Regions

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**[Abstract]**

In preparation for the ever-changing climate and unification of North Korea and South Korea, it is necessary to increase the grain self-sufficiency rate by selecting crops with good utilization in high-altitude regions. The principle is to sow pastures at the end of August. However, sowing occurs in spring because the sowing period is missed when the weather is bad or when the workforce is insufficient. Sometimes when the grassland is completely devastated, it is frequently sowed in spring. In addition, North Korea consists of a high-altitude regions, and has been devastated in a general mountainous region. As a result, the landscape is not good and it is vulnerable to natural disasters such as landslides. Therefore, to prevent this, pasture must be sowed in the high-altitude regions. The goal of this study was to evaluate and compare yield and feed value of pasture species and varieties by spring sowing in high-latitude regions. The study was conducted in Pyeongchang, Gangwon-do, which is 700m height above sea level. The pasture species and varieties was sown on April 24, 2022. Each treatment was carried out by sowing 30 kg/ha, the experiment field size was 1 ㎡ (1m x 1m), and randomized block design with tri-repeat. The total of 14 varieties was used in the study, 6 varieties of Orchardgrass (OG), 6 varieties of Tall fescue (TF) and 2 varieties of Perennial ryegrass (PRG). The grassland composition fertilization using ($N:P_2O_5:K_2O$ at 80:200:70 kg/ha) was conducted and management fertilizer was $N:P_2O_5:K_2O$ at 210:150:180 kg/ha. The first harvest was June 26, 2022 and the second harvest was on August 16, 2022. For statistical analysis of the data, an Analysis of Variance (ANOVA) was performed using the R3.6.3 software program, and all data was subjected to analysis using Duncan's multiple range test. Significance was set at the 5% level. The dry matter yield at the first harvest was the highest in PRG, and second harvest was the highest in TF ($p < 0.05$). Overall, PRG showed a trend of gradually decreasing growth, OG and TF showed a trend of gradually improving growth. This showed that PRG was considerably weaker to summer depression than other pasture species. Comparing the total dry matter yield, TF was the highest (4,565.45 kg/ha), but there was no significance difference with PRG (4,487.24 kg/ha) ($p < 0.05$). In addition, comparing the total TDN (total digestible nutrient) yield, TF was the highest (3147.33 kg/ha), second in PRG (2975.67 kg/ha) and third in OG (2052.33 kg/ha). Since this result is the data of the second harvests, if the result is derived by the end of next year, it will be provided as basic data for selection of pasture species and varieties suitable for spring seeding in high-altitude regions.

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## 농업용 드론 분무 노즐에 따른 벼 초장별 약액 도포율 조사

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**[서론]**
벼 재배 시 멸구류, 도열병, 잎짚무늬마름병 등 병해충은 작물의 다양한 부위에서 치명적으로 피해를 가 할 수 있다. 그래서 효율적인 병해충 방제작업을 위하여 벼의 위치별 농약의 균일한 살포가 요구된다. 또한 최근 벼 재배 시 농업용드론을 활용한 병해충 방제작업의 빈도수가 매우 높아지고 있는 상황이다. 따라서 본 연구에서는 농업용드론을 활용한 항공방제에 따른 분무 노즐의 타입에 따라 벼의 초장별 약액 도포율(coverage)을 규명하고자 하였다.

**[재료 및 방법]**
본 시험은 전북농업기술원 참동진벼 재배 포장에서 수행하였다. 재식밀도는 80주/3.3㎡로 6월 1일에 이앙하였다. 농업용드론은 8엽기(21inch)에 약액의 분무입경이 서로 다른 AI노즐(약 340㎛)과 XR노즐(약 150㎛)을 각각 부착하여 살포하였다. 항공살포조건은 작물 기준(canopy) 2m 고도에서 2m/s 의 전진속도와 40psi(2.76bar) 분무압으로 진행하였다. 약제의 도포율을 조사하기 위해서 약제 처리전 벼를 상단부(80cm), 중단부(50cm), 하단부(20cm)로 구분하여 감수지를 설치하고 약제 살포 후 수거하였다. 수지는 Vision Camera(2024aC, BlueFOX3 Co)에 imaging sensor(M2514-VSW, Computar Co)를 부착하여 촬영 후 이진화 작업을 통하여 분석하였다. 병해충 방제는 무인항공용 방제약제로 등록된 농약을 활용하여 벼 출수기 전 약 일주일 전 실시하였다.

**[결과 및 고찰]**
약액 살포 시 참동진 벼의 평균 초장은 101cm, 주당경수 18.1개/주로 나타났다. 감수지 영상처리를 통하여 각 노즐의 상단부 도포율을 기준으로 높이별 약제 도포율 분석하였다. AI계열 노즐은 중단부에서 73.1%, 하단부는 56.4%로 비율로 나타났으며 XR계열 노즐은 56.4%, 21.4%로 나타났다. 따라서 비교적 약액의 분무입경이 큰 분무 노즐을 농업용 드론 항공방제에 활용하는 것이 벼에 골고루 살포되어 방제 성능이 높다고 추정할 수 있다고 판단된다.

**[사사]**
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## 농업용 드론 항공방제에 따른 벼 재식밀도별 약액 도포율 조사

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**[서론]**
최근 농업현장에서 노동력 및 노동시간을 절감할 수 있는 벼 드문모심기와 농업용드론을 활용한 병해충 방제작업의 수요가 각각 증가하고 있다. 그리고 멸구류, 도열병, 잎짚무늬마름병 등 병해충은 벼의 다양한 위치에서 치명적으로 피해를 줄 수 있기 때문에 충분한 병해충 방제를 위한 농약의 균일살포가 요구된다. 따라서 본 연구에서 농업용드론을 활용한 항공방제 시 벼 재식밀도에 따른 방제효과를 추정하고자 약액의 도포율(coverage)을 조사하였다.

**[재료 및 방법]**
본 시험은 전북농업기술원 신동진벼 재배 포장에서 수행하였다. 벼 재식밀도는 각각 37주, 80주/3.3㎡로 6월 5일에 이앙하였다. 농업용드론은 8엽기(21inch)에 AI계열 노즐이 2개 부착된 기체를 활용하였다. 항공살포조건은 작물 기준(canopy) 2m 고도에서 2m/s 의 전진속도와 40psi(2.76bar) 분무압으로 진행하였다. 약제의 도포율을 조사하기 위해서 약제 처리전 벼의 상단과 하단에 감수지를 설치하고 약제 살포 후 수거하였다. 감수지는 Vision Camera(2024aC, BlueFOX3 Co)에 imaging sensor(M2514-VSW, Computar Co)를 부착하여 촬영 후 이진화 작업을 통하여 분석하였다. 병해충 방제는 무인항공용 방제 약제로 등록된 농약을 활용하여 벼 출수전 약 일주일 전 실시하였다.

**[결과 및 고찰]**
약액 살포 시 벼 재식밀도별 주당경수는 37주/3.3㎡에서 24개, 80주/3.3㎡에서 13개로 나타났다. 감수지 영상처리를 통한 약액 도포율 분석결과 37주에서 80주에 비해 평균 약 83% 증가한 것으로 나타났으며 상단부 49%, 하단부 135% 높게 조사되었다.($P \leq 0.05$) 따라서 재식밀도가 넓은 것이 약액 도포율이 높아 농약 침투 가능성이 높다고 추정할 수 있었다. 또한 연차간 실험과 재식밀도 및 드론 등 시험요인을 추가한 강화된 추가 실험을 통한 현장검증이 필요할 것으로 판단된다.

**[사사]**
본 연구는 농촌진흥청 농업과학기술 연구개발사업(사업번호:PJ016983)의 지원에 의해 이루어진 결과로 이에 감사드립니다.

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**PA-59**

# Alleviation Technology of Cold Stress of Maize(*Zea mays* L.) by Low Temperatures Damage

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**[Abstract]**
Maize is one of the world's three largest crops and has a long cultivation history, and is an important crop used for various purposes such as food, feed, and industrial raw materials. Recently, the agricultural environment is changing, in which the limit of cultivation of crops is shifted to the north due to the rise in temperature due to climate change. This study was conducted in experimental field of Suwon in 2022 by setting a seeding period earlier than the sowing time to establish the North Korean agricultural climatic zone and meteorological conditions. The test cultivars were silage cultivars, Kwangpyeongok and Dacheongok. As a priming test method, it was used to directly plant seeds in the field through immersion using 4mM zinc (Zn) and 2.5mM manganese (Mn), which are trace elements for seeds. The planting season was early on March 15th, April 1st, and April 15th. The number of days from sowing to silk stage of the two cultivars sown on March 15, April 1, and April 15 was 107, 93, and 85 days for Kwangpyeongok and 109, 95, and 87 days for Dacheongok, respectively.The seed priming test did not show any difference from the control group in the growth survey up to the middle stage of growth. In another test, low-temperature recovery was confirmed through nitrogen (2-5%) foliar fertilization after 3 days, 5 days, and 7 days in refrigeration (0 degrees), a selective low temperature treatment for corn in the third leaf stage.As a result of this study, it was confirmed that the low-temperature damaged corn treated at 0°C showed the same growth as that of the untreated corn through nitrogen foliar fertilization. These results suggest that urea foliar fertilization for low-temperature damage reduction of corn for silage in high-latitude climates will be helpful. In addition, through the results of the study, additional studies are needed on the recovery mechanism and field application through urea foliar fertilization.

**[Acknowledgement]**
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PA-60

# Assessment of Methane Emissions and Growth Characteristics in Non-Puddled Transplanted Rice

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**[Introduction]**
Methane has high GWP compared to carbon dioxide and methane occurred in paddy fields. Thus, cultivation technology is one of the most promising target for reducing GHG emissions. Non puddling is cultivation technology that irrigated a paddy after balance process without puddling. Also, non puddling promotes crop growth by inhibiting soil reduction, increasing root growth and promoting uptake nutrients. The aim of the present study was to assessment the non puddled transplant method whether the cultivation technology is suitable about carbon neutral in the future by comparing the methane emission and growth characteristics in non puddled transplanted rice.

**[Materials and Methods]**
This study was conducted at the puddled and non puddled fields of the NICS. The methane fluxes was measured by closed chamber at two points per plot and analyses were conducted with gas chromatography. Gas sampling was conducted once a week during the rice-growing. In intermittent drainage period, gas sampling was conducted twice a week. During same period, soil redox potential(Eh), soil temperature and others was measured. Plant height and the number of tillers per hill were measured at tillering stage and heading stage.

**[Results and Discussion]**
After supplementary irrigation water, Eh value of all plots changed from-444mV to 278mV because of turning to anaerobic environment. Methane emission was decreased in intermittent drainage period and directly after intermittent drainage period. The total methane emissions were highly lower in non puddled plot, 47.9$mg\ m^{-2}\ h^{-1}$ in non puddled plot and 95.8 $mg\ m^{-2}\ h^{-1}$ in puddled plot. thus While, plant height and the number of tillers per hill were not differ all plots. the results showed that methane emission was reduced in Non puddled. These results suggested that non-puddled method promotes soil aggregation, supplying oxygen to the soil and minimizing the anaerobic environment.

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PA-61

# Comparison of Growth Characteristics and General Component Content of Corn According to the Sowing Date in the Central Region of Korea

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**[Abstract]**
The yield characteristics of corn for feed by sowing period and the crude protein, crude fat, and coarse flour contents of grain in the harvesting period were compared. The varieties are Kwangpyeongok(KPO), Dapyeongok(DPO) and Pyeonggangok(PGO), and cultivation was tested by the National Food Engineering Department and the Central Crop Department. It was sown at a planting distance of 70x25cm on April 15, June 14, and July 15, 2021, and the amount of fertilizer was applied through soil inspection. For the growth characteristics, plant height, biomass and grain weight were investigated after 50 days of sowing, and general components were analyzed by drying and pulverizing each seed.
Compared to the results of sowing in April, which is the right time to sow corn, all three varieties sown on June 14 showed an increase in biomass. In the case of sowing on July 15, the fresh weight of KPO and DPO decreased, and the grain weight of KPO and PGO decreased by 10-20% compared to the sowing in April. There was no significant difference in the crude protein content of grain according to the sowing seasons in April and June, but decreased in the corn sown in July. The crude fat content was highest in KPO sown on June 14 and DPO sown on July 15.
Combining the yield and general composition results, it is thought that the cultivation of corn for feed in Suwon in the central part can be sown by mid-June.

**[Acknowledgement]**
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PA-62

# 찰옥수수의 생육과정 중 MSM 시용방법에 따른 수량특성 비교

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**[서론]**
Methyl Sulfonyl Methane(MSM)은 인간에게 물과 같이 중요한 미네랄 성분으로, 식용이 가능한 유황으로써 작물에 처리할 경우, 생장소 사이의 균형을 조절하여 생육을 조절하는 등 작물의 생육에 긍정적인 효과를 기대할 수 있다. 따라서, 옥수수에 식이유황을 접목하여 시용횟수를 달리해 옥수수의 수량특성 및 수량을 알아봄으로써 옥수수의 안전생산기술개발의 기초자료로 활용하고자 수행하였다.

**[재료 및 방법]**
시험재료는 '백옥찰' 품종을 사용하였으며, 시험 설계는 기비처리 유·무를 주구로 배치하고, 세구 배치법으로는 추비 시용횟수 1회 및 2회로 설정하여 시험을 수행하였다. MSM 은 330 g/10a을 100%로 500배 희석하여, 기비는 토양표면에 로터리 경운 후 관비처리 하였고, 추비는 7~8엽기, 출웅기에 엽면시비하였다. 재식거리 및 기타 재배관리법은 농촌진흥청 표준 재배법에 준수 하였으며, 수량특성 및 수량은 농촌진흥청 연구조사분석기준에 준하여 실시하였다.

**[결과 및 고찰]**
MSM 시용방법에 따른 찰옥수수 수량특성 조사에서 기비+추비2회 처리구가 이삭장 22.1㎝, 이삭직경 41.8㎜, 1개 이삭중 179 g으로 가장 길고, 굵고, 무거웠으며, 이삭열수에서는 모든 처리구에서 통계적으로 유의성이 나타나지 않았다. 수량 또한 수량특성 조사값이 가장 높았던 기비+추비2회 처리구에서 1,109 kg/10a 로 가장 많았고, 가장 적은 무시용구 대비 약 12.1% 더 많은 것으로 나타났다. 따라서, 찰옥수수의 생육과정 중 MSM 식이유황을 기비 처리하고, 추비로 7~8엽기 및 출웅기에 2회 엽면시비 하는 것이 찰옥수수의 증수에 유리할 것으로 사료 된다.

**[사사]**
본 과제(결과물)는 2022년도 교육부의 재원으로 한국연구재단의 지원을 받아 수행된 지자체-대학 협력기반 지역혁신 사업의 결과입니다.(2021RIS-002)

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PA-63

# Varietal Variation in Biomass Production and Total Digestible Nutrients of Maize Grown under Lowland Condition

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**[Abstract]**
This study was carried out to select the excellent silage maize varieties customized for paddy cultivation that is vulnerable to lodging and waterlogging in the central and region. Ten varieties (Kwangpyeongok, P3394, etc.) were sown with 3 replicates in Suwon, Gyeonggi-do. It was sown twice in April and June of each year in 2020-2021 and harvested during the yellow ripe stage suitable for silage.
The number of days to flowering stage in lowland condition increased up to 11 days compared to that in upland condition. In April seedling, varieties that showed a relatively small decrease in biomass production and total digestible nutrients (TDN) under lowland condition compared to upland condition were Gangdaok and Kwangpyeongok in 2020, and Dacheongok, Gangdaok and Kwangpyeongok in 2021. Kwangpyeongok, Gangdaok, and Sinhwangok showed relatively higher biomass production and TDN than the other varieties under lowland compared to upland in both 2020 and 2021.
Our results suggest that Kwangpyeongok and Gangdaok are suitable silage maize varieties for lowland cultivation in the central region of Korea.

**[Acknowledgement]**
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PA-64

# Evaluation of Forage Production of Maize with Different Sowing Dates and Ridge Shape for Silage at Paddy Field in the Central Region of Korea

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**[Abstract]**
This study was conducted in 2021 using Kwangpyeongok and Gangdaok, that showed good yield performance both under upland and lowland conditions in the previous year. The experiments were carried out by sowing on April 22, May14, May 30, June 19, and July 10, with aim to determine optimum sowing date in central region of Korea.
The growing degree days (GDD) required to read the flowering stage were 1375.5-1725.3°C for upland and 1582.7-1982.4°C for lowland condition. The lowest GDD was observed in July 10 sowing regardless of ridge formation both under lowland and upland conditions for Kwangpyeongok. However, Gangdaok showed the lowest GDD under no-ridge in lowland and high-ridge in upland, both of which were sown on June 19. The difference in GDD between no-ridge and high-ridge treatment was little depending on the sowing date. In both lowland and upland, there was no significant difference between no-ridge and high-ridge treatments in stover dry matter, ear dry matter, and TDN between no-ridge and high-ridge treatments. Under upland condition, no significant difference in biomass and TDN was observed among sowing date treatments and between varieties. Under lowland condition, biomass production was severely reduced in May 30 sowing treatment, whereas no varietal difference was observed. Reduced biomass in May 30 sowing treatment may be due to excess waterlogging and lodging by rainfall.

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PA-65

# Evaluation of Growth and Yield on Transplanting time and Plant Density in ItalianRyegrass

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**[Abstract]**
In recent years, due to climate change, the livestock industry has become more interested in the production of forage crops. In Korea, more than 74% of forage crops are cultivated in winter rice fields. In particular, Italian ryegrass (IRG) is depends on imports for more than 70% of its seeds. In generally, the IRG rapeseed cultivation method involves sowing from early October to mid-October by drill sowing seeding or spot seedling. However, the sowing period is delayed due to frequent rainfall during. And, same period require a lot of seeds. However, raising seedlings and transplanted IRG will overcome weather conditions and reduce the amount of seeds. This study was intended to be applied to the domestic IRG seed industry in the future through growth and quantity evaluation according to transplant time and planting density for the production of good quality IRG seeds in rice paddy fields. In this study, transplanting time (October 20, October 30, November 10) and planting density (50, 70, and 80) were cultivated at the National Institute of Crop Science in 2021. The amount of fertilizer applied was adjusted to ($N$-$P_2O_5$-$K_2O$) 4.5-12-12 (kg/10a), and then 2.2(kg/10a) of nitrogen was added each year. For the growth survey, leaf area, canopy coverage, plant length, and seed yield were investigated. Along with the transplanting time, the plant length was higher on October 20 than on October 30 and November 10. On the other hand, leaf area index changes differed depending on the transplanting time and planting density, and were particularly high on October 20, 80 density and 70 density, but similar on October 30 and November 10. 1000 seed weight showed no difference with transplanting time and planting density. On the other hand, the seed yield was 215(kg/10a) for 80 density on October 20, 211(kg/10a) for 70 density, 118(kg/10a) for 50 density, and 80 density for October 30 and November 10. and 70 density did not differ. On the other hand, the 50 density on October 30 and November 10 were 164(kg/10a) and 147(kg/10a) respectively. As can be seen from this study, the earlier the transplant, the higher the seed yield. However, the 50 density was reduced in yield compared to the 70 density and 80 density.

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PA-66

# Evaluation of Growth and Yield on Italian Ryegrass in Reclaimed Land

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**[Abstract]**
More than 74% of forage crops in Korea are cultivated in winter rice fields. Italian ryegrass (IRG) can be said to be a representative forage crop, but over 70% of its seeds are dependent on imports. In addition, there are concerns that the stable supply of research fees may be disrupted due to the effects of climate change, war, and other factors. Therefore, it is necessary to secure a large production area for stable supply. Korea's reclaimed land area is 135,000 ha and its agricultural area is 112,000 ha. Therefore, this study attempted to apply IRG to the domestic IRG seed industry through stable cultivation techniques on reclaimed land. In this study, IRG 'Kowiearly' varsity was cultivated in late October 2020 and early October 2021 in the Saemangeum reclaimed land. The seeding methods were conventional drill sowing seeding, new technology spot seedling (30 x 18 cm) and new technology drill sowing seeding. The amount of sowing was conventional drill sowing seeding 2.0(kg/10a), new technology spot seedling 1.5(kg/10a), and new technology drill sowing seeding 1.5(kg/10a). Fertilizer application amount is conventional drill sowing seeding(N-$P_2O_5$-$K_2O$) 9.0-12-12(kg/10a), and new technology spot seedling and drill sowing seeding were(N-$P_2O_5$-$K_2O$) 4.5-12-12(kg/10a) respectively. Fertilizer was applied accordingly. After that, in February, the conventional drill sowing seeding, new technology drill sowing seeding and spot seedling applied 4.0 and 2.2(kg/10a) of nitrogen supplement fertilizer, respectively. Before wintering, plant length was higher in 2022 than in 2021, but leaf number was higher in 2021. Heading time was April 30, 2021 and April 25, 2022. In heading time, plant length was 74 cm in 2021 and 67 cm in 2022, lower than in 2021. On the other hand, There was no difference in the number of panicle and the number of seeds in the 2021 harvester in all treatment plots, and, thus seed yield was no differ. However, the drill sowing seeding and spot seedling of the new technology were somewhat higher than the conventional drill sowing seeding. On the other hand, seed yield was decreased in all treatment plots compared to 2022 because of raifall deficiency in 2021.

**[Acknowledgement]**
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PA-67

## 이앙시기 및 재식밀도별 다복찰과 동진찰 생육 특성

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**[초록]**
다복찰은 전라북도농업기술원에서 2012~2020년에 신명흑찰과 익산488호를 교배하여 육성한 찰벼이며, 중대립, 단간, 내도복, 다수성의 특징을 보인다. 동진찰은 1998년도에 육성되었으며, 우리나라에서 가장 인기 있는 찰벼이다(재배면적 25,161ha/2021년 기준). 드문모심기 재배 기술은 2017년부터 도입되었으며, 밀파 육묘하여 재식밀도 및 재식주수를 감소함으로써 소요되는 재료비 등 경비 및 투입되는 노동력을 절감하는 경제성 있는 기술이다.
따라서 본 연구는 전라북도농업기술원에서 육성한 다복찰 보급 확대 및 가장 인기 높은 동진찰의 드문모심기 재배기술 확립 일환으로 시작되었으며, 2024년까지 3년간 실시할 계획이다.
시험은 기술원 논 포장에서 실시하였으며, 시험품종은 다복찰, 동진찰, 시험요인은 이앙시기(3처리) 및 재식밀도(4처리)를 두었다. 이앙 시기별로 이앙 17일 전에 온탕 소독(62°C, 10분), 종자 소독(32°C, 1일), 침종(32°C, 1일), 간이출하(30°C, 3일) 과정을 거쳐 부직포 육묘(12일 정도)를 실시하였다. 5월 20일(이앙520)부터 5월 30일(이앙530), 6월 9일(이앙609)까지 10일 간격으로 드문모심기 전용 이앙기로 이앙하였으며, 주당 본수는 5.7개 정도였다. 이앙 시기별로 시험포장을 구분하였고 포장내에 2품종, 각각 3.3㎡당 80주, 60주, 50주, 37주 등 재식밀도 처리구를 두었으며, 처리구마다 3반복 조사구(10주/반복, 5본/주) 설치하였다. 10a당 9-4.5-5.7kg($N$-$P_2O_5$-$K_2O$)를 밑거름(50%)-분얼거름(20)-이삭거름(30) 등 3회 거쳐 시비하였다. 중간물떼기는 이앙 32일째부터 10일간 실시하였으며, 예상 출수 30일 전에 충분하게 담수하였다. 이앙 20일째부터 10일 간격으로 경수, 초장, 엽색도 등 생육 조사, 그리고 출수기, 후기 생육 및 병해충을 조사하였다. 향후 수확기에 수량, 수량구성요소, 미질 및 품위를 분석할 계획이다.
시험토양은 pH 6.0~6.3, EC는 0.68~0.85dS/m, 유기물 함량은 52~57g/kg수준으로 높았다. 동진찰 발아율(94.0~98.1%)이 다복찰(89.9~94.9%)보다 우수하였다(3~6%P ↑). 다복찰 묘 충실도(102~106mg/주)가 동진찰(79~101mg/주)보다 다소 좋았으며, 이앙530 묘소질이 가장 좋았다. 동진찰 초장은 다복찰에 비해 다소 길었으나 이앙시기 및 재식밀도별 초장의 변화 유형은 비슷하였다. 이앙520구의 80주에서 초장이 가장 작았고 이앙609구에서는 80주에서 다소 길었으나, 처리구간의 유의성은 없었다. 동진찰 및 다복찰 경수는 37주에서 이앙 후 40일째, 50주, 60주, 80주에서는 30일째 가장 컸다. 출수기는 다복찰에 비해 동진찰이 3~7일 정도 빨랐으며, 특히 이앙520 동진찰에서는 재식밀도가 높을수록 출수기가 빠른 경향을 보였으며, 이앙530 이후에는 재식밀도간 차이가 거의 없었다. 동진찰에 비해 다복찰 간장이 3~6cm 작았으며, 2품종 모두 이앙609구에서 가장 낮은 값을 보였다. 수장도 간장과 비슷한 경향을 보였다. 수수는 2품종 모두 이앙이 늦을수록 증가하였으며, 37주에서 가장 높았으며, 80주에 비해 다복찰, 동진찰 각각 73.8%, 77.4% 높았다. 다복찰의 경우 3.3㎡당 수수는 이앙시기별과 관계없이 상대적으로 80주에서 가장 많았고 이앙520에서 재식밀도간 차이는 감소하였지만 이앙시기가 늦을수록 수수는 증가하는 경향을 보였다. 동진찰도 비슷한 경향을 보였으며, 이앙520과 이앙609사이에 수수 차이는 적었다. 병 발생은 잎집무늬마름병, 세균성벼알마름병, 이삭누룩병이 주로 관찰되었으며, 세균성 벼알마름병은 출수기와 맞물린 이앙530에서 가장 크게 발생하였으며, 이앙520도 비슷한 경향을 보였다. 이삭누룩병 발생이 심하였는데 재식밀도간 차이보다는 이앙시기별 차이가 더 크게 발생하였으며 품종 간의 병 발생 차이는 없었다.
이상의 결과로 수수 측면에서 조기 이앙할 경우에는 50~60주, 늦은 이앙 시에는 80주가 유리할 것으로 보이며, 추후 주당 립수, 등숙률, 천립중 등을 조사하고 경영비 등을 고려하여 합리적인 이앙시기 및 재식밀도를 판단할 수 있을 것으로 판단된다.

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PA-68

# Changes according to Water Management of Methane Emissions through Rice Plants in Rice Paddy Fields

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**[Introduction]**
It is known that methane is generated when the anaerobic condition due to irrigation of rice paddy continues, and about 90% of it is released into the atmosphere through the aerenchyma of rice plant. In this regard, this study was conducted to examine the changes caused by intermittent drainage other than continuously flooding plot.

**[Materials and Methods]**
Saeilmibyeo was transplanted as young seedling on June 9, 2022 in the test field (Wanju) of the National Institute of Crop Sciences in order to check the change in the amount of greenhouse gas generated by water management and the effect of rice plant body. Water management includes continuously flooding, mid-season drainage(7/6~7/20), AWD(alternate wetting & drying) 10cm or 15cm . AWD treatment was carried out from 20$^{th}$ day after transplanting. Irrigation was performed again to 5 cm above the ground when the water level reached 10 cm or 15cm below ground. AWD plot was Continuously flooded 20 days from the 20th day before heading date to heading date, and then the AWD treatment was carried out again. The amount of methane generated was collected using the chamber method and quantified through GC method. Eight rice stock were planted in the chamber was compared with empty chamber(removing rice stock) to evaluate the rate of release into the atmosphere through the rice plant.

**[Results and Discussion]**
The amount of methane generated in the continuously flooding plot was insignificant until 10 days after transplanting, and then reached a maximum about 30 days after transplanting. Of the 91.6kg/10a methane generation (accumulated amount from June 21st to August 24th), 88% was emitted through rice plants from the continuously flooding plot, and only 12% was volatilized directly from the soil into the atmosphere. However, in intermittent drainage(midseason drainage, AWD 10, and AWD15 etc.), the proportion of the amount emitted through rice plant was relatively reduced to 43%, 76%, and 56%, respectively. It was found that this was not a decrease in the amount emitted directly from the soil, but rather a decrease in the amount released through the rice.

**[Acknowledgement]**
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PA-69

# Comparison and Analysis of Functional Materials by Wheat Sprouts Variety according to LED Light Conditions

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**[Introduction]**

Wheat varieties differentiated from imported wheat are being developed to promote the production and consumption of domestic wheat, but farmers are avoiding it due to low economic feasibility compared to other crops and difficulties in the cropping system due to climate conditions. Therefore, this study was conducted to set light conditions in indoor plant factories that were not affected by weather and natural disasters, compare the analysis of functional substances for each variety of wheat sprouts, and use them as basic data for future plant plant-style sprout cultivation conditions and high functional cultivation methods.

**[Materials and Methods]**

To analyze phenol components such as total flavonoids and total polyphenols according to light conditions and compare antioxidant properties (DPPH, ABTS), this study cultivated wheat sprouts of Saegeumgang, Jogyeong, and Ariblack, Arijinblack varieties at the Chungcheongbuk-do Agricultural Research & Extension Services in a plant factory.Wheat seeds are seeds produced by the National Institute of Food Science and were planted on seedbeds (30x60cm) for breeding, immersed in distilled water, and grown after germinating under cancer conditions for 24 hours. The light sources used red LED, blue LED, mixed light (red+blue+fluorescent light), and dark conditions, and each light source set a PPFD value of 100 μmol·m-2 · s-1 and cultivated under light conditions for 16 hours a day. The temperature was set to 25°C, cultivated 12 days after sowing, and harvested to analyze the functional substance content.

**[Results and Discussion]**

The total polyphenol content and flavonoid content, which are phenol components, were analyzed to compare the functional substance content between wheat sprouts according to LED light sources, Therefore the total flavonoid content was the highest at 674.6 mgCE/100g in the red light section of arijinblack, and all four species were significantly the lowest in the dark condition treatment section.

The total flavonoid content by light treatment showed different results for each type.numerically, the dark condition section of Ariblack was the highest at 1603.1 mgGAE/100g, and the colored wheat, Ariblack and Arijinblack, showed a high tendency in mixed light, and the general wheat, Saegeumgang, and Jogyeong, showed a high tendency in the mixed light section.

The total polyphenol content by wheat sprout variety was high in the order of Ari black, Saegeumgang, Jogyeong, and Arijinblack, and the mixed light and dark condition treatment section of Ariblack were significantly the highest, and the Arijin black variety showed the lowest tendency. The total polyphenol content by light treatment was different between varieties, and the red light was significantly higher for Saegeumgang, the dark condition treatment section for Ari black, and the mixed light treatment section for Jogyeong and Arijin black varieties.

The DPPH radical-scavening activity of wheat sprouts according to light treatment was compared. All four varieties of wheat sprouts have improved DPPH radical-scavening activity. Comparing the average value of each variety, the activity was significantly the highest at 66.7% under the dark conditions of the jogyeong, and the lowest at 60.6% under the dark conditions of the Saegeumgang. In the light treatment conditions, the activity was the highest at 64.5% in the arijin black variety. As a result of evaluating additional antioxidant activity using ABTS+ radical, it showed the highest activity of 80.6% in the light treatment section of Saegeumgang and the lowest activity of 66.6% in the dark treatment section of Saegeumgang. It was confirmed that antioxidant activity was improved in wheat sprouts grown under light conditions in all varieties except Arijin black.

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PA-70

# Physiological and Spectroscopic Changes of Rice by Nitrogen Fertilization Conditions

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**[Abstract]**
An appropriate amount of nitrogen fertilizer input during rice cultivation is essential for rice growth, quality control, and reduction of greenhouse gases in paddy fields. Therefore, it is necessary to develop a technology that can check whether an appropriate amount of fertilizer is applied in paddy fields. In this study, we tried to derive a method for diagnosing nitrogen fertilization level using spectroscopic diagnosis, physiological analysis, and molecular indicator genes. Nitrogen fertilization treatment was performed in a greenhouse by dividing into five treatment conditions: no fertilization (N0), low fertilization (N0.5), standard fertilization (N1.0), excessive fertilization (N1.5), and double fertilization (N2.0), respectively. Growth characteristics analysis was investigated by nitrogen fertilization conditions and growth stages, and the height of the canopy was analyzed using a laser scanner. Physiological and spectroscopic analyses were performed by analyzing chlorophyll and sugar contents and measuring SPAD and leaf spectrometer on rice leaves. In addition, real-time PCR experiment was performed to check the relative expression levels of several known nitrogen metabolism related genes. These results suggest that spectroscopic techniques can be helpful in diagnosing the level of nitrogen fertilization in rice paddy fields.

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PA-71

# Effect of Elevated Temperature on Physiological and Molecular Responses and Photoassimilate Production of Rice Leaves During Early Seed Development

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**[Abstract]**
The increase in atmospheric temperature due to climate change prolongs the period of exposure to high-temperature environments during rice cultivation. In particular, high-temperature during early seed development greatly affects on the productivity and quality of rice. The high temperature at this time not only affects the transport and distribution of assimilates from leaves to seeds and the accumulation of starch in the seeds, but also affects the leaves, which are the production organs of assimilates, and increases the consumption of assimilation products due to an increase in respiration. Therefore, in this study, rice was grown in temperature gradient chambers(TGC) to analyze the effects of high temperature on physiological responses, assimilate production, and changes in gene expression in rice leaves. Analysis of chlorophyll and sugar contents and RNA-seq experiments were performed using flag leaves collected under normal and elevated temperature conditions, respectively, during the early seed development stage, and then these results were comprehensively discussed.

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PA-72

# Study on the Method of Diagnosing the Individuals Crop Growth Using by Multi-Spectral Images

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**[Abstract]**
In this study, multispectral images of wheat according to soil water state were collected, compared, and analyzed to measure the physiological response of crops to environmental stress at the individual level. CMS-V multi-spectral camera(Silios Technologies) was used for image acquisition. The camera lens consists of eight spectral bands between 550nm and 830nm. Light Reflective information collected in each band sensor and stored in digital values, and it is converted into a reflectance for calculating the vegetation index and used. According to the camera manual, the NDVI(Normalized Difference vegetation index) value was calculated using 628 nm and 752 nm bands. Image measurement was conducted under natural light conditions, and reflectance standards(Labsphere) were captured with plants for reflectance calculation. The wheat variety used Gosomil, and the wheat grown in the field was transplanted into a pot after heading date and measured. Three treatments were performed so that the soil volumetric water content of the pot was 13~17%, 20~23%, and 25%, and the growth response of wheat according to each treatment was compared using the NDVI value. In the first measurement after port transplantation, the difference in NDVI value according to treatment was not significant, but in the subsequent measurement, the NDVI value of the treatment with a water content of 13 to 17% was lowest and was the highest at 20 to 23%. The NDVI values decreased compared to the first measurement in all treatment, and the decrease was the largest at 13-17% water content and the smallest at 20-23%. Although the difference in NDVI values could be confirmed, it would be difficult to directly relate it to the water stress of plants, and further research on the response of crops to environmental stress and the analysis of multi-spectral image will be needed.

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PA-73

# Effects of Food Waste Mixed Organic Fertilizer Treatment on Growth and Yield of *Capsicum annuum*

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**[Abstract]**
The global population is increasing every year, and the amount of food waste is also increasing. Direct landfilling of food waste has been prohibited since 2005, and in accordance with the London Convention in 2013, the discharge of livestock manure, sewage sludge, and food waste into the sea is prohibited. In the case of incineration to treat the discharged food waste, the heat point is lowered due to the moisture in the food waste itself, so fuel must be added. Therefore, this study was conducted to get basic data for setting the limit of application by investigating the growth and yield of crops after treating food waste dry powder mixed fertilizer (MF) on red pepper. In the experiment, continuous cultivation was carried out for two years in 2021 (1st year) and 2022 (2nd year). The treatment groups were set as Not Treatment (NT), Chemical Fertilizer (CF), Mixed Fertilizer (MF), Mixed Fertilizer×2 (MF×2). After harvest, crop growth and yield were investigated. As a result of the 1st years of growth survey, CF, MF, MF×2 show significant difference in shoot length compared to NT. About fresh weight and dry weight, CF show significant difference compared to NT. The 2nd years of growth survey, the shoot and root length, fresh weight did not show significant difference with NT. In case of dry weight, MF is significant increased compared to NT. As a result of the yield survey of the 1st year, all treatment groups did not show a significance in yield compared to the NT. In case of 2nd year, all treatment groups show significantly increased value compared to NT. The yield of MF was highest among the treatment groups. In the future, it is thought that it is necessary to quantitatively evaluate the effect of food waste dry powder mixed fertilizer through additional experiments and continuous cultivation, and to establish an appropriate amount of use and establishment of a manual based on this.

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PA-74

# Effect of Continuous Treatment of Mixed Organic Fertilizer With Food Waste on the Growth and Yield of *Solanum lycopersicum*

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**[Abstract]**
According to the statistics of the Ministry of Environment, the amount of food waste generated in Korea is 15,903 tons, which accounts for about 30% of the daily household waste. Food waste in Korea is on the rise, and various odors, greenhouse gases, and leachate generated in the process of discharging, transporting, and processing are emerging as social problems. Accordingly, there is a need for a method for recycling food waste. Therefore, this study was carried out to establish an appropriate limiting dose by manufacturing fertilizer mixed with food waste powder and treating it on tomatoes to investigate the growth and yield of crops. The experiment was carried out with continuous cultivation in 2021 (1st year) and 2022 (2nd year), and the treatment groups were set to No Treatment (NT), Chemical Fertilizer (CF), Mixed Fertilizer (MF), and Mixed Fertilizer×2 (MF×2). As a result of the 1st year growth survey, shoot and root length did not show a significant difference between the treatment groups, and the fresh weight showed a significant difference between the MF and MF×2 . As a result of the 2nd year growth survey, there was no significant difference in shoot length, root length, and dry weight between the treatment groups, and the fresh weight of the CF was significantly greater than that of the MF×2. The yield of 1st year, MF×2 increased significantly compared to other treatment groups. In the case of 2nd year, CF, and MF×2 show significantly high values compared to NT. Judging from these results, continuous cultivation using food waste powder mixed fertilizer did not have a significant effect on crop growth and yield. However, it is considered that several studies including continuous cultivation experiments are needed to accurately set the appropriate application amount and limit the application amount of the mixed fertilizer for food waste.

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PA-75

# Effect of Continuous Treatment of Mixed Organic Fertilizer With Food Waste on the Growth of Lettuce

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**[Abstract]**
According to data from the Ministry of Environment, food waste accounted for 27% of the nation's household waste in 2020, and 4.67 million tons of food waste is being discharged per year. According to the Food Waste Direct Landfill Prohibition Act, food waste must be incinerated, composted, fodder, and decomposed before landfilling. The cost of incineration and landfilling of food waste is considerable. Therefore, through the process of turning food waste into fertilizer, we are going to investigate the limit of crop application and the change in the growth of crops during continuous use of food waste fertilizer. This study investigated the growth of lettuce such as shoot length, root length, leaf number, fresh weight, and dry weight after treating lettuce with food waste dry powder mixed fertilizer. The experiment was carried out continuously in 2021 (1st year) and 2022 (2nd year), and the treatment groups were set to No Treatment (NT), Chemical Fertilizer (CF), Mixed Fertilizer (MF×1), and Mixed Fertilizer×2 (MF×2), was repeated 3 times. As a result of the 1st year growth survey, there was no significant difference between NT and CF in the case of shoot length, but MF×1 and MF×2 were significantly decreased compared to NT. Root length was not significantly different in all treatment groups. As for the leaf number, there was no significant difference between NT and MF×1, but CF and MF×2 were significantly decreased compared to NT. In fresh weight, MF×1 and MF×2 were significantly decreased compared to NT, and in the case of dry weight, there was no significant difference between NT, MF×1, and MF×2. As a result of the 2nd year growth survey, there was a significant difference in CF and MF×2 in leaf number, but there was no significant difference in all treatment groups with respect to shoot length, root length, fresh weight, and dry weight. Through continuous additional research, it is necessary to confirm the change in soil composition and the growth of crops due to food waste fertilizer treatment.

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**PA-76**

# Effect of *Rumex acetosella* Extract on Germination and Growth of *Festuca arundinacea*

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**[Abstract]**
외래잡초인 애기수영(*Rumex acetosella*)는 생태계 교란종으로 생물다양성을 감소시키고, 우리나라 목초지에 우점하고 있어 큰 문제를 야기한다. 애기수영의 경우, 살초효과 및 제초활성물질인 chrysophanic acid 와 catechol이 밝혀져있지만, 톨페스큐(*Festuca arundinacea*)에 대한 살초 효과 연구는 미비하다. 이에 본 연구는 톨페스큐 종자에 대해 애기수영 MeOH 추출물을 처리한 Seed bioassay를 진행해 $IC_{50}$ 값을 구하고, 톨페스큐에 애기수영 MeOH 추출물을 경엽처리를 진행한 후 생육조사를 진행했다. Seed bioassay의 경우, petri dish 위에 톨페스큐 종자 20개가 치상하고, 애기수영 지상부 추출물과 지하부 추출물을 각각 20,000 mg $L^{-1}$, 10,000 mg $L^{-1}$, 5,000 mg $L^{-1}$, 2,500 mg $L^{-1}$ 농도로 serial dilution 하여 1mL씩 분주한 뒤, 일주일 뒤에 발아한 종자에 대해 생체중을 조사하고 Prizm 프로그램을 이용해 $IC_{50}$을 구하였다. 경엽처리의 경우, 톨페스큐 종자 파종 4주 뒤에 $IC_{50}$값이 더 낮았던 지상부 추출물을 100,000 mg $L^{-1}$, 50,000 mg $L^{-1}$, 25,000 mg $L^{-1}$, 12,500 mg $L^{-1}$, 6,250 mg $L^{-1}$ 농도로 serial dilution 한 뒤 5mL씩 일주일 간격으로 3회 경엽처리를 진행하였고, 마지막 처리 일주일 뒤 초장, 근장, 생체중, 건물중을 조사하였다. Seed bioassay 결과, 애기수영 지하부 추출물에 대한 톨페스큐의 $IC_{50}$값은 3274가 나왔고, 애기수영 지상부 추출물에 대한 톨페스큐의 $IC_{50}$값은 2728가 나왔다. Seed bioassay 결과를 바탕으로 효과적이었던 지상부 추출물을 이용해 톨페스큐 경엽처리를 진행하였다. 애기수영 지상부 추출물 경엽처리 결과, 톨페스큐 초장과 생체중이 추출물 처리량이 높아짐에 따라 낮아졌으며, 100,000 mg $L^{-1}$ 처리구는 Control과 비교해 유의적으로 감소하였고, 처리량이 높아짐에 따라 근장이 감소했지만, 유의적인 차이는 없었다. 그리고 건물중은 100,000 mg $L^{-1}$ 처리구가 Control, 12,500 mg $L^{-1}$, 6,250 mg $L^{-1}$ 처리구와 비교해 유의적으로 낮았다.

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# Screening and Identification of Salt Tolerant Peanut (*Arachis hypogaea L.*) Genotypes under Salinity Stress

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**[Abstract]**

Salinity in surface waters is increasing around the world. Many factors, including increased water extraction, poor irrigation management, and sea-level rise, contribute to this change, and posing a threat to plant development and agricultural production. Seeds exposed to high salinity, have a lower probability of germinating and various physiological and biochemical effects. Salinity stress affects more than 20% of agricultural land and about 50% of irrigated land. In the current study, our objective is to identify the salt-tolerant peanut (*Arachis hypogaea L.*) Korean genotypes under salinity stress. Thus, two-week-old 19 diverse peanut Korean genotypes were exposed to 10 days of salinity (150 mM NaCl) stress. Based on the growth attributes investigation, Baekjung and Ahwon genotypes showed significantly higher shoot lengths compared to control plants. Whereas, the Sinpalwang genotype exhibited a significantly positive response for plant growth and reduced wilting symptoms compared to other genotypes. This study was able to find out peanut tolerant and sensitive genotypes for salt stress. These results may provide a good template for further salt-tolerant peanut cultivar improvement programs. Identified diverse salt-responsive genotypes can be utilized as source material in Korean breeding schemes for peanut crop improvement for salt and other abiotic stress tolerance.

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# Effect of *Solidago altissima* L. Extract on Forage Crop Germination

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**[Abstract]**
There are 28 families and 166 species of exotic weeds on agricultural land and among these, 23 families and 80 species of exotic weeds occur on pastures. Among them, the *Solidago altissima* is a perennial weed belonging to the asteraceae family and it is an exotic weed that spreads to the surrounding area using methods such as high seed production, vegetative propagation using underground rhizomes and allelochemical. Accordingly, in 2009, the Ministry of Environment designated it as an ecosystem-disrupting species. This study was conducted to obtain basic data about the effects of *S.altissima* derived allelochemicals on forage crops. The root of *S.altissima* was separated, dried in the shade and then pulverized to prepare an root powder. Powder was repeatedly extracted with methanol for 3 days and concentrated under reduced pressure to obtain an root methanol extract. Dissolve the extract in distilled water, dispense it in a separate-funnel and proceed with liquid-liquid extraction by adding equal amounts of n-haxane (Hex), chloroform ($CHCl_3$), ethyl acetate (EtoAC), and butanol (BuOH) in order of increasing polarity. A seed-bioassay was performed using fractions for each solvent, followed by separation and purification by silica gel column chromatography. As a result of the fraction germination test for each solvent, the $IC_{50}$ values using the fresh weight of each fraction were 898.3 mg $L^{-1}$, 676.3 mg $L^{-1}$, 1160 mg $L^{-1}$ and 1360 mg $L^{-1}$. CA, CB, and CC fractions were obtained through primary silica gel column chromatography that used $CHCl_3$ fraction. As a result of seed-bioassay using each fraction, the $IC_{50}$ values for the fresh weight of each fraction was 537.3 mg $L^{-1}$, 1280 mg $L^{-1}$ and 1947 mg $L^{-1}$. Based on this, 5 fractions were obtained as a result of secondary silica gel column chromatography using the CA fraction. A seed-bioassay was performed, as a result, the lowest $IC_{50}$ value was calculated as 226.7 mg $L^{-1}$ in the CAE fraction. Based on this, the fraction was analyzed by GC-MS. The results of this study can be used as basic research data on the effects of weeds on forage crops and allelochemicals secreted from *S.altissima.*

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# An Analysis of the Growth Characteristics of Triticale (x *Triticosecale* Wittmack) in Pocheon, Gyeonggi-do according to Seeding rate and Seeding date

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**[Introduction]**
Triticale (x *Triticosecale* Wittmack) is a hybrid between wheat and rye. Triticale is a crop that has both the high nutritional value of wheat, adaptability of rye. It is not used in Korea for edible, but it is used as an edible or feed crop in Northern Europe, Eastern Europe, and North America. In this study, We wanted to test whether it could be cultivated in the high-latitude area such as North Korea. Therefore, Pocheon, a high-latitude area in Gyeonggi-do, was selected to cultivate. Gwangyoung(GY), Minpung(MP), and Saeyoung(SY) were used in the experiment.

**[Materials and methods]**
The triticale varieties used in the experiment were 1.Gwangyeong(GY) 2. Minpung(MP) 3. Saeyoung(SY), provided by RURAL DEVELOPMENT ADMINISTRATION (RDA). The experimental area was gyeonggi-do pocheon yeongjung-myeon (100 m above sea level). Sowing was conducted four times; the first and second sowing in the fall, and the third and fourth sowing in the spring of the following year. The seeding rates were 1x (15 kg/10 a, standard seeding rate by RDA), 1.5x (22.5 kg/10 a), and 2x (30 kg/10 a). The fertilizer levels were N 12 kg/10 a and P 6.3 kg/10 a. Wintering rate, culm length, head length, fresh weight and dry weight were measured at harvest period on July, 2022. 30 cm were randomly selected three times per plot to measure fresh and dry weight 20 samples were three times selected to measure height.

**[Results and Discussion]**
The total length of triticale was 111.4 cm and 96.4 cm in the first and second sowing. And third and fourth sowing were the average of 76.1 cm and 86.8 cm. The total fresh weight of each cultivar, there was no significant difference, however, SY showed higher value than GY and MP in the first and second sowing. In the second sowing, the fresh weight of 1x MP was 478.7 g, which was much higher than that of GY 209.0 g and SY 247.7 g showing significant difference. 1x SY was higher than 1.5x SY, 2x SY in the first sowing and lower than 1.5x, 2x in the second sowing. In addition, 1.5x MP had a lower fresh weight than 1x and 2x in the third sowing, and the highest in the fourth sowing. Therefore, It was found through this experiment that the appropriate sowing period can vary depending on the seeding rate even for the same variety.

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# Comparison of Triticale (x *Triticosecale* Wittmack) Growth Characteristics according to Seeding date and Seeding rate in Mountainous Areas in Gangwon-do

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**[Introduction]**
Most of self-sufficient roughages in south Korea are rice straws, and the proportion of high-quality roughages such as grass and feed crops continues to decrease. Triticale (x *Triticosecale* Wittmack) is a suitable self-sufficient roughage that grows even in barren environments and has vital cold resistance. This experiment attempts to identify the growth characteristics of the triticale through seeding in fall and spring each. To preparing for unified agriculture, appropriate seeding period and seeding rate are determined in a Gangwon-do which climate similar to that of the North Korean region.

**[Materials and Methods]**
The triticale seeds used in the experiment received from the Central Crop Department of the Rural Development Administration, Gwangyoung(GY), Minpung(MP), and Seyoung(SY). Bongpyeong in Gangwon-do, was selected as the experimental site. The seeding were conducted two times in fall of 2021 (first seeding and second seeding), and also two times in spring of 2022 (third seeding and fourth seeding). The seeding rates were set to three levels: 15kg/10a(X1), 22.5 kg/10a(X1.5), and 30kg/10a(X2). The wintering rate, head length, culm length, total length, fresh weight, and dry weight were investigated on July, 2022. To measure characteristics, 30 cm were randomly selected three times per plot for weight and 20 samples were three times selected for height.

**[Results and Discussion]**
When comparing the total length values, GY second seeding X1.5 showed the highest value (average 134.5cm), but there was no statistical significance difference among the seeding date and the seeding rate in GY. In fresh weight, GY and SY were not affected by the date of seeding and the rates of seeding. However, the second seeding (491.0g) was significantly higher than the first (328.6g) during the fall seeding of MP, and did not change significantly from the rates of seeding. There was no statistical significance difference according to the seeding date and the seeding rate in all varieties, but among spring seeding dry weight, the third MP X2 showed the highest value with an average of 128.7g.

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## 엉겅퀴종자의 형태 및 발아 특성

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**[서론]**
가시엉겅퀴(*Cirsium japonicum*)는 국화과에 속하는 여러해살이 풀로, 예로부터 항균, 진통, 소염, 항암, 지혈, 혈당강화, 간 보호 및 신경계뿐만 아니라 기억력 향상 등의 약효가 있는 것으로 알려져 있다. 이처럼 우수한 효능으로 식·의약 소재로 개발 가능성이 높아 최근 재배면적이 증가하면서 가시엉겅퀴 재배기술 및 식품으로서 표준화가 필요한 실정이다. 또한, 식물소재 대량 증식을 위한 연구가 미흡하고 특히, 가시엉겅퀴의 발아에 대한 연구가 보고된 바가 없어 육묘 생산을 위한 체계적인 발아특성 연구가 필요하다. 따라서, 본 연구는 엉겅퀴 종자의 안정적인 생산 확립의 기초자료로 활용하기 위해 엉겅퀴 종자의 형태 및 발아특성을 알아보고자 수행하였다.

**[재료 및 방법]**
본 실험에 이용된 가시엉겅퀴 종자는 전라북도 익산군 용동면에서 채집하여 정선 한 종자를 실험에 이용하였다. 종자 형태의 특성은 종자 100립 중 30립을 무작위 선발하여 4반복으로 길이와 너비를 측정한 후 평균과 표준오차를 구하였으며, 종자의 활력 검증은 tetrazolium (TZ) 검사로 하여 활력을 판단하였다. 발아 환경 조건에 따른 발아특성은 치상 후 1일 간격으로 종자의 발아 상태를 조사하였고, 발아율(GP), 평균발아소요일수(MGT), 발아속도지수(GSI), 발아균일도(GU), 파종 후 최종 발아율에 대한 50% 발아까지 도달하는데 소요되는 기간(T50) 등을 분석하였다.

**[결과 및 고찰]**
가시엉겅퀴 종자는 긴 난형의 형상으로 종피는 황갈색으로 보였다. 종자의 크기는 길이 3.55 ± 0.057 ㎜, 너비 1.50 ± 0.037 ㎜ 이고, 천립중은 2.03 ± 0.062 g 이였으며, 종자의 단면은 무배유종자로 TZ 테스트 결과 모두 배가 전체적으로 붉은색으로 염색되어, 배 상태가 매우 양호하여 활력이 높은 것으로 판단되었다. 온도에 따른 발아특성에서는 15°C에서 발아하지 않았으며, 25°C에서 GP, MGT, GU가 각각 23.3%, 1.94, 2.11로 가장 높고, 빠르게 나타나 엉겅퀴 발아시 최적 온도는 25°C로 판단된다.

**[사사]**
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## 식이유황 처리가 찰옥수수의 생육에 미치는 영향

채세은[1], 박의진[2], 한소은[2], 이예림[2], 추지웅[2], 김성렬[2], 전승호[3]*
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**[서론]**
황(S)은 16개의 식물 필수영양소 중 질소(N), 인(P), 칼륨(K) 다음의 4번재 다량 영양소로, 식물 생장과 수율을 위해 요구도가 높은 영양소이다. 황의 시용으로 땅콩의 수량증가, 딸기의 당 함량 향상, 홍화 수량 증가, 마늘의 향기성분 함량 증가 등의 수량 증대뿐만 아니라, 품질 향상에도 효과가 있음이 보고되었다. 하지만, 옥수수에 식이유황을 적용한 연구는 미흡한 실정이다. 이에, 식이유황 처리횟수가 찰옥수수의 생육에 미치는 영향을 알아보고자 시험을 수행하였다.

**[재료 및 방법]**
본 연구는 순천대학교 부속농장에서 '백옥찰'을 시험품종으로 사용하여, 농촌진흥청 표준재배법에 준하여 재배시험 하였다. MSM 시용방법은 1 g/1평(100%)기준으로 ① 기비(BF, basal fertilizaton)+추비1회, ② 기비+추비2회, ③ 추비1회, ④ 추비2회, ⑤ 무시용구로 하였으며, 살포시 100 g 당 200 L의 수돗물에 희석하여 시용하였다. 기비는 이식전 토양표면에 관주처리하였고, 추비는 잎이 7~8매 일 때, 출웅기 때 총 2회 엽면시비 하였다. 생육특성조사는 농촌진흥청 연구조사분석기준에 준하여 실시하였다.

**[결과 및 고찰]**
식이유황 처리에 따른 옥수수 7~8엽기 시기의 기비 후 추비 전 생육특성 조사에서 Fv/Fm 값은 무기비 처리구 보다 기비 처리구에서 평균 0.719 로 높게 나타났으며, 초장, 엽수, NDVI 값은 모든 처리구간의 통계적 유의성이 나타나지 않았다. 수확기 생육특성 조사에서 초장은 기비+추비 2회 처리구가 210㎝로 가장 길게 조사되었으며, 경태와 엽수에서는 기비+추비 1회 및 기비+추비 2회 처리구에서 굵고, 많은것으로 나타났다. Fv/Fm 값 또한 기비+추비 1회 및 기비+추비 2 회 처리구에서 가장 높게 조사되었다. 이상의 결과로 찰옥수수의 재배과정 중 식이유황 처리가 찰옥수수 생육에 영향을 미치는 것으로 사료된다.

**[사사]**
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PA-83

# Growth and Yield Characteristics to Fertilization Levels of New Sweet Sorghum Varieties 'Dalrong' and 'Saerom'

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**[Introduction]**
Sweet sorghum (*Sorghum bicolor*(L.) Moench) is an annual C4 plant in the family *Cruciferae*. The juice can be processed into sweeteners, alcoholic beverages, and biofuels, and the by-products remaining after squeezing the juice can also be used as livestock feed or biochemical materials. In Korea, native varieties are cultivated for four months from May to September and the juice is used for the production of alcoholic beverages, but there are no registered varieties. The Bioenergy Crop Research Institute (BCRI) bred 'Dalrong' with high sugar content and high amount of juice, and 'Saerom' with high biomass production in 2019. The new varieties have long stems and often falls down when strong winds such as typhoons blow during cultivation. Therefore, growth and yield responses of the new varieties to the level of fertilization were compared with that of native variety, 'Chorong', for the development of cultivation technology.

**[Materials and Methods]**
This study was conducted from May to August 2022 at the experimental field of BCRI in Muan, Jeollanam-do. The chemical properties of the soil were as follows: 9.2 g $kg^{-1}$ organic matter, 7.0 pH, 0.08 $dS \cdot m^{-1}$ EC, 0.5 $cmol^{+}$ $kg^{-1}$ K, 4.4 $cmol^{+}$ $kg^{-1}$ Ca, and 1.8 $cmol^{+}$ $kg^{-1}$ Mg. The standard fertilization (N-P-K 10-7-8) of sorghum was used and calculated into 100% fertilization, 50% fertilization, and non-fertilization. Each treatment was applied with urea, fused superphosphate, and potassium chloride. The varieties 'Chorong', 'Dalrong' and 'Saerom' were used. Seedling started in mid-April, and plugs were planted on May 19th, at intervals of 70 cm between rows and 30 cm between plants. Except for main stems, all new stems emerged later were removed. The stems were supported with a plastic rope in mid-July to prevent them from falling down by the wind. When the ears came out, they were covered with a net to prevent damage to birds. As the growth and yield parameters, heading date of the ears, stem length, and fresh weight of the stems were investigated based on the analysis criteria of agricultural science and technology research of RDA. All investigations were performed in three replications, and 10 plants per replication were investigated. The juice was extracted from the stems with a press-type juicer (GJ-456, Remkorea, S.Korea), and the amount of juice and sugar content (PAL-1, ATAGO, Japan) were measured.

**[Results and Discussion]**
The new varieties 'Dalrong' and 'Saerom' were headed 5 and 11 days later, respectively, compared to the variety 'Chorong', which were headed on July 20th. In particular, as the levels of fertilization decreased, the heading of 'Saerom' was delayed. Stem length was longer in varieties 'Dalrong' (373 cm) and 'Saerom' (387 cm) than in the 'Chorong' (272 cm) by more than 1 m. As the level of fertilization decreased, stem length increased but stem diameter decreased. There was no difference in the index of lodging because all stems were supported to each other. The fresh yield of stems in 'Chorong', 'Dalrong' and 'Saerom' were 23.8, 31.1, and 42.8 tons/ha, respectively. In particular, the variety 'Saerom', which had a large production of juice, had twice as much juice as 'Chorong'. However, there were no significant differences in the production of juice among the levels of fertilization. The sugar content of the juices of 'Chorong', 'Dalrong' and 'Saerom' were 13.8, 13.9, and 7.3 °Brix, respectively. The variety Dalrong showed a similar sugar content to 'Chorong', but 'Saerom' had a 47% decrease compared to 'Chorong'. Except for 'Chorong', the sugar content significantly decreased as the fertilization levels decreased. Therefore, considering the production of juice and sugar content, appropriate fertilization was required for the new sweet sorghum varieties.

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PA-84

# Effects of Shading on the Growth and Chlorophyll Fluorescence under Agrivoltaic System Conditions

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**[Abstract]**
Agrivoltaic System (AVS) was introduced with the concept that it could generate electricity by using the extra light remain after crops use for photosynthesis in farm, which can earn additional income. However, crop yield was declined under the AVS condition due to the decrease in light energy. In the past, many researchers have been studied about crop states under shading conditions. However, the phenomenon of partial shading such as under the AVS is not well studied. In this study, to figure out the response of crop under the different light conditions, the electron transport rate (ETR) and non-photochemical quenching (NPQ) of rice was investigated using the chlorophyll fluorescence measurement. Also, physiological changes of crops under the shading conditions were investigated.
The growth experiment under partial shading under AVS and overall shading which made of 35% shade cloth was conducted to understand the eco-physiological responses of rice to light in terms of the photosynthesis. Under the shading conditions, SPAD value and chlorophyll contents were higher, but the leaf thickness was lower than control. The overall shading condition show lower ETR than others during the growing season. In contrast, NPQ was higher than other treatments. This means the available light energy cannot contribute to photosynthesis under the shading condition.

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PA-85

# Analysis of Nationwide Soil Chemical Trait for the Application of Standard Nitrogen Level in Rice Cultivation

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**[Abstract]**
When 7 kg·10a$^{-1}$, which is less than the nitrogen standard application amount of 9 kg·10a$^{-1}$, is applied, the protein content is lowered and the palatibility is improved. In order to examine the applicability of nitrogen fertilization of 7 kg·10a$^{-1}$ nationwide, soil samples were collected from 240 paddy fields in 8 provinces in 2021, and the organic matter content, effective phosphoric acid, and effective silicic acid were analyzed for each sample. As a result of one-way ANOVA analysis between samples collected for each province, there was no significant difference in the content of organic matter, effective phosphoric acid, and effective silicic acid except for some provinces. The contents of organic matter was higher than the appropriate level(25 ~30 g·kg$^{-1}$) except for Gyeongsangbuk-do, the effective phosphoric acid was higher than the appropriate level(80 ~120 mg·kg$^{-1}$) in all provinces, and the effective silicic acid was lower than the appropriate level(157 ~180 mg·kg$^{-1}$) except for Gyeonggi-do, Jeollanam-do and Gyeongsangnam-do. As a result of analyzing the recommended fertilization amount based on the nitrogen application amount of 7 kg·10a$^{-1}$, 68.3% of the 240 samples were able to give nitrogen fertilizer less than 7.5 kg·10a$^{-1}$, and the rest had to be given more than that to satisfy the standard fertilization amount.
As a result of this study, 68.3% of rice paddies nationwide can be cultivated with a standard fertilization amount of 7 kg·10a$^{-1}$, however it was thought that continuous nutrient management would be required for other paddies.

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PA-86

# Changes in Rice Yield and Quality According to the Levels of Phosphate and Potassium Fertilization Under Reduced Nitrogen Fertilizer Condition

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**[Abstract]**
In order to investigate changes in rice yield and quality according to phosphate and potassium fertilization levels when nitrogen fertilizer was applied at 7 kg·10a$^{-1}$, a field experiment was conducted at National Institute of Crop Science of Korea in 2021. Three Korean rice varieties were grown in paddy fields, and phosphate and potassium fertilizer were treated at three levels(N-P-K 7-4.5-5.7 kg·10a$^{-1}$, 7-3-3 kg·10a$^{-1}$, 7-0-0 kg·10a$^{-1}$). When phosphate and potassium fertilizers were not treated, the yield of Ilpum and Chilbo was significantly reduced, and there was no significant difference in Hopyung.. The head rice ratio was significantly lower in the untreated plot of Hopyung and Chilbo, but there was no significant difference in the Ilpum. Protein content was significantly decreased in the untreated plot of Chilbo, and there was no significant difference in other varieties.
As a result of this study, it was confirmed that yield, head rice ratio, and protein content were lowered when phosphate and potassium fertilizers were not treated, and the degree of decrease was different depending on the variety.

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PA-87

# Effects of Different Nitrogen Application Levels on Yield and Protein Content of Rice Varieties in Korea

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**[Abstract]**
In order to evaluate the effect of nitrogen application levels on yield and protein content of rice varieties, a field experiment was conducted at National Institute of Crop Science of Korea in 2020. Five levels(0, 3, 5, 7, and 9 kg·10a$^{-1}$) of nitrogen fertilizer were treated to six Korean rice varieties. The nitrogen uptake amount, soil nitrogen content before and after rice cultivation, milled rice yield, and protein content in head rice were analyzed. As the treatment of nitrogen fertilizer increased, the nitrogen uptake amount of plants increased significantly. However, changes in nitrogen content in the soil before and after rice cultivation were different for each cultivar. The amount of nitrogen change in the soil decreased as the amount of nitrogen application increased in the three cultivars of Haepum, Gopum, and Odae, and the other three cultivars showed the opposite trend. As a result of correlation analysis of nitrogen application amount, nitrogen uptake amount, milled rice yield, and protein content of head rice, the five varieties except for Haepum showed a high correlation between these factors. The amount of nitrogen application and nitrogen uptake of plant showed a positive correlation about the milled rice yield and protein content of head rice. In particular, the protein content in head rice appeared to be more affected by nitrogen uptake amount than nitrogen application amount.
As a result of this study, the yield and protein content of rice had positive correlations with the level of nitrogen fertilizer, and had a high correlation with the nitrogen absorption of plants.

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PA-88

# Growth and Quality Characteristics in Response to Elevated Temperature during the Growing Season of Korean Bread Wheat

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**[Abstract]**
Wheat (*Triticum aestivum* L.) is the major staple foods and is in increasing demand in the world. The elevated temperature due to changes in climate and environmental conditions is a major factor affecting wheat development and grain quality. The optimal temperature range for winter wheat is between 15~25°C, it is necessary to study the physiological characteristic of wheat according to the elevated temperature. This study presents the effect of elevated temperature on the yield and quality of two Korean bread wheat (Baekkang and Jokyoung) in a temperature gradient tunnel (TGT). Two bread wheat cultivars were grown in TGT at four different temperature conditions, i.e. T0 control (near ambient temperature), T1 control+1°C, T2 control+2°C, T3 control+3°C. The period from sowing to heading stage has accelerated, while the growth properties including culm length, spike length and number of spike, have not changed by elevated temperature. On the contrary, the number of grains per spike and grain yield was reduced under T3 condition compared with that of control condition. In addition, the. The grain filling rate and grain maturity also accelerated by elevated temperature (T3). The elevating temperature has led to increasing protein and gluten contents, whereas causing reduction of total starch contents. These results are consistent with reduced expression of starch synthesis genes and increased gliadin synthesis or gluten metabolism genes during late grain filling period. Taken together, our results suggest that the elevated temperature (T3) leads to reduction in grain yield regulating number of grains/spike, whereas increasing the gluten content by regulating the expression of starch and gliadin-related genes or gluten metabolism process genes expression. Our results should be provide a useful physiological information for the heat stress response of wheat.

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PA-89

# Effect of Compost Application on Soybean Growth and Yield in Barren Soil

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**[Introduction]**
In barren soils, it is absolutely necessary to improve soil fertility in order to increase crop productivity due to a long-term shortage of soil organic matter and chemical fertilizers. In addition, North Korea's food productivity is about 50% of that of South Korea, and in order to increase the productivity of major crops, it is important to develop early ripening, disease-resistant, multi-variety varieties and intensive cultivation of crops that can increase food self-sufficiency early. Therefore, this study was conducted to establish the amount of organic compost input that can improve soil literacy in a short period of time in barren agricultural land to promote northern agriculture in preparation for unification.

**[Materials and Methods]**
Daewon and Seonpung soybeans were used for the test varieties, and the planting distance was 60 × 20 cm. The compost (1,000kg/10a) was divided into 4 treatments of no treatment, 1.0 times, 1.5 times, and 2.0 times, and sowed by repeating egg mass method 3 for each variety. Other cultivation management followed the Rural Development Administration's Agricultural Technology Guide, and growth and yield characteristics were investigated according to the Rural Development Administration's Agricultural Science and Technology Research and Analysis Criteria.

**[Results and Discussion]**
As a result of analyzing the physicochemical composition of the soil, pH, EC, and organic matter content increased as the amount of compost increased, and phosphoric acid was the highest at 162.6 mg/kg at twice the standard compost amount. As for the above-ground growth, the higher the composting dose, the greater the plant height and appearance, and the leaf color also increased, but there was no difference in the number of branches. The yields of Daewon and Seonpoong soybeans were 18~19% higher than the untreated ones, at 323 kg/ and 330 kg/10a, respectively, at 1.5 times the standard compost amount. Falling damage was severe at 2.0 times the amount of compost.

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PA-90

# Effects of Organic Manure on Maize Growth in Barren Land

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**[Introduction]**
Organic manure helps with a balanced supply of nutrients, including micronutrients, increased soil nutrient availability due to increased soil microbial activity, decomposition of harmful elements, improved soil structure and root development. (Han et al. 2016). According to Murmu et al. (2013), when tomato and maize were grown in acidic soils, organic fertilizer application improved crop productivity, nitrogen utilization efficiency and soil health compared to chemical fertilizers. The objective of this study is to investigate the effects of organic manure treatment on maize growth in barren land.

**[Materials and Methods]**
This project was conducted by creating a barren land (reclaimed using mountain soil) at Dongguk University Ilsan Agricultural Research Station. A total of 4 maize hybrids (Gwangpyeongok, Pungmiok, Singkwangok, and Shinhwangok 2) was used. Organic manure composed of 30% poultry manure, 10% cattle manure, 10% swine manure, and 55% organic matter was used in this study. The growth and yield characteristics of maize were investigated, such as days to silking date (day), plant height (cm), ear length (cm), ear width (cm), weight of 100 grains (g), and yield (kg/10a).

**[Results and Discussion]**
As a result of confirming the effect of organic manure on the initial growth of maize, the maize was much taller and had better leaf development in the barren land treated with organic manure. On the other hand, in the barren land that was not treated with organic manure, the maize was short and poorly developed. All varieties showed excellent growth and yield in the fields treated with organic manure. It was confirmed that organic manure application had an effect on maize growth and yield. These results can be used as basic data to develop an organic manure fertilization method to improve maize productivity in barren land in the future.

**[Acknowledgement]**
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PA-91

# Effect of Drought Stress on Morpho-Physiological Attributes of Adzuki Bean (*Vigna angularis*)

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**[Introduction]**

Adverse weather conditions are becoming more common due to climate change. Drought stress is one of the important abiotic stresses, which causes yield loss in the majority of plant species. Adzuki bean is a widely cultivated legume crop, and it is very important to understand how drought stress affects plants at the early growth stage. In this study, we investigated the effect of drought stress on morpho-physiological growth attributes where the plants were exposed to 10 days of drought stress in the growth chamber. The goal of this study was to access the drought effect on attributes of the Korean adzuki bean and establish drought screening for adzuki bean genotypes. This study can be further explored for developing the drought-resistant adzuki bean which can withstand adverse conditions and produce a higher yield.

**[Materials and Methods]**

The experiment was carried out in controlled environmental conditions inside the growth chamber. The photoperiod was set to 14 hours of daytime with a temperature of 28°C ± 2°C. The seeds were sown in pots of size 13.0 cm (diameter)*10.5(height). All the plants after emergence were grown under well-watered conditions for 10 days until they reached the vegetative (V2) stage. After then the plants were divided into two sets; control and drought treatment. The control plants were regularly watered for the next 10 days whereas the drought-exposed plants were not watered for the next 10 days. Different morpho-physiological characters; fresh plant weight, dry weight, root weight, shoot weight, plant height, soil moisture content and total chlorophyll content were measured by the respective means. The experiment was conducted with four replications.

**[Results and Discussion]**

The morpho-physiological characteristics of adzuki beans in response to drought stress were quantified in this study. Except for the total chlorophyll content all the other parameters were significantly higher in the controlled plants compared to the drought-stressed plants at $p \leq 0.001$ level. There was a significant decrease in the plant attributes like fresh plant weight, dry plant weight, root weight and plant height in the drought-stressed plants in comparison to the controlled plants at $p \leq 0.001$ level. Likewise, moisture content was also significantly reduced in drought-stressed plants compared to the controlled plants at $p \leq 0.001$ level. However, the plant's chlorophyll content was slightly higher in the drought-stressed plants than in the controlled plants although it was statistically non-significant. Specifically, plant height showed severe alteration due to the drought stress which may ultimately further affect the plant yield. More studies should be focused on investigating the rehydration of plants and checking the plant attributes till the seed maturity stage.\

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PA-92

# 새만금간척지에서 부분경운 파종방법이 사료작물 수량 및 노동력 절감에 미치는 영향
# Effect of Partial Tillage Seeding Method on Forage Crops Yield and Labor Saving in Saemangeum Reclaimed Land

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**[서론]**
간척지 토양은 공유수면을 매립하여 만든 간척농지로 국내 간척지 면적은 113천 ha로 국내 경지면적의 7 % 이상을 차지할 만큼 넓은 면적을 차지하고 있다. 간척농지는 면적이 크기 때문에 여기에 사료작물을 재배하면 많은 양의 조사료를 생산할 수 있을 것이다. 그러나 면적이 넓고 기본 경작단위를 2 ha이상 넓게 구성되어 있어 조사료를 재배할 때 일반 노지보다 농작업에 소요되는 종자, 재료비, 노동력 등 경영비가 많이 소요된다. 특히, 대면적에 작물을 재배할 때 소요되는 노동력과 노동시간이 많이 드는데도 불구하고 생산량과 가격이 낮아 경제성이 낮게 나타나고 있다. 따라서, 대면적을 이용하여 조사료 생산을 확대하기 위하여 일반 노지 재배보다 더 경제성 있는 재배방법을 모색하고자 새만금간척지에 사료작물을 재배할 때 부분경운직파기를 도입하여 노동력 절감정도를 분석하였다.

**[재료 및 방법]**
본 시험은 김제 국립식량과학원 새만금간척지 시험포장에서 2020년 10월부터 2021년 6월까지 수행되었다. 사료작물은 호밀(곡우호밀), 트리티케일(조성)을 사용하였으며 처리내용은 종자 파종시 일반 경운재배와 부분경운파종 재배를 두었다. 일반경운방법은 농가 관행에 준하여 농기계와 작업과정을 거쳐 파종하였고, 부분경운파종은 부분경운직파기를 이용하여 파종하였다. 시비량은 사료작물 표준시비량인 T-N-$P_2O_5$-$K_2O$ = 544-500-180 kg $ha^{-1}$을 시비하였다. 기타 재배법은 표준재배법에 준하여 재배하면서 파종방법별 사료작물의 발아율, 노동력 절감 정도, 사료작물 수량 등을 조사하였다.

**[결과 및 고찰]**
동계 사료작물을 파종할 때 부분경운 직파기는 경운부터 파종까지 5단계의 과정을 1회로 단축할 수 있고 농기계도 관행경운이 3개가 필요한 반면 부분경운 직파는 1개의 장비로 파종작업을 수행 할 수 있어 편리하였다. 또한 관행경운은 경운부터 파종 및 배토까지 5단계를 순차적으로 진행하는 반면 부분경운직파기는 한번에 진행함으로써 농작업을 획기적으로 단축시킬 수 있었다. 간척지에서 부분경운직파기를 이용하여 사료작물을 파종할 때 노동력 절감정도는 관행경운(산파)에 비하여 농작업 시간은 약 72.4%, 작업인력은 약 77.8%가 절감되었다. 사료작물(호밀, 트리티케일)의 $m^2$당 출현율은 트리티케일, 호밀 모두 부분경운직파에서 약간 높았으나 유의성은 없었으며 $m^2$당 경수는 호밀, 트리티케일 모두 부분경운직파에서 월등히 많아 부분경운직파가 사료작물의 입모에 유리한 것으로 판단되었다. 출현 이후 호밀과 트리티케일의 생육은 관행경운구와 부분경운직파구 모두 뚜렷한 차이 없이 비슷한 수준을 보였고, 생체수량은 부분경운직파로 재배한 것과 관행경운하여 재배한 구간에 유의적인 차이없이 비슷한 양이 생산되었다.

**[사사]**
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PA-93

# Suggestion of Spring Seedling Amounts and Drone Spreader Type for Italian Ryegrass using Drones

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**[Abstract]**
The production area of Italian ryegrass feed is gradually increasing and labor-saving technologies are being developed. If sowing and fertilization are carried out agricultural drones, working hours and labor are reduced. The purpose of this study is to suggest an appropriate seedling amount for feed production by drone spreading of Italian ryegrass in spring. In addition, we would like to review the productivity of the drone seeding machine that is being developed by Rural Development Administration(RDA) of Korea.
Italian ryegrass was sown by a drone in February at the NICS located in Gyehwa-hwa, Jeollabuk-do, South Korea. In Experiment 1, 50kg/ha, 60, 70, and 80 seeding rates were sown with a horizontal spreader drone. In Experiment 2, uniform spreaders type drone and horizontal spreader type were sown with the same seeding amount and compared. The drone was sown using the AF-52 aircraft.
The higher the seeding amount, the higher the emergence rate. As the seeding amount increased, the plant length increased, but the number of tillers per individual decreased. The dry matter weight of the feed was the highest at 1,326kg/10a at the seeding rate of 70kg/ha, and decreased by 20.5% at the seeding rate of 80kg/ha. The coverage ratio was the highest at 96 at the seeding rate of 70kg/ha, which was the most advantageous for spring sowing. In the comparative experiment according to the spreader type, the uniform spreader had a high emergence rate per unit area. When the uniform spreader was used, the dry matter weight of the feed was 17% higher than that of the horizontal one, and the coverage was about 5% higher.

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PA-94

# The Effects of Seeding Period and Reflective Mulching on Growth and Yield in Soybean Biovars

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**[Introduction]**

Soybeans are representative summer field crops in Korea, which can be rotated with other crops and increase productivity as a result of nitrogen fixation by rhizobium. In order to effectually apply the positive effects of soybean cultivation, this study would like to find out the appropriate seeding period according to the soybean biovars. Also, in soybeans the higher the amount of solar radiation within the range of not being affected by drought damage, the more positive the growth, flowering, and harvesting. This study was conducted to increase the amount of photosynthesis in the middle and lower canopies of soybeans by using reflective mulching.

**[Materials and Methods]**

This study was conducted at the farm affiliated with Chungnam National University for two years from 2021 to 2022. The area of one experimental plot was about 3㎡, and the total field area was about 470㎡. The arrangement method of plots is a randomized block design of three replications. The planting distance is 60cm×15cm. And three cultivars of soybeans are used: Chamol-kong of the early maturing cultivar, Taekwang-kong of the medium-late maturing cultivar, and Sunpung-kong of the late maturing cultivar. The effect of growth and yield on these three cultivars was investigated by varying the seeding period and the use of reflective mulching. The seeding periods were divided into four sections: May 20th, May 30th, June 10th, and June 20th. Each seeding period was divided into a plot using reflective mulching and a non-reflective plot. Three times the growth investigations were conducted to obtain several factors.

**[Result and Discussion]**

In all cultivars' stages of the vegetative growth, the reflective mulching plots were reached about 1 to 2 days earlier than that of the non-reflective plots. And the germination rate was about 5% higher, especially in the reflective mulching plots. Since then, there was no significant difference in the date of reaching the growth stage of the reproductive growth period, and there were differences between cultivars according to the planting period and reflection mulching. When compared within the same cultivar, that Chamol was sown on May 20, Taekwang was sown on June 10, and Sunpung was sown on June 20 had better growth characteristics and higher yields. And even during the same seeding period, reflective mulching plots were better and more.

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PA-95

# 강원 중부평야지에서 생태형 및 재식밀도에 따른 이앙시기별 수량 및 품질평가

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**[서론]**
벼 드문모 심기는 필요한 육묘상자의 수를 절감하여 경영비 절감 및 소득 향상에 기여할 수 있는 재배기술이다. 벼 드문모 재배 면적이 점차 증가함에 따라 강원도에서 벼 재배면적이 넓은 중부평야지를 중심으로 최적 재배방법을 확립할 필요가 있다. 본 시험은 조생종 오대, 중생종 청품 등 2품종의 재식밀도 및 이앙시기에 따른 쌀수량과 품질 변화를 관찰하여 최적 재배기술을 개발하기 위한 기초 자료로 활용하고자 수행하였다.

**[재료 및 방법]**
생태형 및 재식밀도에 따른 이앙시기별 수량 및 품질을 평가하고자 2020년부터 2021년까지 2년간 강원도 춘천 벼 시험포장에서 출수기 및 수량구성요소 등 주요농업형질을 조사하고 품질을 평가하였다. 5월 5일, 5월 20일, 6월 5일에 손이앙 하였으며, 질소시비량은 10a당 총 9kg을 50%(기비) : 20%(분얼비) : 30%(수비) 분시하였다. 재식밀도는 3.3m$^2$당 80(30×14㎝)주, 60(30×18㎝)주, 50(30×22㎝)주, 37(30×30㎝)주 등 4가지로 설정하였고, 재식본수는 5본으로 이앙하였다. 기타 재배는 농촌진흥청 벼 표준재배법을 준용하였다. 벼 생육은 출수기, 간장, 수장, 수수 및 영화수를 조사하였다. 수량구는 적산온도 1,100°C에 수확하여 정조중을 칭량한 후 수분함량 15%를 기준으로 쌀수량을 환산하였다. 이밖에 등숙율, 현미천립중 등 수량구성요소와 완전미율, 분상질율 등 품질을 조사하였다.

**[결과 및 고찰]**
오대와 청품 모두 재식밀도가 낮을수록 출수기가 늦어지는 경향을 보였다. 간장은 오대에서 재식밀도가 낮을수록 길어지는 경향을 보였으며, 수수는 오대와 청품 모두 재식밀도가 낮을수록 많아졌다. 수장은 재식밀도가 낮을수록 길어지는 경향을 보였으며 이에 따라 영화수 또한 증가하였다. 현미천립중은 5월 5일 이앙한 시험구에서 오대와 청품 모두 재식밀도가 낮을수록 증가하는 경향을 보였으나, 5월 20일 및 6월 5일 이앙한 시험구에서는 유의미한 변화가 관찰되지 않았다. 오대의 쌀수량은 5월 5일 이앙구에서 50주/3.3㎡에서 562kg/10a로 가장 많았으며, 5월 20일 이앙구에서는 37주/3.3㎡, 6월 5일 이앙구에서는 50주/3.3㎡에서 각각 512kg/10a, 547kg/10a로 가장 많았다. 청품의 쌀수량은 5월 5일 이앙구에서는 80주/3.3㎡, 5월 20일 이앙구에서는 50주/3.3㎡, 6월 5일 이앙구에서는 50주/3.3㎡의 재식밀도에서 각각 573, 530, 552kg/10a로 가장 많았다. 완전미율과 분상질율을 비교했을 때 이앙시기가 늦을수록, 그리고 재식밀도가 낮을수록 품질이 향상되는 경향을 보였다. 벼 드문모 심기는 비용과 노동력 절감에 유리하므로 중산간지 및 동해안지 등 다양한 강원도내 벼 재배지대에서 지속적인 연구가 필요할 것으로 여겨진다.

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PA-96

# The Effects of Water Level and Temperature on Seed Germination and Early Seedling Development of Rice (*Oryza sativa* l.)

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**[Abstract]**
The application of direct seeding cultivation reduces time, labor, and cost. However, this application often has poor seedling establishment and leads to lower yield as compared to transplanting system. The tolerance to anaerobic and low temperature germination is important to improve seedling establishment and the wide-spread application of direct seeding method. This study was carried out to evaluate the responses of three japonica cultivars to different temperatures (15°C, 18°C, 21°C, 24°C, and 27°C) and different flooding levels (1 cm, 4 cm, 7 cm, 10 cm) during germination and seedling development. The mean survival percentage significantly increased ($P<0.05$) when the flooding level decreased and when temperature increased. There were significant effects of the interaction between temperature and water depth on survival percentage and seedling height. When temperature decreased from 27°C to 15°C, the germination duration significantly increased from 6.4 days to 16.3 days while the germination speed, survival percentage, and seedling height decreased from 5.3 seeds day$^{-1}$, 61.9% and 190.6 cm to 2.2 seeds day$^{-1}$, 33.2%, and 47 cm, respectively. The increase in temperature under submergence condition was associated with the increased expression of *Amy3D and ALDH2a* but the decreased expression of *ADH1* and *PDC1.* The results of this research would be used for further studies and breeding programs to improve rice seedling establishment and the application of direct seeding cultivation.

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# Temperature Effect on the Growth Parameters of Rice during Vegetative Period

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**[Abstract]**
Temperature is a crucial environmental factor for rice cultivation due to the climate change and can influence the rice growth and development. Therefore, the effect of temperature on plant growth characters was examined during the vegetative stage. Plants were grown under three different temperatures: 23°C/13°C for 18°C, 26°C/16°C for 21°C and 29°C/19°C for 24°C in the phytotron. The temperature was treated after transplanting and ended in early panicle initiation stage. Heading date of the two varieties were strongly affected by the temperature and were delayed in the 18°C. The plant height in the 18°C was 21 % shorter than the 21°C and 24°C and the tiller and leaf number were increased in the 18°C. All the growth rates of the characters were the slowest in 18°C. The stem dry weight was significantly increased in 18°C. Nitrogen content was increased in the leaves of 18°C whereas available phosphate and potassium content was found to be increased in the stems of 21°C and 24°C. *OsNRT 2.1* was overexpressed in the leaves and stems of 18°C and *OsNRT2.3a* could be expressed in 18°C and 21°C temperatures whereas more expressed in 21°C. *OsPT1* and *OsPT6* could be expressed in the leaf of 18°C and 24°C but could be expressed in the stem of 18°C. *OsHAK1* and *OsHAK5* could be overexpressed in the leaves and stems of 18°C. For hormone, *OsCKX2* gene was found to be up regulated in the leaves of 18°C and *OsIAA1* gene could be expressed more in the stem of 24°C.

**Keywords:** growth parameters, nutrient uptake, dry matter, rice, temperature

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# Growth Characters and Life Cycle of Mungbean Per Sowing Period

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**[Abstract]**

Mungbean is used for not only seed but sprout. so, consumption of mungbean has been on the rise in Korea. Life cycle of mungbean tends to be short among Legume. For that reason, Mungbean can be harvested for various cropping system and season per regions and farmers regardless of sowing date and harvesting date. So, Prior research is needed about growth characters and life cycle of mungbean per sowing period.

Mungebean cultivar 'Dahyun' and 'Sanpo' supplied by Korea Agriculture Technology Promotion Agency(KOAT) is cultivated in wagner pot. Sowing period is proper time of seeding in Jeollanam-do and Gyeongsangnam-do that is major cultivation region of mungbean in korea from early May to mid July every 2 weeks.

Length at maturity stage tends to increase from early May(sowing date: 4$^{th}$ May) to early July(sowing date: 5$^{th}$ July), but after that, It tends to decrease from mid July(sowing date: 19$^{th}$ July). Number of branches and nods shows a similar trend. Length of pod has no tendency and no difference per sowing date. Number of pod per plants has also no tendency per sowing date. Test plots sowing in late May has the most number of pods.(Sanpo 22.9pods, Dahyun 16.8) Number of seeds per pod tends to increase to late May and Test plots sowing in mid July has the most number of seed per pod.

In case of sowing at early May, Days of emergence is 7d. its summation of temperature is 132.2°C. After that, it tends to decrease to mid June. After mid June, Days of emergence is fixed to 3d. Average temperature growing up in this season, Summation of temperature from sowing to emergence takes the lowest point in test plots sowing in mid June.(Sanpo 88.6°C, Dahyun 88.6) Days of flowering tends to fasten from early May to mid July. Two cultivar shows same level. Days of maturity tends to fasten to mid June. after that tends to slow.

In case that many research results about growth characters and life cycle mungbean per sowing period are drawn, it is expected that it result in increase of cultivation area and income of farmer.

**[Acknowledgement]**

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PA-99

# Shading Effect on Rice Growth Characters

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**[Abstract]**
For abnormal weather disaster and building constructions, the shading stress could occur in crops more often. Those shading stress can effect on rice growth characters. Therefore, we investigated the shading effect on rice growth characters. Shading treatments were treated using shading screen as 35, 55, 75 and 100%. To check the shading effect on rooting after transplanting, shading stress treated after transplanting for 20 days as 35, 55 and 75%, And 35, 55, 75 and 100% of shading were treated 60 days after transplanting to check the growth characters. After transplanting, the shading stress effected on leaf and root growth. At 19 days after transplanting, leaf number reduced by shading stress. In 35, 55 and 75% shading stress, the leaf number reduced as 0.38, 0.45 and 0.9 respectively compared to control treatment. And root length was also reduced as 0.39, 0.6 and 1.93 cm respectively compared to control treatment. The plant height was slightly increased in 35 and 55% and reduced in 100%. Leaf growth speed per day was reduced as 0.0167 according to shading stress. And root growth speed also reduced as 0.0426 according to shading stress. The shading stress during vegetative stage effected on plant height and tiller number. In 35, 55 and 75% of shading stress, the plant height was slightly increased but it was reduced in 100%. Tiller number was significantly reduced by shading stress. According to 10% of shading stress, about 7% of the tiller number was reduced. However, leaf color did not change by the shading stress. The leaf area in 2$^{nd}$ to 4nd leaf from new leaf reduced as 297 and 1044 in 75 and 100% of shading stress and increased as 70 and 99 in 35 and 55%. These leaf area change was affected by both the length and width of the leaf.

**[Acknowledgement]**
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**PA-100**

# Detection of Wildfire Disease by Hyperspectral and RGB Imaging in Soybean (*Glycine max* L.)

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**[Introduction]**

Soybean (*Glycine max* L.) is an important oil seed crop in the world and in South Korea. The occurrence and severity of bacterial wildfire caused by *Pseudomonas syringae* pv. *tabaci* have progressively increased, which poses a serious risk to soybean production. Under favorable conditions, the spreading of wildfire can lead to a devastating entire crop. Therefore, it is crucial to accurately identify early, asymptomatic/symptomatic wildfire infection. In this study, we aim to test the possibility of early detection of wildfire infection by emerging imaging approaches such as the hyperspectral and Red, Green and Blue (RGB) method.

**[Materials and Methods]**

We used 16 soybean cultivars to investigate against the wildfire disease infection at the vegetative growth stage and replicated (n=9) experiments were conducted in the plant growth chambers. The hyperspectral and RGB images were collected continuously for 8 days after inoculation (8 DAI). The hyperspectral images were analyzed by the software of (ENVI V.5.5.3) and the RGB images were analyzed with the (WinDIAS) image system.

**[Results and Discussion]**

Our findings showed that the disease ratio of all the cultivars appeared to symptom 2 DAI, then the disease ratio started decreasing from 4 DAI in all the cultivars except the Uram cultivar which showed high symptoms (12.31%) at 2 DAI and started reducing ratio from 3DAI. The results obtained from the RGB images showed that Taekwang was a susceptible cultivar to the disease infection (36.77%) and showed a significant difference in the disease ratio compared to other cultivars. Likewise, the visual scoring showed a high score with Taekwang indicating a weak responding cultivar to the disease infestation same as to the disease ratio pattern. Similarly, there was a significant difference between the leaf's reflectance with the disease ratios at wavelength 526.57 nm, 550.02 nm, 573.54 nm, and 597.13 nm. These results indicated that identified wavelength may be important for wildfire disease detection. In addition, RGB visible analysis can able to identify the most resistant and tolerant cultivar. Further research towards identifying precise wavebands may help to predict the wildfire disease occurrence in soybean at the vegetative growth stage.

**[Acknowledgement]**

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**PA-101**

## IRG 이용방법 및 품종의 차이가 후작 콩의 지상부 및 지하부 생육과 수량에 미치는 영향

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**[서론]**
콩(*Glycine max* L.)은 쌀과 밀 다음으로 소비량이 많은 한국의 대표적인 밭 작물이다. 남부지역의 주요 사료작물이자 피복작물로도 이용가능한 이탈리안라이그라스(*Lolium multiflorum*, Italian ryegrass, IRG)는 한국에서 주로 벼와 작부 체계를 이룬다, IRG-벼 작부체계에 대한 연구는 있으나 밭작물 중심의 IRG-콩 작부체계에 대한 연구는 미흡한 실정이다. 또한, IRG 재배가 후작물에 미치는 효과에 관한 연구는 대부분 지상부 변화에 대한 한정적 연구로 지하부의 변화까지 함께 알아보는 경우는 거의 없는 실정이다. 따라서 본 연구에서는 IRG-콩 작부체계에서 IRG 이용방법(사료용 vs. 녹비용) 및 품종의 차이가 후작 콩의 지상부 및 지하부 생육과 수량에 미치는 영향을 구명하고자 하였다.

**[재료 및 방법]**
본 연구의 포장실험은 경남 진주시 대곡면에 위치한 경상국립대학교 부속농장에서 실시하였다. 실험 설계는 RCBD Split-plot으로 4반복하였고 Main plot은 IRG 품종(1. 조생종 Kowinearly; Ko, 2. 중만생종 Tam90; Ta, 3. 휴한지 Fallowed field; F), Sub plot은 IRG 이용방법(1. 녹비용: 지상부, 지하부 모두 투입; +CC, 2. 사료용: 지상부 제거 및 지하부 단독 투입; -CC)으로 설정하였다. IRG 파종은 2020년 11월 7일에 40kg/ha 이루어졌으며, 농촌진흥청 표준재배법에 따라 기비 및 추비를 시비하였다. 2021년 5월 1일에 IRG를 수확한 후 -CC 처리구의 지상부를 제거하였으며 +CC 처리구는 예취 후 토양에 다시 투입하였다. F는 겨울동안 작물재배가 이루어지지 않았다. 로터리를 실시한 포장에 대원콩을 6월 8일에 파종하였으며 수량조사는 10월 21일에 이루어졌다. IRG 수량 조사, 콩 엽록소 함량 측정, 콩 수량 및 수량 구성 요소 조사, 콩 뿌리 형태학적 특성 분석을 실시하였다.

**[결과 및 고찰]**
IRG 지상부 건물중은 평균 638 kg/10a, 지하부 건물중은 평균 223 kg/10a였으며 지상부와 지하부 모두 품종 간 유의한 차이는 없었다. 엽록소 함량은 생육 중기(R1 단계)에 +CC 처리구가 321 mg/m$^2$로 F(316 mg/m$^2$) 및 -CC 처리구(300 mg/m$^2$)에 비해 각각 1.6%, 7% 높았다. 콩 수량은 +CC 처리구가 243 kg/10a로 F(200 kg/10a) 및 -CC 처리구(193 kg/10a)에 비해 각각 22%, 26% 높았다. 이는 +CC 처리가 다른 처리에 비해 후작 콩 수량 증대에 효과가 있음을 보여준다. 콩 뿌리 길이, 표면적, 부피는 품종별로 비교했을 때 R3 및 수확기에 Tam90 처리구가 Kowinearly 처리구 및 F보다 큰 경향을 보였다. 콩 뿌리 길이, 표면적, 부피는 이용방법 별로 비교했을 때 R3 및 수확기에 -CC 처리구가 +CC 처리구 및 F보다 큰 경향을 보였다. R3 단계에서 -CC는 F 대비 뿌리 길이, 표면적 및 부피에서 각각 28%, 21%, 15% 컸다.
결론적으로 IRG가 녹비용으로 쓰이는 경우(+CC) 콩 수량 증대를 시킨다. 사료용으로 쓰이는 경우(-CC) 뿌리발달을 촉진하며 이는 가뭄이나 척박지에서의 환경 적응성 증대에 긍정적 영향을 미칠 것으로 보인다.

**[사사]**
이 논문은 2022년도 정부(교육부)의 재원으로 한국연구재단의 지원을 받아 수행된 기초연구사업이며(No. 2021R1I1A3040330) 이에 감사드립니다.

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**PA-102**

## 양파 후작 옥수수와 콩의 파종시기 차이가 작물의 생육과 수량에 미치는 영향

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**[서론]**

양파(*Allium cepa* L.)는 남부지방에서 여름작물인 벼(*Oryza sativa* L.)와 함께 작부체계를 이룬다. 작부체계 다양화를 위해 옥수수(*Zea maize* L.)와 콩(*Glycine max* L.)을 타작물로 도입할 수 있다. 여름작물의 밭재배가 소득작물인 양파의 이식과 수확에 영향을 미치지 않기 위해서는 적절한 파종시기를 설정하는 것이 중요하다. 따라서, 본 연구는 양파 후작물로 옥수수와 콩의 파종 적기와 한계기를 구명하고자 파종시기별 생육변화와 수량을 조사하였다.

**[재료 및 방법]**

본 연구는 경상북도 고령군 다산면에 위치한 관행 양파-벼 재배 농가 포장에서 2021년 6월부터 2021년 11월까지 진행하였다. 실험의 설계는 3반복의 완전임의배치법으로 배치하였다. 파종기는 15일 간격으로 6/15, 6/30, 7/15에 각각 실시하였으며 옥수수는 사료용인 '광평옥', 콩은 '대원' 각각 1품종씩 이용하였다. 답전윤환 환경에서 습해 경감을 위해 40cm 깊이의 배수로를 실험포장 주변에 조성하였고 기타 재배관리는 농촌진흥청 표준재배법을 따랐다. 생육변화를 관찰하기 위해 4주차 이후 2주 간격으로 canopy height와 LAI를 측정했다. 각 시기별 수확적기에 도달하였을 때 수량 및 수량구성요소 조사를 실시하였다. 이후 일원분산분석을 통하여 유의성 검정($P<0.05$)을 실시하였다.

**[결과 및 고찰]**

1. 광평옥(사료용)

광평옥의 경우 canopy height는 생육 초기에는 6/30 파종에서 컸지만 생육 후반기에는 6/15 파종이 가장 큰 양상을 보였다. 한편, LAI는 파종시기에 따른 통계적 유의성은 12WAP를 제외하고는 보이지 않았다. 파종-출사와 파종-수확 모두 파종 처리에 따른 생육 일수 차이는 보이지 않았다. 이삭 수량을 제외한 전체 건물중, 간엽 건물중, TDN 수량에서 6/15 파종이 파종시기 중 가장 큰 값을 보였는데 그 중, TDN 수량은 6/15 파종이 915.9 kg/10a로 6/30 파종(813.1 kg/10a)과 7/15 파종(722.4 kg/10a)보다 각각 12%, 27% 높은 수량을 보였다.

2. 대원콩

대원콩의 경우 canopy height와 LAI 모두 생육 초기에는 6/30 파종에서 컸지만 생육 후반기에는 6/15 파종처리구에서 가장 컸다. 파종-개화, 파종-수확에 도달하는 생육기간은 파종이 지연될수록 짧아졌으며 7/15 파종의 경우 생육후기 저온으로 인해 생육 지연이 발생해 양파 이식 전까지 수확이 불가능하였다. 개체당 협수와 백립중은 6/15 파종과 6/30 파종 간의 차이가 존재하지 않았지만, 개체당 립수(6/15 파종 109.8 ea/plant vs. 6/30 파종 65.3 ea/plant)와 수량(6/15 파종 283.7 kg/10a vs. 6/30 파종 188.2 kg/10a)에서 6/15 파종이 각각 68%, 51% 컸다.

따라서, 사료용 옥수수인 광평옥은 파종이 지연된다면 생육후기 저온 등의 영향으로 수량 감소가 발생하고, 대원콩에서는 7/15일까지 파종이 지연된 경우 생육 일수 감소와 생육 후기 저온의 영향으로 수량이 감소하였다. 따라서 옥수수와 콩 모두 6/15일에서 6/30일 사이에 파종하는 것이 양파-여름 밭작물 작부체계에 적합한 파종시기이다.

**[사사]**

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**PA-103**

# Estimating Rice Height Using Three-Dimensional (3D) LiDAR

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**[Introduction]**

Various components such as temperature and solar radiation, cultivation method have an impact on the crop growth and production, and monitoring the current status of crop growth is essential for the optimum growth. To monitor the crop growth on the field with a non-destructive way, it is necessary to develop an algorithm that can estimate the height of rice canopy using 3D LiDAR.

**[Materials and Methods]**

Two rice cultivars ('Nampyeong' and 'Dongjin1') were planted in experimental field that located at National Institute of Crop Science (NICS; Wanju, Jeollabuk-do). The twenty rice heights at 3 points by cultivar were measured by ruler at 3~6 day intervals before heading date, and then they were scanned by LiDAR. The 3D point cloud data for twenty plants were extracted from scanned LiDAR data using SCENCE and CloudCompare program. The extracted data were calculated on a histogram of height, and the shape of histogram were fitted to Gumbel distribution. Finally, the rice height was estimated by simple linear regression using parameter of Gumbel distribution.

**[Result and Discussion]**

The estimated heights using simple linear regression were similar to measured heights. The correlation between the measured and estimated rice height for each cultivar showed significant result ('Nampyeong': $R^2 = 0.97$, 'Dongjin1': $R^2 = 0.98$), and the result for both cultivars was also similar as well ($R^2 = 0.97$). In addition, it is necessary to develop an algorithm for estimating related to the other growth components.

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PA-104

# Effects of High Temperature on Photosynthesis in Mung Bean (*Vigna radiata*)

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**[Introduction]**

The growth and physiological conditions of plants change depending on the environment. Due to climate warming, the temperature in Korea is expected to increase by 1.7°C compared to the past 100 years, and the number of days of temperatures above 33°C is expected to triple from 8.8 days to 26.4 days. In this study, to know the effects of high temperature on mung beans, we investigated the growth and physiological changes of mung beans affected by high-temperature stress.

**[Materials and Methods]**

In 2021, high-temperature treatment was performed using the temperature gradient greenhouse (2.2m × 25m × 2.5m) in *V. radiata*, and the rain shield greenhouse was placed to control at the Southern Crops Department of Rural Development Administration (Miryang). The mung bean cultivar 'Dahyeon' was sown on June 30th and cultivated in Wagner port(1/2,000). After being treated at high temperatures for 3, 6, and 9 days, they have been checked the photosynthesis. The temperature gradient greenhouse was designed to maintain a high temperature of T1: 1 to 2°C, T2: 2 to 4°C, T3: 4 to 5°C, and T4: 5 to 6°C, as a maximum temperature standard, relative to the rain shield greenhouse. The growth characteristics of photosynthesis in mung bean were investigated before and after treatment, and the quantitative characteristics investigation was conducted after harvest.

**[Results and Discussion]**

The photosynthetic assimilation was measured after high temperature stress experiments of mung bean 'Dahyeon' during the growing season in the temperature gradient greenhouse. Although there is no significance, photosynthetic assimilation and stomatal conductivity tended to decrease from T1 to T4 after high-temperature treatment for 3, 6, and 9-day periods. The longer the high-temperature treatment period, the lower the photosynthetic assimilation. It was confirmed that high-temperature adversely affected photosynthetic assimilation.

**[Acknowledgement]**

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**PA-105**

# 새만금간척지의 강우특성에 따른 사료용 옥수수의 두둑 높이 감소와 생장 반응
# Decrease of Ridge Height and Growth Response of Maize Depending on Rainfall Characteristics in Saemangeum Reclaimed Land

Kwang-Seung Lee[1]*, Kang-Ho Jung[1], Su-Hwan Lee[1], Jin Jung[1], Bang-Hun Kang[2], Hyeoun-Suk Cho[1]

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**[Introduction]**
새만금간척지는 매우 고운 모래 함량이 높고 배수가 불량하여 밭작물의 근권내 통기성 확보를 위한 두둑의 형성과 유지관리가 매우 중요하다. 본 연구는 새만금간척지에서 사료용 옥수수 경작시 두둑 보전처리에 의한 두둑 높이 감소와 사료용 옥수수 생육 변화를 조사하기 위해 수행되었다.

**[Materials and Methods]**
두둑 보전을 위해 대조구와 함께 식물체 잔재 피복(RR), 배수로 식생(VF), 식물체 잔재 피복×배수로 식생(RR+VF)의 처리구를 두었다. 배수로 깊이는 20cm로 하였으며, 사료용 옥수수는 광평옥을 재식거리 70×25cm로 파종하였다.

**[Results and Discussion]**
두둑 높이 변화에 영향을 미치는 강우 특성을 비교하기 위한 강우 침식 계수는 1차년도의 505.8 MJ mm $ha^{-1}$ $hr^{-1}$보다 2차년도의 2,653.5 MJ mm $ha^{-1}$ $hr^{-1}$가 더 크게 나타났다. 두둑 높이의 감소량(DRH)은 처리구간 유의한 차이가 없었으나 강우 침식성이 강했던 2년차가 8.5 cm로 1년차의 6.6 cm보다 DRH가 컸다. 시험토양의 토양 침식성 계수 역시 0.587 Mg hr $MJ^{-1}$ $mm^{-1}$로 국내 평균인 0.027 Mg hr $MJ^{-1}$ $mm^{-1}$보다 크게 나타났다. DRH는 사료용 옥수수의 생체중과 음의 상관관계를 보였는데, 이는 두둑의 감소가 작물 생육에 부정적인 영향을 미치는 반면 두둑 보전 처리는 DRH에 유의미한 영향을 미지지 않는다는 것을 의미한다. 따라서 새만금의 경작지 두둑을 유지하기 위한 다양한 보전처리의 연구가 필요하다.

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PA-106

# 밀 생산량 예측을 위한 머신러닝 기반 생육 데이터 중요도 분석 및 주요 조사항목 선정
# Importance Analysis of Wheat Growth Data and Selection of Optimal Sampling Items to Predict Wheat Yield based on MachineLearning

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**[서론]**
밀은 1인당 연간 소비량이 연간 33kg로 59kg인 쌀 다음으로 많이 소비되는 식량작물이다. 우리밀의 자급률은 0.7%로 98%인 쌀에 비해 매우 낮아, 밀산업 육성에 대한 요구가 있어왔다. 2020년 밀산업육성법이 시행됨에 따라, 농식품부는 2025년까지의 밀 자급률 5% 달성을 목표로 재배면적을 확대 및 국산 밀 생산성 증대를 위해 노력하고 있다. 생산량 예측 모델은 생산성 향상 계획 및 효과를 정량화하기 위한 주요한 도구로, 밀산업육성법 시행과 함께 밀 생산량 예측모형에 대한 수요도 높아지고 있다. 생산량 예측을 효율적으로 수행하기 위하여, 생육데이터를 선별하여 생산량 예측에 필요한 주요한 생육 조사 항목을 찾아내고자 한다.

**[재료 및 방법]**
Amit 등(2022)은 주간 날씨 데이터, 토양 조건 및 작물 계절 변수(파종, 개화 및 수확 날짜)를 사용하여 밀의 수확량을 예측하였고, Keach 등(2021) 최소 및 최대 기온, 강수, 지구 태양 복사 조도, 눈 깊이의 5가지 기상 요소를 사용하여 밀의 수확량을 예측하였다. 기존 연구에서는 주로 환경요인을 활용하여 생산량을 예측하였지만, 필지 내 수분관리에 따른 생산량 변화 및 생육단계별 작물의 생육자료를 활용한 생산량 예측 연구를 찾아보기 어려웠다. 본 연구는 밀의 생육단계별 생육 데이터를 수집하여, 이를 바탕으로 생산량을 예측해 중요한 요인을 찾고자 한다. 분석에 사용된 생육데이터는 전라북도 남원시 운봉읍에 위치한 실증단지의 4개 처리구(한발처리구 A, 무처리구 B, 적정처리구 C, 과습처리구 D)에서 수집하였다. 각 처리구별 3개 블록으로 실험하고, 생육데이터는 각 블록별로 5반복 샘플링을 수행하였다. 생육 데이터는 잎, 줄기, 종자, 각각의 건물중, 생체중, 수분함량과 잎의 너비와 길이를 측정하여 확보하였고, 동시에 생육지표로 식생군의 LAI, SPAD를 측정하였다. 개화기를 포함한 4월 28일부터 5월 31일까지 2주 간격으로 조사된 생육데이터를 활용하여 생산량을 예측해 분석하였다.

**[결과 및 고찰]**
생산량 예측모델 중 XGBoost모델(MAE 163.44)은 개화기 이후 4주차의 SPAD 및 잎의 너비, 개화기의 잎 너비, LAI, 개화기 이후 2주차의 LAI가 중요한 변수로 나타났다. Linear Regression모델(MAE 191.22)은 개화기 이후 2주차 수분함량과 LAI, 개화기의 LAI와 잎의 길이가 중요한 변수로 나타났다. 본 연구에서 생육조사를 통해 밀의 생육단계별 작황에 따라 주요한 조사항목을 선별한 의미가 있다. 하지만 대상지역이 한 지역으로 한정되어 기상, 토양 등 환경요인을 반영하지 못한 점이 한계로 생각되는 바, 향후 연구에서는 지속적인 모니터링과 다른 지역의 생육자료를 확보하여, 환경조건, 생육조건을 모두 고려할 계획이다.

**[사사]**
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# Nitric Oxide-Induced Downregulation of a NAD(P)-Binding Rossmann-Fold Superfamily Gene Negatively Impacts Growth and Defense in *Arabidopsis thaliana*

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**[Abstract]**
Plant defense systems against pathogens have been studied extensively and are currently a hot topic in plant science. Using a reverse genetics technique, this study looked into the involvement of the NO-downregulated NAD(P)-binding Rossmann-fold superfamily gene in plant growth and defense in *Arabidopsis thaliana*. For this purpose, the knockout and overexpressing plant of the candidate gene along with the relevant controls were exposed to control, oxidative and nitro-oxidative stresses. The results showed that candidate gene negatively regulates plants' root and shoot lengths. To investigate the role of the candidate gene in plant basal defense, *R-gene*-mediated resistance and systemic acquired resistance (SAR) plants were challenged with virulent or avirulent strains of *Pseudomonas syringae pathovar tomato* (*Pst*) *DC3000*. The results showed that the candidate gene negatively regulates plants' basal defense, *R-gene*-mediated resistance and SAR. Further characterization via GO analysis associated the candidate gene with metabolic and cellular processes and response to light stimulus, nucleotide binding and cellular location in the cytosol and nucleus. Protein structure analysis indicated the presence of a canonical Oxidoreductase family NAD (P)-binding Rossmann fold domain of 120 amino acids with a total of 121 plant homologs across 35 different plant species in the clad streptophyta. Arabidopsis eFP browser showed its expression in almost all the above-ground parts. Protein analysis indicated C225 and C359 as potential targets for S-Nitrosylation by NO. SMART analysis indicated possible interactions with mevalonate/galactokinase, galacturonic acid kinase, arabinose kinase, putative xylulose kinase, GroES-like zinc-binding alcohol dehydrogenase and various glyceraldehyde-3-phosphate dehydrogenases.

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# Effects of Sowing and Harvesting Time on Feed Value and Quality of Triticale (X *Triticosecale* Wittmack)

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**[Abstract]**
The amount of required forage is increasing by 20% every year in South Korea, but the cultivation area for forage production is limited. The yield ability of triticale forage is the highest among the winter forage crops including rye and the crop has cold tolerance within the average low temperature of −10°C in January. Therefore, this study analyzed effects of sowing and harvesting times on feed value and quality for efficiently using and supplying triticale as livestock feed. Seed of the triticales, 'Joseong' was sown in 2021 fall (October) and 2022 spring (March). The triticales were harvested according to growth stages: seedling stage, booting stage, heading stage, 10 days after heading, and 20 days after heading. Moisture contents of each harvested triticales were adjusted to about 60%, and then the triticales were fermented for 40 days at room temperature under anaerobic conditions as silage. We have analyzed pH and organic acid to determine the feed value and quality of each silage. The contents of lactic acid in silage of the triticale harvested at the seedling stage of both fall and spring-sown (1.61%, 1.63%) were the highest among all of the silages; the booting stage (0.75%, 1.33%), the heading stage (0.50%, 0.69%), 10 days after the heading stage (0.31%, 0.42%), and 20 days after heading stage (0.22%, 0.40%). Such as the contents of lactic acid in the silages, and the pH value of the silages The pH value in both the fall- and spring-sown became lower as the triticale was grown up: seedling stage (7.05, 6.85), booting stage (6.21, 6.75), heading stage (6.18, 6.28), 10 days after heading stage (6.22, 6.17), and 20 days after heading stage (6.15, 5.81). Taken together, the results showed that the feed value and quality of triticale silage were more affected by harvesting time than sowing time.

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# Comparison of Methane Emissions by Rice Ecotype in Paddy Soil

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**[Abstract]**
South Korea greenhouse gas emissions have increased year by year, resulting in a total emission of 727.6 million tons of $CO_2$ eq in 2018, a 2.5% increase compared to 2017. Among them, the agricultural sector emitted 21.2 million tons of $CO_2$ eq., accounting for 2.9% of the total. Among the greenhouse gases emitted from the agricultural sector, a particularly problematic is methane gas emitted from rice paddies. Methane is one of the important greenhouse gases with a global warming potential (GWP) that is about 21 times higher than that of carbon dioxide due to its high infrared absorption capacity despite its relatively short remaining atmospheric period. Since the pattern of methane generation varies depending on the rice variety and ecological type, research related to this is necessary for accurate emission calculation and development of reduction technology. Accordingly, a study was conducted to find out the changes in greenhouse gas emission according to rice varieties and ecology types.
As for the rice eco-type cultivar, early maturing cultivar (Haedamssal) and medium-late rice cultivar (Saeilmi) were used. Haedamssal was transplanted on May 25 and June 25, and Saeilmi was transplanted on June 10 and June 25.
The amount of methane generated according to the growing day showed a tendency to increase as the planting period was earlier. The difference between varieties was that Haedamssal showed higher methane production than Saeilmi. The total $CH_4$ flux in the saeilmi was 18.7 $kg \cdot h^{-1}$(Jun 10 transplanting), 12.4 $kg \cdot h^{-1}$(Jun 25 transplanting) during rice cultivation. Lower methane emission was observed in Saeilmi than in Haedam rice. In addition, the earlier the planting period, the higher the methane emission.
This study is the result of the first year of research, and it is planned to investigate the amount of greenhouse gas emission between double cropping and single cropping using wheat cultivation after harvest for each ecological type.

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## 밀과 트리티케일 재배가 식물체의 탄소고정과 토양 탄소함량에 미치는 영향

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**[서론]**
온실가스 증가에 의한 지구 온난화는 에너지의 전환과 함께 농산물 생산 방식의 전환을 요구하고 있다. 식물은 탄소동화작용을 통하여 대기 중의 이산화탄소를 흡수하는 광 독립 영양생물이다. 탄소농업(Carbon farming)은 이러한 식물의 특성을 이용하여 대기 중의 탄소를 토양, 작물의 뿌리, 목질과 잎 등으로 격리시키는 농업방식이다. 토양과 식물체에 의해 대기 중으로 방출되는 양보다 토양과 식물체로 격리하는 양을 증가시키는 것이 탄소농업의 목적이며, 농업 부문에서 경운, 유기물 피복, 퇴비, 작부체계, 바이오차 등이 활용되고 있다. 동계 맥류는 겨울과 봄에 토양을 피복하여 온실가스의 배출을 줄이며, 또한 대기 탄소를 고정하는 기능을 가진다. 본 연구는 겨울철 밀과 트리티케일 재배가 작물의 탄소 흡수량과 토양 탄소 함량에 미치는 영향을 구명하였다.

**[재료 및 방법]**
본 시험은 경상남도농업기술원 시험포장에서 2021년부터 2022년까지 수행하였다. 밀과 트리티케일 품종은 각각 백강밀과 조성을 사용하였다. 파종일은 10월 28일이었고, 휴폭 150 cm에 휴립광산파로 파종하였다. 밀은 6월 2일에 종실을 수확하였으며, 트리티케일은 녹비로 활용하기 위하여 4월 28일에 수확하였다. 밀과 트리티케일의 파종량은 각각 16 kg/10a, 22 kg/10a이었다. 파종 전 퇴비 시용량은 밀과 트리티케일 모두 1,500kg/10a이었고, 비료는 질소 표준시비량에 준하여 유박을 밀은 170kg/10a, 트리티케일은 225kg/10a을 시용하였다, 작물 재배는 유기농업에 준하여 관리되었다. 생육 및 수량 특성은 농촌진흥청 농업과학 연구조사 분석기준에, 토양과 식물체 분석은 농촌진흥청 토양 및 식물체 분석법에 준하여 실시하였다.

**[결과 및 고찰]**
트리티케일의 건물수량은 2022년 3월 16일에 지상부 443g/$m^2$, 지하부 58g/$m^2$이었고, 녹비용으로 수확한 4월 28일에 지상부 1,633g/$m^2$, 지하부 134g/$m^2$로 증가하였다. 4월 28일에 트리티케일 식물체의 질소와 탄소 흡수량은 지상부에서 각각 23.2g/$m^2$, 682g/$m^2$이었고, 지하부에서 각각 1.0g/$m^2$, 43.7g/$m^2$이었으며, 탄질비는 34.1이었다. 밀의 건물수량은 2022년 4월 28일에 지상부 2,011g/$m^2$, 지하부 137g/$m^2$이었고, 수확일인 6월 2일에 지상부(밀짚) 764g/$m^2$, 지하부 63g/$m^2$로 감소하였다. 밀 종실의 건물수량은 715g/$m^2$으로 식물체 전체 건물중의 46.4%를 차지하였다. 수확기에 밀짚의 질소와 탄소 흡수량은 각각 1.8g/$m^2$, 316g/$m^2$이었고 뿌리의 질소와 탄소 흡수량은 각각 0.3g/$m^2$, 25.2g/$m^2$이었으며, 탄질비는 161.4이었다. 밀 종실의 질소와 탄소 흡수량은 각각 12.8g/$m^2$, 301g/$m^2$이었다. 트리티케일 수확기의 토양 표토(0-30cm) 총 탄소량은 3,977kg/10a로 시험 전 토양보다 206kg/10a 증가하였고, 밀 수확기의 토양 표토 탄소량은 3,757kg/10a로 시험 전 토양보다 14kg/10a 감소하였다. 토양 총 탄소량의 변화는 퇴비와 유박의 투입에 의하여 증가하였다가 분해과정을 통하여 감소한 것으로 판단된다. 종실 수확을 하지 않는 녹비용 트리티케일 재배는 밀 재배보다 토양에 환원할 수 있는 탄소량을 116% 증가시킬 수 있는 효과가 있었다. 금후에 트리티케일과 밀짚의 토양 환원, 그리고 경운 방식이 후작물의 수량과 토양의 탄소함량 변화를 검토할 계획이다.

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# Possibility of Jack Bean (*Canavalia ensiformis*) Cropping System in Southern Regions of Korea

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**[Abstract]**
Various types of cropping systems have been developed, such as a highly profitable cropping system, and there is a need to develop for each region. Jack bean [*Canavalia ensiformis* (L.)] is widely consumed for tea in which young seedpods are dried, roasted, and boiled in water. Jack bean is rich in histidine and urease that improve allergic rhinitis and they are effective in alleviating inflammation. Thus, young dried and roasted seedpods are very profitable. However, only 'young pods (soft, pre-swelling)' should be used for tea processing according to the 'Food Code' (Ministry of Food and Drug Safety). Therefore, the pods to be harvested were set based on a length of more than 20 cm and a thickness of less than 2 cm. In the southern region of Korea, onion and garlic are grown as primary crops in winter. Therefore, the possibility of a cropping system linked with Jack bean in summer was studied. Onion and garlic were sown and transplanted on October 25, 2021. Garlic was harvested on May 23, 2022, followed by onion on May 31, 2022. After that, the jack bean was transplanted on May 31, June 7, June 17, and June 27 to determine the appropriate period for the transplanting. The young seedpods were harvested 100-110 days after the transplant. Compared to the yield of young seedpods, there was no significant difference according to the transplantation period. Given that young seedpods are harvested before planting onion and garlic, 'Onion - Jack bean' and 'Garlic - Jack bean' cropping systems will be advantageous for income improvement.

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PA-112

## 콩 생산성 향상 모델 개발을 위한 콩 농가 데이터 수집 현황 및 기초 분석

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**[Abstract]**
콩[(Glycine max(L.)]은 우리나라에서 벼와 더불어 주요한 식량작물이다. 농촌진흥청에서는 콩 생육데이터를 수집하여 생산성 향상모델을 개발하기 위해 '농업빅데이터수집및생산성향상모델개발' 사업을 수행하고 있다. 수집되는 콩 데이터는 농가정보, 콩 생육정보, 토양정보 부분으로 구성되어 있으며 농가정보는 시군, 시군구, 품종, 파종량, 종자확보경로 등이 수집되고 있다. 그리고 콩 생육정보는 경장, 줄기굵기, 마디수, 가지수, 꼬투리수, 꼬투리립수, 개체당 입수, 종실수량 등이 수집되어 있다. 토양정보는 수분, 지온, EC 등이 수집되고 있다. 주요 항목의 평균은 경장 47.4 ㎝, 줄기굵기 11.1 ㎜, 마디수 12.7 개, 꼬투리수 54.0 개, 꼬투리립수 2.7 개, 종실수량 227.9 ㎏/10a 정도이며 토양수분은 26.3 %, 지온은 27.1 °C EC는 2.58 ds/CM 정도이다. 주요 형질의 상관관계는 종실수량과 개체당 협수가 0.651로 나타났으며 가지수, 꼬투리수, 개체당협수와 줄기굵기는 각각 0.783, 0.653, 0.663 정도로 나타났다. 추후 이를 기반으로 다중회귀 등 분석 가능한 방법(머신러닝 등)을 적용하여 콩 수량을 예측할 수 있는지 검토할 필요가 있다. 또한 본 사업으로 수집된 자료를 분석하여 콩 수량에 영향을 미치는 주요 요인을 평가한 결과는 콩 생산성 향상을 위한 모델 작성에 중요한 자료로 활용될 수 있을 것으로 예상된다.

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PA-113

# Growth Characteristics of Soybean Cultivar According to the Temperature Rise

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**[Abstract]**
As the average temperature rises due to climate change, damage to caused by rising temperatures is spreading all over the world. If soybeans are exposed to high temperature during the reproductive stage, pod setting rate and seed weight is reduced, therefore, various studies are needed to prevent crop damage due to high temperature. This study is to research the effect of high temperature on yield decrease during the grow stage of soybean.

**[Materials and methods]**
This study was carried out Temperature Gradient Chamber(2.4m×25m) in NICS. Cultivars of soybeans were Daewon and Pungsan, and it was sown at intervals 60×15cm on June 23rd. Temperature treatments were average temperature(Ta) +1°C, +2°C, +3°C +4°C, and temperature sensors were installed to measure the temperature during the growth period of soybean. The reproductive stage of soybean was measured from beginning bloom stage(R1) to full pod stage(R4). Height, stem diameter, No. of branch, and pod per plant were measured as the growth and yield component.

**[Results and discussion]**
Full bloom(R2) stage of Daewon and Pungsan was measured at Ta+1°C, +2°C on Aug. 2nd and Aug. 6th, respectively. But it was delayed to Aug. 3rd and Aug. 8th at Ta+3°C and to Aug. 5th and Aug. 10th at Ta+4°C. In beginning pod(R3) stage, Daewon was meaesured on Aug. 12th and Pungsan on Aug. 19th at Ta+1°C and Ta+2°C. But it was delayed to Aug. 13th in Daewon and Aug. 22nd in Pungsan at Ta+3°C and to Aug. 18th in Daewon and Aug. 26th in Pungsan at Ta+4°C, so as the temperature increased, growth of soybean was delayed. In growth and yield component of Daewon, height was the highest(71.4cm) at Ta+1°C and the lowest(58.4cm) at Ta+4°C. No. of pod per plant was more than 60 at Ta+1~+3°C, Ta+4°C was 47.2. In Pungsan, height was the highest(69.0cm) at Ta+3°C and the lowest(55.8cm) at Ta+4°C. Stem diameter the thickest(9.3mm) at Ta+2°C and the thinnest(6.1mm) at Ta+4°C. No. of pod per plant was the most at Ta+2°C(113.8), but the least at Ta+4°C(62.8). Therefore the higher temperature, the worse growth and yield of soybeans.

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**PA-114**

# Comparison of Pollen Morphology Responded by High Temperature in Adzuki Bean (*Vigna angularis*) and Mung Bean (*Vigna radiata*)

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**[Abstract]**

Plant reproduction associated with crop yields is highly vulnerable to global climate change components such as high and cold temperatures. The objectives of this study were to determine the effects of season-high exposure to temperature treatments in pollen morphology on Adzuki bean (*V. angularis*) and Mung bean (*V. radiate*). *V. angularis* and *V. radiata* were treated at high temperatures in the high temperature gradient greenhouse designed to cause temperature deviation. The pollen shapes treated at high temperature were compared by an electron scanning microscope. As a result, it was confirmed that the number of abnormal pollens morphology at high temperature was the least in *V. radiata*, and *V. angularis* was vulnerable to high temperatures. Also, it was found that the number of abnormal pollen morphology at T4 (Con +5~6°C) varied according to the cultivars of *V. angularis.* Therefore, the differences in *Vigna* species or cultivars with thermo-tolerance in pollen morphology to high temperature are projected to occur in the changeable future climate.

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PA-115

# Comparison of Total Biomass and Leaf Areas of Two Rice Cultivars with Terrestrial Laser Scanner (TLS)

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**[Introduction]**
Biomass of plant was considered the most important agronomic trait in crops but measuring biomass was difficult task during growing seasons because plant needed to destruct for weight samples. Recently, measuring height of a plant based on image analysis showed promising results. Further, estimate biomass with image based phenomics methods are needed to explore.

**[Materials and Methods]**
Two rice cultivars were planted in experiemental rice paddy field station that located at the RDA (Wanju, Jeollabuk-do). Five plants for each cultivar obtained three-dimensional images data with territorial laser scanner (TLS) at one time point. Also, selected individual plant was measured for dried weight, number of leaves, total leaf area, and number of branches. The whole process was repeated in seven times in various growth stages of rice. The canopy structure data were extracted from 3D images and the SCENIC software was utilized.

**[Result and Discussion]**
The data analysis indicated that robust relationship between canopy structure data and total biomass. The correlation between the canopy data and biomass of plants showed significant result ($R^2$ = 0.91). In further analysis, relationship between the canopy and biomass within same cultivar showed higher correlation ($R^2$ = 0.96). Also, the correlation between the canopy data and total leaves areas of plants showed significant result ($R^2$ = 0.90). The result indicated that the TLS could utilized estimating biomass without scarifies plants. Later, it might be worth to investigate whether each cultivar has specific growth pattern and discriminate specific cultivar among in various cultivars in rice paddy fields.

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PA-116

# Evaluation of the Growth and Yield of Oat According to Differences in Bird Netting Coverings

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**[Introduction]**
Oats are a crop with the lowest cold resistance among winter cereal. Vinyl mulching may be used to overcome damage during wintering, but vinyl is difficult to recycle and causes environmental pollution when discarded. On the other hand, using a bird netting for the warming is easy to recycle. Therefore, we evaluated the growth and yield characteristics according to the difference in bird netting covering treatment.

**[Materials and Methods]**
Oats were sown in the late fall 2021 at upland field by drill seeding in Wanju region and overwintered after microfiber bird netting (PE) treatment (0, 1, 2 layers) for two varieties of naked oat cultivars ‘Joyang’ and ‘Daeyang’, respectively. Sowing amount was 19kg per 10a and standard fertilizer level was 7.2 kg(N-P-K=15-14-6) per 10a. After wintering, we investigated the growth and yield characteristics of naked oats.

**[Results and Discussion]**
In both cultivars, the plant height, number of leaves increased and ratio of dead leaf decreased after winter when treated with bird netting compared to those without bird netting. In particular, the ratio of dead leaf decreased significantly as the number of bird netting increased. Significant increases were observed in culm length, spike length, number of grains per spike, and number of spikes per $m^2$ in ‘Joyang’ according to the treatment of bird netting, however, there was generally no significant difference in ‘Daeyang’. Both the heading and maturing date showed a tendency to become faster in both varieties according to the treatment of the bird netting. There was no difference in Liter weight and Thousand grain weight between the non-net and the bird netting in both varieties. The yield was found to be more than 300kg per 10a in the treatment of the bird netting, however, there was no statistical significance in ‘Joyang’ and a significant increase in yield was observed in ‘Daeyang’. It is thought that ‘Daeyang’ has stronger cold resistance than ‘Joyang’ and has a synergistic effect due to the warming effect of the bird netting. To summarize the results, the treatment of bird netting before wintering is more beneficial to growth after winter than in the case of no nets, it can lower the ratio of dead leaf, and it will help increase the yield.

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PA-117

# Development of Ion-Selective Electrodes for Agriculture

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**[Abstract]**

There is a growing need to develop ion sensors for agriculture. As a result, several technologies have been developed, such as colorimetry, spectrophotometry, and ion-selective electrode (ISE). Among them, ISE has some advantages compared to others. First, it does not require pre-treatment processes and expensive equipment. Second, it is possible for the portable detection system by introducing small-sized electrodes. Finally, real-time and multiple detections of several ions are pursued. It is well-known that N, P, and K nutrients are critical for crop growth. With the development of agriculture techniques, the importance of soil nutrient analysis has attracted much attention for cost-effective and eco-friendly agriculture. Among several issues, minimizing the use of fertilizers is significant through quantitative analysis of soil nutrients. As a result, it is highly important to analyze certain nutrients, such as N (ammonium ion, nitrate ion, nitrite ion), P (dihydrogen phosphate ion, monohydrogen phosphate ion), and K (potassium ion). Therefore, developing sensors for accurate analysis of soil nutrients is highly desired.

In this study, several ISEs have been fabricated to detect N, P, and K. Their performance has been intensively studied, such as sensitivity, selectivity coefficient, and concentration range, and compared with commercialized ISEs. In addition, preliminary tests on the in-situ N, P, and K monitoring have been conducted inside the soil.

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PA-118

# Proper Amount of Fertilizer and Seeding Rates of Forage Barley (Cv.Youjin) in Korea'S Midwest Reclaimed Land

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**[Introduction]**

Forage barley 'Youjin' is a variety developed by the Rural Development Administration. It's palatability is increased thanks to the degeneration of the hooded awn. Also, it is known that the amount of roughage is high and its quality is excellent when used as a silage. In addition, since its forage value is superior to that of the imported roughage, it is a crop with great effects in terms of cost and forage value when replaced with domestic forage instead of imported forage in the manufacturing of mixed forage. Youjin is resistant to the cold, so it can be grown nationwide except in the mountainous areas in the central and northern regions, and it is known that it is better to use nitrogen fertilizer properly during cultivation and not to grow it in places with bad drainage. Therefore, this study was conducted to provide basic data on the appropriate amount of fertilization and sowing for Youjin forage barley varieties in reclaimed land.

**[Material and Methods]**

This experiment was conducted in Seokmun Reclaimed land, located in Songsan-myeon, Dangjin-si, chungcheongnam-do, South Korea. The variety used in this experiment was Youjin. It was sown on October 15, 2021 by drill seeding, and 100% (22kg/10a) and 150% (33kg/10a) were sown based on the standard seeding rates. Nitrogen fertilizer was distributed at a ratio of basic fertilization: top dressing=4:6, while phosphorus and potassium were added as basal fertilizers for each field, with the standard amount of fertilizer being 0, 100, 150, and 200%. The harvest date was May 17, and the main survey items were soil characteristics, crop growth, yield, and forage nutritive value.

**[Results and Discussion]**

The pH and EC of the cultivated soil were within an appropriate range, and the amount of exchangeable cations Na and K was not very high, maintaining a relatively suitable environment for crops to grow. The average temperature in January and February was below zero, and it was confirmed as a suitable temperature for the growth of crops due to the increase in temperatures from March after the wintering of barley. In terms of culm length, panicle length, total tiller number, and leaf area, the best results were obtained with a seeding rate of 22kg per 10a, and a 100% and 200% amount of fertilizer. Dry weight was the highest with a seeding rates of 22kg per 10a and a 100% amount of fertilizer. The crude protein content was the highest at a seeding rate of 22kg per 10a and a 200% amount of fertilizer, as well as at a seeding rate of 33kg per 10a and a 150% amount of fertilizer. NDF showed increased results with increased fertilizer amount in the case of 22kg per 10a seeding rate, but showed no consistency at 33kg per 10a seeding rate. Regarding TDN, the fertilization level was 0% in the case of 22kg per 10a seeding rate, and it was the highest at 150% in the case of 33kg per 10a.

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PA-119

# Effects of Low Temperature on Leaf Senescence and Seed Growth during Late Reproductive Stage (R5-R6) in Soybean (*Glycine max* (L.) Merrill)

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**[Introduction]**
Soybean is a representative summer crop in Korea, but the possibility of exposure to low temperatures during the seed growth period is increasing due to the frequent occurrences of abnormal climatic events in recent. This study was conducted to find out the influences of the low temperature during the seed growth period in the Korean soybean cultivar.

**[Materials and Methods]**
Soybean (cv. Sunpoong) plants were grown in pots (15cm D and 13 H) containing mixed soil (silty loam soil: commercial horticultural nursery soil = 1:1). The growth temperature for vegetative growth in the greenhouse was 25 to 30°C (day) and 20°C (night) with 13 h day length. The average night temperature was controlled to 20°C (control), 10°C, and 7°C after R5 or R6 stage. Physiological characteristics were measured on SPAD, chlorophyll fluorescence, and NDVI with portable devices and net photosynthetic rate (Pn) with a handheld device (CID-340, Bio-Science, USA), and hyperspectral properties with a snap-shot type camera (Specim IQ, Specim Ltd, Finland) at intervals of 5 days from day 0 of temperature treatments.

**[Results and Discussion]**
Among the physiological characteristics, NDVI and SPAD were different between temperatures from the 15th day of treatment, showing higher values in the order of control, 10°C-R6, 10°C-R5, 7°C-R6, and 7°C-R5. Chlorophyll fluorescence (Fv/Fm) was similar to the results of SPAD and NDVI on day 20. Pn showed a higher value in low-temperature treatment than in the control, especially, the treatment of 7°C-R5 showed higher photosynthesis by 96% as compared to the control on the 10th day. The hyperspectral reflectance of the pods was similar on the 15th day, but the hyperspectral reflectance increased only in the control on the 20th day. The hyperspectral reflectance of the uppermost (youngest) leaf was more affected by temperature than the growth stage, and the occurrence of increases in hyperspectral reflectance occurred early in the order of control, 10°C-R6, 10°C-R5, 7°C-R6, and 7°C-R5. The vegetation indices that showed significant differences from the beginning of hyperspectral analysis were GCI, PSSRb, and PSSRc. The shoot dry weight was the lowest in control and higher at 7°C treatment. The fresh weight of pods was 64% higher at 10°C and 83% at 7°C compared to the control, but 7°C-R5 was about 20% lower in dry weight. The other treatments, however, showed similar weight. The seed number and seed weight showed lower values as the treated temperature was lower and the treatment time was faster. Therefore, low temperatures delay leaf senescence and leaf falling, making harvesting difficult and interfering with the translocation of photosynthates, affecting the seed yield, and this damage becomes more severe when the seed is less filled.

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PA-120

# Effect of Input Crushed Kenaf as an Organic Material Source on the Soil Aggregate Formation in Reclaimed Land

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**[Introduction]**
Soil porosity play a role in supplying nutrients, oxygen, and water necessary for plant growth. Soil aggregation is a factor that has a great influence on the formation of soil porosity. Soil aggregation changes the physical structure of the soil to increase air permeability and water retention, thereby greatly affecting the growth of crop. Soil organic matter serves as a source of nutrients for crops, and as an energy source for micro-animals, bacteria, and fungi, promotes the growth of microorganisms, strengthens the secretion of mucus, and increases the formation of soil aggregates. Kenaf is an effective natural organic resource that can promote the formation of aggregates in reclaimed soil with high productivity. So, we input chopped kenaf in reclaimed land as an organic material and analyzed the degree and pattern of soil aggregate formation.

**[Materials and Methods]**
For the test, 3,000 kg/10a/year of chopped kenaf was added from 2020 to 2021 in the Saemangeum reclaimed land. The aggregation analysis was performed by the wet sieving method according to the NIAST methods. The diameters of the sieves used were 2.0 mm, 1.0 mm, 0.5 mm, 0.25 mm, and 0.1 mm. The distribution of the particle size was compared using the mean weight diameter, and the average particle size was directly measured with a stereo-microscope at 7 times magnification and then averaged.

**[Results and Discussion]**
The input organic material acted as central core in soil, and the formation of aggregates was promoted. The decomposition of by-products and the increase of microorganisms affected by crop cultivation, also increased the aggregation formation compared to the non-input. Input chopped kenaf and after controled by automated water supply system lead the highest aggregate formation rate 18.6%, with liquid fertilizer treatment 16.0%, input chopped kenaf 14.2%, standard fertilization 10.8%, which was significantly higher than 8.2% of the non-treatment. Because the decomposition period was not sufficient, the maturity of the aggregate was generally low. The distribution of small grain size<0.1mm was the highest, and the ratio decreased as the particle size increased. Showing the highest distribution ratio was 0.5～1.0mm. When organic matter was added, the aggregate diameter was generally larger than non-input, and the treatment with the largest aggregate diameter was input chopped kenaf + automated water supply system.

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**PA-121**

# Nitric oxide-Releasing Chitosan Nanoparticles: A Potential Impeding Strategy Against Salinity Stress in *Arabidopsis thaliana*

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**[Abstract]**
Plants being sessile are prone to various abiotic challenges, including salinity. Plants generally cope with salt stress by regulating their endogenous NO levels. NO exogenously applied in various forms also successfully impedes the salt stress, but its small size, short half-life, and high volatility rate hamper its application in agriculture. NO application via CS as a nanocarrier is an alternate option to ensure the optimal kinetic release of NO for a long period compared to the free NO form. Herein, we synthesized and characterized GSNO-CS NP by ionic gelation of TPP with CS and then reacting with GSH, followed by reaction with $NaNO_2$ suspension. The synthesized NPs were characterized using non-destructive analytical techniques such as DLS, FTIR, and SEM to ensure their synthesis and surface morphology. NO-release profile confirmed optimal kinetic NO release for 24 h from NO-CS NP as compared to free NO form. The efficiency of NO-CS NP was checked on Arabidopsis plants under salinity stress by gauging the morphological, physiological, and enzymatic antioxidant system and SOS pathway gene expression levels. Overall, the results revealed that NO-CS NP successfully mitigates salinity stress compared to free GSNO. Concluding, the findings provide sufficient experimental evidence for the application of nanotechnology to enhance NO delivery, thus inducing more benefits for the plants under stress conditions by mitigating the deleterious impacts of salt stress on the morphological and physiological status of the plants, and regulating the ions exchange by overexpression of SOS pathway candidate genes.

**[Abbreviations]**
**NO:** Nitric oxide; **CS:** Chitosan; **GSNO:** S-nitroso glutathione; **NP:** Nanoparticle; **TPP:** Tripolyphosphate; **GSH:** Glutathione; **DLS:** Dynamic light scattering; **FTIR:** Fourier transform infra radioscopy; **SEM:** Scanning electron microscopy; **SOS:** Salt-overly sensitive.

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PA-122

# Analysis of Internal Environmental Differences and Appearance Rate by Type of Nonwoven Fabric During Sesame Seedling

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**[Introduction]**

Sesame seeds are small grain seeds, and when cultivated directly, it takes a lot of labor to thin out, and the height of grinding increases, which is disadvantageous for machine harvesting and and the quantity decreases. Early sowing (from late April to early May) to avoid the rainy season of sesame seedlings is increasing, and as a result, the cultivation of sesame seedlings is increasing. However, due to the large daily temperature difference during the sowing in April, farmers are having difficulties due to the low appearance rate. In order to distribute the cultivation of sesame seeds, this study attempted to develop a technology to secure a stable appearance rate using nonwoven fabric.

**[Materials and Methods]**

Sesame seeds were used as a “Geonbaek” variety, and one seed was sown in 128-hole and 200-hole seedling trays. The topsoil used a lightweight topsoil ‘baroker’. After sowing, the irrigation water was sprayed 450 ml per tray, and 500 ml of irrigation was performed from the 2nd after sowing. The types of nonwoven fabrics were covered with 80g, 130g, 200g, and 400g white nonwoven fabrics for each thickness and treated for 1, 2, and 3 days. The survey items investigated the temperature, humidity, and appearance rate in each nonwoven fabric.

**[Results and Discussions]**

The appearance rate of sesame seeds was higher than that of 200-hole trays in 128-hole trays. The appearance rate by nonwoven thickness was high in the order of 200g and 130g (94.27%) > 400g (93.40%) > control (90.43%) > 80g (85.81%) in 128-hole trays. The appearance rate by number of processed days was high in the order of 2 days > 3 days > 1 day. In the 200-hole tray, 130g (83.11%) > control (82%) > 200g (81.78%) > 400g (81.00%) were high. The incidence of one day treatment of 200g and 400g was less than 60%, which was low in the overall average. The temperature range inside the greenhouse was 14.1°C to 39.9°C and the average temperature was 24.1°C. The average temperature for each nonwoven thickness was 80g (27.6°C) > 130g (26.4°C) > 200g (25.6°C) > 400g (25.1°C) > greenhouse (23.9°C) and for humidity, 400g (77%) > 80g (74%) > 200g (58%) > 130g (52%). In the future, experiments will be conducted at lower temperatures to find ways to maintain a high standing rate at lower temperatures.

**[Acknowledgement]**

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**PA-123**

# Efficacy of Synthesized NO-releasing Nanoparticles on the Germination and Growth of *Arabidopsis thaliana*

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**[Abstract]**
Nitric oxide (NO) is a versatile signaling molecule, which is not only involved in plant growth and development but also regulates biological processes in response to biotic and abiotic stresses. Exogenous application of NO regulates the endogenous level of nitric oxide in response to stress conditions and therefore, NO donors are frequently used for stress alleviation. However, NO has very short half-life along with high reactivity. Therefore, conventional NO donors are often disadvantageous due to the relative instability of NO. On the contrary, development of NO releasing nanoparticles is a potential technique for enhancing the availability of NO in plants. Therefore, our aim was to synthesize such potential NO releasing nanoparticles which may be useful for application in agriculture. We have prepared Chitosan encapsulated S-nitrosoglutathione nanoparticles (GSNONP) and tried it with different concentrations for basic research in *Arabidopsis thaliana*. Our results suggest that lower concentration of this nanoparticle is highly effective for better growth of plants whereas higher concentration produces toxicity that leads to plant death. We observed better growth of *Arabidopsis thaliana* at 1μM concentration of the GSNONP compared to free GSNO.

**Keyword:** Nitric oxide, S-Nitrosoglutathione, Chitosan encapsulated S-Nitrosoglutathione nanoparticles.

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PA-124

# An Optimum Sowing Date of Summer Cultivation for Seed Production of Oats (*Avena sativa* L.)

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**[Introduction]**
Oats are an important forage crop that can be year-round cultivation. However, there is no study on seed production for summer cultivation for forage oats. So, this study was conducted to determine the optimal sowing date for seed yield of summer oat (*Avena sativa* L.).

**[Materials and Methods]**
Summer oat cultivars "Darkhorse (DH)" and "Highspeed (HS)" were sown at upland field by drill seeding in Wanju region between 2017 and 2018. Fertilizer levels was 150-140-60kg(N-$P_2O_5$-$K_2O$) per hectare. We investigated seed yield from 4 sowing dates: Jul 15$^{th}$(1st), Jul 30$^{th}$(2nd), Aug 15$^{th}$(3rd) and Aug 30$^{th}$(4th). We evaluated the agronomic characteristics and germination rate of summer oats.

**[Results and Discussions]**
Delayed sowing resulted in significantly increased plant height for both years and cultivars. There was no significant difference in spike length of DH and HS which ranged from 12.8 to 17.8 cm. The sowing date of Jul 30$^{th}$ produced a higher number of grains per spike, but this yield differed significantly by year and cultivars. In 2017, the 1st sowing resulted in the lowest DH yield at 132 kg per 10a, while the 2nd sowing had the highest yield at 227 kg. HS yield was the lowest in the 1st sowing at 126 kg and the highest in the 3rd sowing at 219 kg. In 2018, DH had the lowest yield from the 1st sowing at 184 kg per 10a, and the highest from the 2nd sowing at 240 kg, but there was no significant difference between these yields. The first sowing for HS gave the lowest yield at 160 kg, and the 2nd sowing produced the highest at 258 kg. The germination rate of harvested seeds from each sowing date in 2017 and 2018 was found to be higher than 85% and there was no significant difference between the two cultivars in the 2018 germination rate test. Thus, we found the optimal sowing date for summer cultivation of oats for the highest seed yield to be between July 30 (2nd) and August 15 (3rd).

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PA-125

# Effect of Growth Regulators on Organogenesis in Diploid and Tetraploid *Codonopsis lanceolata* In Vitro Culture

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**[Abstract]**
This study aimed to investigate the effect of growth regulators on the formation of the organ in the in vitro propagation of diploid and tetraploid *Codonopsis lanceolata*, and gain the basic data for in vitro propagation of superior *C. lanceolata*. In the case of diploid *C. lanceolata*, the highestshoot formation (3.0) was observed at 0.5 mg·L$^{-1}$ addition medium with low IBA concentration. The shoot formation of tetraploid *C. lanceolata* was suppressed by addition of IBA. In the addition of IAA, the shoot formation of diploid *C. lanceolata* was slightly higher at 1.0 mg·L$^{-1}$ addition medium than that of control group, whereas tetraploid *C. lanceolata* showed the highest number (5.4) from control group. In the case of NAA, the shoot formation of diploid and tetra *C. lanceolata* tended to decrease at higher concentration. In terms of BA addition, the shoot formation of diploid *C. lanceolata* was increased by the addition of BA, whereaswhile the growth of shoot was decreased by the addition of BA. In the case of tetraploid *C. lanceolata*, shoot was found to be formed by the addition of low concentration of BA, and the growth of shoot was inhibited with the higher addition concentration of BA. With the addition of kinetin, the shoot formation of diploid *C. lanceolata* was slightly higher than that of control group, and the formation of adventitious root was highest (5.3) in the control group. In the case of tetraploid *C. lanceolata*, the shoot formation was similar in all treatment groups, but the formation and growth of adventitious root were significantly lower than that of diploid *C. lanceolata*. In the case of TDZ addition, the shoot formation of diploid *C. lanceolata* showed the pronounced results at 5.0 mg·L$^{-1}$ addition medium, and the growth of shoot was inhibited by the addition of TDZ. The formation of adventitious root was 5.3 and 4.9 in the control group and 0.1 mg·L$^{-1}$ addition medium respectively. The formation of the shoot of tetraploid *C. lanceolata* showed better results with the higher concentration of TDZ, and the growth was better with the lower concentration of TDZ. The formation and growth of adventitious root were significantly slower than that of diploid *C. lanceolata*.

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PA-126

# Effect of N, P and K Fertilizers Application on Growth, Yield and Mineral Nutrient Content in *Platycodon grandiflorum* for. *duplux*

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**[Abstract]**
This study was carried out to investigate the effects of nitrogen, phosphorus, potassium (three main macro elements of fertilizer) on growth, yield and mineral contents of *Platycodon grandiflorum* for. *duplux* and to obtain the basic data of the proper fertilizer application for increasing the yield of *P. grandiflorum* for. *duplux*. Plant height showed significantly good results in all fertilization treatments compared to non fertilizer group (the control, T0), and in particular, the highest was 85.7 cm in the complete group (T4). Chlorophyll content showed a high amount in the range of 20.7 to 23.8 against all fertilization treatment groups, except for non fertilizer (T0) and non nitrogen (T1). The fresh weight of roots were higher quantity than other fertilization treatments in the complete group 55.8 g (T4). The mineral nutrient content of Na, Mg, Cu and Al of the roots of *P. grandiflorum* for. *duplux* from T1 group showed the lowest amount compared to other groups. In addition, P from T2 group, Mn from T3 group and Ca, Fe, Zn from T4 group also exhibited the lowest mineral content compared to other groups respectively.

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PA-127

# Comparison and Characteristics of Grouping in the Productive Association of Soybean (*Glycine max* L.) Grown in Paddy Field

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**[Introduction]**

Recently, to improve the self-sufficiency of soybeans, the government has selected the field crop joint management support project (soybean) as fostering project since 2019 and is promoting a policy to expand the cultivated area of soybean grown in paddy field. This management as the productive association of soybean grown in paddy field is farming associations that are higher than the farmhouse unit organization, and there are with 44 in 2020 and 38 in 2021, total managements are 82. The purpose of this study is to derive a productivity improvement plan by examining the differences in organizational characteristics, production base, and field in the productive association of soybean grown in paddy field.

**[Materials and Methods]**

We analyze the report data on the soybean cultivation area in Korea, the number of members of farmers, and the quantity of soybean cultivation in 81 crop joint management in 2022, and use a questionnaire to analyze the organizational characteristics, level of expertise, production base (number of floods, etc.), and cultivation method in the productive association of the soybean grown in paddy field (one place did not cultivate soybeans in 2022).

**[Results and Discussion]**

In productive association of soybean grown in paddy field, the yield of 81 crop joint managements could be divided into 25% of low or up (19 places) and 50% of the median (43 places), and the yield of low group was less than 270kg/10a in the 1st quartile, and up group (each 19 places) was over 310/10a in the 3rd quartile. The the cultivation area per farmer was 2.52ha and 1.43ha of quantity in the upper and lower complexes. There was no difference in the area and frequency of flooding. However, there was significance in rapid response to flooding (the difference between forced drainage within 24 hours and after 24 hours). In the upper complex, the plain land had a higher proportion of cultivated area than the lower complex, and it responded well to drought and flooding.

The productive association of soybean (Glycine max L.) grown in paddy field were grouped into six, the soybean grown in paddy field general cultivation (A), new (F)·old (B) reclaimed land (the year of reclaimed land was classified as of 1990, divided by the occurrence of salt damage), vulnerable to flooding (C), high input and high yield (D), and non-standard cultivation (E). The number of complexes was 30 for A, 16 for B, 10 for F, 11 for C, 9 for D, and 5 for E. The yield (kg/10a) by the group was 218 for F and 333 for D (mean 279). The frequency of flooding was the highest in B and C groups, and the lowest in D. E and D groups were high, and F was low. These detailed research results can be applied to method of grouping productive association of other crops.

**[Acknowledgement]**

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PA-128

# Effect of Plant Growth Regulator Treatment on Isoflavones in Soybean

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**[Abstract]**

The soybean (*Glycine max*(L.) Merrill), an important food crop in the world, is popular because of its high quality protein and oil content. Soybeans as a food have long been known for their beneficial effects on health and are well-recognized globally. Isoflavones, significant soybean secondary metabolic products, may be crucial in avoiding some cancers and lowering the risk of cardiovascular disorders. This study investigates the correlation between plant growth regulator and the effect on the isoflavone levels in soybean leaves. The study was carried out in the green-house of the southern crop department in miryang. Soybeans(Seonpung) were cultivated in 1/2000 of the Wagner pot. Ethephon(500, 1000, 2000 ppm) and ABA(100, 200, 400 ppm) were used as plant growth regulators, and they were each treated on R2, R5, and R7 stage. After treatment, leaves were sampled three times at intervals of 5 days, and the content of 6 isoflavones and coumestrol was analyzed. Soybean isoflavones were analyzed using Ultra Performance Liquid Chromatography (Acquity UPLC H-Class system, Waters). The isoflavones content showed an overall highly in the R5 stage, and the level was similar to that of no treatment in the R2 and R7 stage. The difference between the growth regulators was found to be higher than that of ethephon when ABA was treated. The coumestrol content was confirmed to be high in the order of R7, R5, and R2 on the treatment time, and it was found that the content increased as the treatment time was delayed. In the treatment with the growth regulator, the coumestrol content tended to be higher when ethephon was treated than ABA.

**[Acknowledgement]**

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PA-129

# Evaluaion of Seven Cultivars of Italian Ryegrass for Salinity Tolerance and Growth in Reclaimed Paddy Field

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**[Introduction]**
The purpose of this study was to select IRG varieties suitable for productivity enhancement in reclaimed land located in South-West area of Korea, where salt concentration of soil was about 0.3%. For this purpose, 7 Korean bred varieties were compared for salinity tolerance by hydroponics and greenhouse test with salt concentration of 0% and 0.3%, and their productivity was evaluated in the reclaimed paddy field located in Muan, Korea.

**[Materials and Methods]**
The 7 varieties used in this study were Kowinearly, Greencall, Greenfarm, Greenfarm3, IR603, IR605 and IR901, which were obtained from the National Institute of Animal Science, RDA. The germination test was carried with 0% and 0.3% saline water in incubator at 15°C, 20°C and 25°C. The early growth characteristics were investigated by hydroponics with salt concentration of 0% and 0.3%, respectively. For the greenhouse test, the salt concentration of the soil was adjusted to 0% and 0.3% with sun-dred salt, and 3kg/seeds were sown in rows. The field test was conducted in the reclaimed paddy field located in Muan area, where the initial salt concentration was 0.3%, and the seeds were sowed by drill seeding with 4 kg/10a of seeding rate. The amount of fertilization in both greenhouse experiment and field test was 18 kg/10 of nitrogen, 15 kg/10a of phosphoric acid, and 15 kg/10a of potassium.

**[Results and Discussion]**
The germination percentage decreased at saline water compared at 0% salinity, but the reduction in germination at 0.3% salinity was not a practical cultivation problem. Among the 7 varieties of Italian ryegrass, IR603 showed relatively high growth in the early growth in hydroponics and greenhouse test. In the test of Muan reclaimed paddy, the dry yield (kg/10a) of IR603 (648kg) was the highest compared to the other varieties; IR605 (643kg), Greenfarm (599kg), Kowinearly (586kg), IR901 (571kg), Greenfarm3 (413kg) and Greencall (364kg). The feed values of 7 varieties were similar with no significant difference. In conclusion, IR603 was superior to those of other cultivars in early growth characteristics in hydroponics and the growth and yield in both greenhouse and reclaimed paddy fields test.

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PA-130

# Effect of Medium Reuse on Medium Properties and Seed Potato Productivity

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**[Introduction]**

In the production of seed potatoes, cultivation of substrate culture is widely used because it is convenient to manage. However, there is a hassle of exchanging the medium during cultivation of potato medium, and the medium is used once at the farm and is easily discarded. Therefore, it is necessary to study the medium reuse method. This study investigated the effect of medium reuse on medium properties and seed potato productivity

**[Materials and Methods]**

The potato cultivars were Saebong, Haryeong, and Geumsun, and the places were greenhouse of Sacheon-myeon, Gangneung. The test treatment was carried out using new commercial medium and medium reused 1~4 times, and was tested in spring cultivation from 14 April to 8 July. Disinfection treatment of the reuse medium was performed using a sterilizing agent, and gas was removed after plastic coating. The investigation were the physical and physicochemical properties of the medium, and the number of tubers, tuber weight, specifications, and occurrence of physiological disturbances.

**[Results and Discussion]**

As the number of times of medium reuse was repeated, the water content (physical properties) and inorganic nutrients (chemical properties) of the medium decreased. According to medium reuse, the number of tubers was 4.0-4.8 per plant, and the tuber weight was 209-250g per plant. Specific gravity and occurrence of physiological disturbance was not significant according to the medium reuse treatment. Therefore, when thoroughly disinfecting the medium, the medium could be used up to 4 times. If the medium is reused, it is possible to reduce the cost of purchasing new medium, which has an economic effect of saving 14,720 won per $m^2$.

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PA-131

# Evaluation of Growth and Yield When Harvesting Italian Ryegrass Transplanted After Cultivation of Paddy Rice

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**[Abstract]**

Seed production of italian ryegrass has a problem of lodging during ripening and a decrease in quality due to difficulty in drying seeds during harvest. Therefore, in order to produce high-quality Italian ryegrass in paddy fields, it was carried out to reduce the density and solve the lodging problem through transplanting.

In this experiment, *Lolium multiflorum* cv. Kowinearly was transplanted in autumn from a paddy field in Sindong-ri, Gwansan-eup, Jangheung-gun, Jeollanam-do. var. Kowinearly was made into a bed at 90 g/box and stacked in boxes. It was transplanted on October 27th after 2 days of germination at 30°C and 15 days of seedling and greening. When transplanting, they were transplanted at intervals of 30×14cm. The existing cultivation method, drill seedling, was sowed at a level of 50 kg/ha, and both transplanting and drilling were carried out at a nitrogen fertilization rate of 45 kg/ha.

The number of ears during transplant cultivation was 1,016/$m^2$ and the drilling tended to be higher at 2,278/$m^2$, but this was probably due to the difference in seeding amount. The seed number of an ear tended to be 56% higher in transplantation, which had a significant impact on yield. The seed yield was 2,096 ka/ha in transplantation, which was 21% higher than that of drilling. When looking at the relationship with weed occurrence, there were areas where all the weeds, such as amul foxtail, occurred due to the low density. Even in the same transplanting area, the seed yield was about 1,000kg/ha less in the area where the weeds were abundant. It seems that weed management is important in paddy cultivation. Therefore, it seems necessary to develop an exclusive herbicide for Italian ryegrass cultivation.

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PA-132

# Evaluation of Rice Nitrogen Utilization Efficiency under High Temperature and High Carbon Dioxide Conditions

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**[Abstract]**

According to the 5th Climate Change Report, global average temperature in 2081 ~2100 will increase 1.8°C based on RCP 4.5 and 3.7°C based on RCP 8.5 from the current climate value (IPCC Working Group I AR5). As temperature is expected to increase due to global warming and the intensity and frequency of rainfall are expected to increase, damage to crops is expected, and countermeasures must be taken. This study intends to evaluate rice growth in terms of nitrogen utilization efficiency according to future climate change conditions.

In this experiment, *Oryza sativa* cv. Shindongjin were planted at the SPAR facility of the NICS in Wanju-gun, Jeollabuk-do on June 10, and were planted and grown according to the standard cultivation method. Cultivation conditions are high temperature, high $CO_2$ (current temperature+4.7°C · $CO_2$ 800ppm), high temperature (current temperature+4.7°C · $CO_2$ 400ppm), current climate (current tempreture · $CO_2$ 400 ppm). Nitrogen was varied as 0, 9 , 18 kg/10a.

The N content and C/N ratio of all rice leaves, stems, and seeds increased at high temperature, and the N content and C/N ratio decreased under high temperature and high $CO_2$ conditions compared to high temperature. Compared to the current climate, NUE increases by about 8% under high temperature and high $CO_2$ conditions and by about 2% under high temperature conditions. This seems to be because the increase in temperature and $CO_2$ induced the increase in biomass. ANUE related to yield decreased by about 70% compared to the current climate under high temperature conditions, and decreased by about 45% at high temperature and high $CO_2$, showing a tendency to decrease compared to high temperature. This appears to be due to reduced fertility and poor ripening due to high temperature stress. However, as the nitrogen increased, the number of ears and the number of grains increased, slightly offsetting the production reduction factor.

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PA-133

# Photosynthesis Monitoring of Rice using SPAR System to Respond to Climate Change

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**[Abstract]**

Over the past 100 years, the global average temperature has risen by 0.75 °C. The Korean Peninsula has risen by 1.8 °C, more than twice the global average. According to the RCP 8.5 scenario, the $CO_2$ concentration in 2100 will be 940 ppm, about twice as high as current. The National Institute of Crop Science(NICS) is using the SPAR (Soil-Plant Atmosphere Research) facility that can precisely control the environment, such as temperature, humidity, and $CO_2$. A Python-based colony photosynthesis algorithm has been developed, and the carbon and nitrogen absorption rate of rice is evaluated by setting climate change conditions.

In this experiment, *Oryza Sativa* cv. Shindongjin were planted at the SPAR facility on June 10 and cultivated according to the standard cultivation method. The temperature and $CO_2$ settings are high temperature and high $CO_2$ (current temperature+4.7°C · $CO_2$ 800ppm), high temperature single condition (current temperature+4.7°C · $CO_2$ 400ppm) according to the RCP8.5 scenario, Current climate is set as (current temperature · $CO_2$ 400ppm). For colony photosynthesis measurement, a LI-820 $CO_2$ sensor was installed in each chamber for setting the $CO_2$ concentration and for measuring photosynthesis, respectively.

The colony photosynthetic rate in the booting stage was greatest in a high temperature and $CO_2$ environment, and the higher the nitrogen fertilization level, the higher the colony photosynthetic rate tends to be. The amount of photosynthesis tended to decrease under high temperature. In the high temperature and high $CO_2$ environment, seed yields, the number of an ear, and 1000 seed weights tended to decrease compared to the current climate. The number of an ear also decreased under the high temperature. But yield tended to increase a little bit under the high temperature and high $CO_2$ condition than under the high temperature. In addition, In addition to this study, it seems necessary to comprehensively consider the relationship between colony photosynthetic ability, metabolite reaction, and rice yield according to climate change.

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PA-134

# Assessment of Critical Temperature for the Grain Filling of Late Transplanted Temperate Rice

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**[Abstract]**
Grain filling traits of rice were traced to determine the critical temperature that ceased grain filling process, from the late transplanted temperate rice varieties in the field conditions of 2020 and 2021. The tested three varieties were transplanted six times with four target heading dates of 20 Aug. (control), 10 Sep., 20 Sep. and 30 Sep. Nine times of sampling were made from a week after heading with three replicates for each treatment.
Development of grain filling percentage, grain dry weight and milled rice weight demonstrated sigmoid curves in the first and second transplants of 2020, and in the first to third transplants of 2021. The three grain filling traits in the 2020 third transplants and in the 2021 fourth transplants initially increased with the progress of grain development, and reached the peaks at certain time points, then decreased thereafter. Non-linear regression analyses, performed for the traits in the transplants that showed sigmoid curves except control, indicated that 95% of the final data (95% FD) was attained when the seven-day moving temperature (Sd-MovT) was 8.4-9.6°C, which excluded the cases when the temperature before the dates of 95% FD was lower than that on the dates of 95% FD. Sd-MovT on the date of peak data was 8.5-9.8°C in the 2020 third transplants and 6.9-8.3°C in the 2021 fourth transplants. Grain development was observed when seven-day mean temperature (Sd-MT) from 35 to 41 days after heading date was 9.4-10.8°C in the 2020 third transplants and 10.1-11.9°C in the 2021 fourth transplants. But Sd-MT of 8.7–9.1°C in 2020 and 6.9-7.6°C in 2021, at 42-48 days after heading, resulted in no progress of grain development. Overall, Sd-MovT at the point of stagnated grain development appeared in the range of 6.9–9.8°C. The lowest Sd-MT that showed the progress of grain development was 9.4-9.5°C and the highest Sd-MT that showed no grain development was 9.1°C, both of which appeared in Odae and Haiami of the 2020 third transplants Therefore it is concluded that critical temperature for the grain development of temperate rice in natural conditions exists between 9.1°C and 9.5°C.

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# Assessment of Critical Temperature for the Growth and Development of Early Transplanted Temperate Rice

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**[Abstract]**
Effect of temperature during the period of 10 days from transplanting (10 DFT) on the growth and development of rice plants was investigated by transplanting semi-adult seedlings six times from 5 April to 15 May at 10-day interval in the field conditions of 2020 and 2021, with aims to investigate the critical temperature for early transplanting of temperate rice.
In the two experimental years, mean temperature for 10 DFT appeared 9.1, 10.5, 11.6, 13.8, 13.9, 16.2, 16.4, 16.7, 17.1, 17.8°C depending on the transplanting date. Mean temperature of 9.1°C and 10.5°C for 10 DFT appeared in the April 5 and April 15 transplants in 2020 showed negative or no effect on the increase of rice growth and acceleration of heading date when compared to those of right after transplanting treatments in the same year. Mean temperature of 11.6°C for 10 DFT appeared in the April 5 transplant in 2021 demonstrated greater biomass from early to heading stage but the same heading date compared to April 15 transplant, indicating that 11.6°C for 10 DFT had a positive effect on rice growth but no effect on advanced heading. Both more biomass and advanced heading stage were observed when the mean temperature for 10 DFT was 13.8°C or higher, compared to those of right after transplanting treatments. These findings indicate that effective 10-DFT mean temperature for rice growth exists between 10.5 and 11.6°C, and that for rice development in terms of heading stage lies between 11.6 and 13.8°C in natural condition.
Further field and indoor studies are suggested to narrow down the critical temperature for early transplanting of temperate rice, which will enable to maximize the crop period in high altitude regions with low temperature.

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# Rice Varieties Adaptable to the Temperature and Day-Length Conditions of the Major Rice Production Area in North Korea

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**[Abstract]**
The heading response of 40 genotypes, originated from South Korea, North Korea, and northern China, was tested under the temperature and day-length conditions of thirteen major rice production area in North Korea, with aims to select adaptable varieties to the given environment and crop period for each region. To simulate regional environment, seven-day mean temperature with 10°C daily temperature range and day-length for each region were imposed at a weekly interval in the walk-in phytotrons.
Olbyeo1, Olbyeo2 and Sonbong9 originated from North Korea, Kenjiandao3 and Nongdae3 from northern China, and Joun from South Korea demonstrated the earliest heading stage depending on the regional environment. Thirty-four varieties reached heading stage within the regional safe marginal heading date (SMHD) under Haeju and Sariwon conditions while 16 - 17 varieties reached the stage under Wonsan, Changjon, Supung, and Yongyon environment. Some of the middle and mid-late maturing varieties originated from South Korea could reach heading stage within SMHD under the temperature and day-length conditions of Kaesong, Haeju, Sariwon, Nampo, and Pyongyang located in west-southern plain. Majority of early maturing varieties, but not middle or mid-late ones, showed heading stage within SMHD under the conditions of Singye, Anju, Kusong and Sinuiju. Only some early maturing varieties demonstrated heading stage within SMHD under Yongyon, Changjon and Wonsan environment.
These results provide basic information on the varieties able to complete their normal life cycle under the regional environment in North Korea. It it further suggested that yield performance of the selected varieties for each region in this study be tested to select high yielding rice varieties adaptable to North Korean environment.

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# Spatiotemporal Patterns of Starch Deposition in Amaranth Grains (*Amaranthus cruentus* L.)

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**[Abstract]**
In this study, we investigated whether there is another amaranth GBSS isoform in an attempt to characterize the synthesis of amylose in the pericarp. We used I2/KI staining to analyze the temporal and spatial starch accumulation patterns during seed development. The spatiotemporal starch accumulation patterns in developing seeds were observed by staining with I2/KI. Starch granules were observed in the pericarp in the initial developmental stage (3 DAP). A few starch granules were detected in the perisperm in the early-late developmental stage (8 DAP), during which the pericarp starch contents rapidly decreased. Starch granules were distributed throughout the perisperm in the mid-late developmental stage (15 DAP). Similar results were reported for other cereal crops, including barley, rice, and sorghum. Starch granules in the pericarp are synthesized during the early seed developmental stages but are absent in mature seeds. We recently reported that starch deposits in the perisperm of developing amaranth seeds are detectable only after the initial developmental stage. Prior to this stage, the pericarp is the major site of starch deposition. A recent study suggested that GBSSII isoforms are responsible for amylose synthesis in pericarps.

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# The Effect of Irrigation and Fertilization on Agronomic and Physiological Traits in Wheats

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**[Introduction]**
The objective of this study was to determine the effects of different treatments in irrigation and additional N-fertilization on agronomic and physiological traits of Ofree known as ω-gliadin deficient Korean wheat cultivars, cultivated in Gyehwado.

**[Materials and Methods]**
Ofree was cultivated with 2 different irrigation conditions, no irrigation (I-0) and 2 times irrigations at heading and milky stage (I-2), and 3 different fertilizations, conventional fertilization (40kg/ha at regrowing stage, N-0), 2 different additional N-fertilizations, booting (40kg/ha, N-1) and bolting (40kg/ha, N-2) stage. Agronomic, culm and spike length, tiller, yield, etc, and physiological traits, leaf area index (LAI), changes of weight in leaf, culm and spike during maturation, etc, were evaluated.

**[Results and Discussion]**
Culm and spike length were longer at irrigation treatment, grain yield, 1,000 kernel weight, and test weight were higher at additional N-fertilization treatment, but there was no difference in tiller and root weight at the heading stage. The LAI of the plant was higher at I-2 and N-2 but the leaf area index of I-0 and N-1 was similar to I-0 and N-0, but no difference was found in the LAI of the canopy. The chlorophyll content of N-1 and N-2 was higher than others, but no difference was found in photosynthesis yield. There was no significant difference in the weight of leaf, culm, spike, and grain during maturation with the treatments, although spike and grain weights were increased with the progress of maturation. Quality evaluation, flour and noodles, is in progress.

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# 간척지에서 염농도에 따른 콩 품종별 생육 및 수량
# Effect of Soil Salinity on Growth Characteristics and Grain Yield of Soybean Cultivars in Reclaimed Land

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**[서론]**
국내 간척지 면적은 113천 ha로 국내 경지면적의 7 % 이상을 차지할 만큼 넓은 면적을 차지하고 있다. 간척농지는 기계화, 규모화 영농에 적합한 우량농지로 조성이 되어 있으나, 일반 농경지에 비해 토양산도와 EC가 높고, 유기물, 유효인산이 낮아 지속적인 토양관리가 필요하다. 최근 정부에서는 간척지 범용화를 위해 벼 대체 밭작물 생산을 장려하고 있다. 소득성이 높고, 규모화 재배에 적합한 작물로 콩을 꼽을 수 있다. 간척지에서 작물의 생산성에 큰 영향을 주는 인자는 염류(Salinity)이다. 본 연구에서는 간척지에 도입 유망한 콩 품종 선발을 위하여 다양한 염류 수준에서 품종별 생육특성 및 수량성을 평가하였다.

**[재료 및 방법]**
본 시험은 국립식량과학원 새만금간척지 시험포장에서 2021년 6월부터 11월까지 수행되었다. 공시 품종은 대풍, 대풍2호, 진풍, 미소, 태선, 우람 등 6개 이었다. 본 시험은 강우에 의한 염류 영향을 최소화하기 위하여 비닐온실에서 수행하였다. 적응성 검정을 위한 토양 EC는 대조구로 0.5 dS/m이하, 2.0 dS/m, 4.0 dS/m로 설정하였고 생육기간 동안 해당 염농도의 염수를 주 2회 점적관수하였다. 염류 영향을 최소화 하고자 퇴비는 시용하지 않았으며, 시비량(kg/10a)은 질소(요소)-인산(용성인비)-가리(염화가리)를 6-7-3으로 전량 기비 처리하였다.

**[결과 및 고찰]**
처리 염도 수준에 따라 콩의 생육 및 수량은 유의적으로 감소하였다. 0.5dS/m에서 수량성은 139~202kg/10a 으로 '대풍', '대풍2호', '미소'등이 양호하였고, 2.0dS/m에서 수량성은 65~131kg/10a로 '미소', '대풍2호'이 양호하였으며, 4.0dS/m에서는 42~96kg/10a로 '미소', '대풍2호'가 양호하였다. 염농도에 따른 평균 수량성은 0.5dS/m에서는 174kg/10a, 2.0dS/m에서는 108kg/10a, 4.0dS/m에서는 69.7kg/10a 이었다. 염농도가 증가에 따라, 총협수와 100립중이 유의적으로 감소하여 수량 감소에 직접적으로 영향을 준 것으로 사료되었다. 총협수는 중립종인 '대풍2호'가 39.4개/주로 가장 양호하였고, 100립중은 대립종인'미소'품종이 평균 19.4g으로 가장 양호하였다. 낮은 염도에서도 적응성이 낮은 '태선', '진풍'을 제외하고 EC 수준에 따른 콩 수량 감소율이 가장 낮은 품종은 '미소'로 y(kg/10a)=-48.5·EC + 237.2으로 산출되어, 간척지에 도입 유망한 품종으로 고려되었다.

**[사사]**
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## 파종기 이동에 따른 중부지역 밭작물의 생육 및 수량 변화

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**[서론]**
본 연구는 기후 변화에 대비하여 밭재배에 주로 이용되는 전작물을 대상으로 중부지역에 적정한 파종시기를 구명하기 위해 수행되었다. 이를 구명하기 위해 파종기의 이동에 따른 수량구성요소와 관련된 형질의 변화를 분석했다.

**[재료 및 방법]**
본 연구는 충주시 건국대학교 실습농장에서 실시했다. 공시재료는 밀(조경, 우리, 금강, 탑동), 감자(수미, 추백, 은선, 단오), 옥수수(미백2호, 미흑찰, 감미옥)로 선정했다. 밀은 10월 20일, 11월 4일, 11월 9일, 3월 10일 3월 17일 파종했다. 감자는 3월24일, 옥수수는 4월4일을 파종적기로 하여 10일 정도의 간격으로 3시기(조파, 적파, 만파)에 걸쳐 파종하였다.

**[결과 및 고찰]**
4품종의 밀 모두 춘파보다는 추파가 수량이 많게 나왔다. 수량과 간장은 추파 1차를 최대로 하여 파종기가 늦어질수록 줄어드는 특성을 보였다. 추파 1차 밀 수량은 금강밀 422kg, 탐동밀 481kg, 조경말 267kg, 우리밀 733kg이었다. 조경밀을 제외하고는 추파2차가 천립중이 가장 높았으나, 경수는 추파 1차가 앞도적으로 많았다. 수당립수는 탑동밀 추파 1차가 18개, 우리밀 추파 1차가 28개로 가장 많았고 파종시기가 늦어질수록 감소했다. 금강밀은 추파 2차(21개), 조경밀은 추파 3차(24개)가 수당립수가 가장 많았다. 겨울 추위와 봄 가뭄으로 인해 작황이 좋지 않아 대부분이 평균 수량에 못미치는 결과가 나왔으나, 추파 1차 우리밀과 탐동밀은 평균 수확량보다 각각 38%, 2.4% 증수했다.
상품성이 있는 감자의 수량은 4품종 모두 적기 파종(2차)이 가장 높았다. 2차 파종한 감자의 수량(kg/10a)은 수미 3,024kg, 추백 4,182kg, 은선 3,477kg, 단오 4622kg 이었다. 강우 부족(전년 대비 강수량 135.6mm 감소), 일교차 확대(평균 일교차 1.8도 상승) 등의 기후 변화로 인해 감자 생육이 부진했고 상태가 불량한 감자가 많이 나와 상서율이 1.7~67.2%로 전반적으로 낮았다.
옥수수는 전반적으로 맺힌 이삭수는 많았으나 대부분 등숙이 불량하거나 병충해를 입어 상품성 있는 이삭수가 적었다. 이삭수(개/10a)는 미백2호 1차, 3차가 4667개, 미흑찰 2차가 4000개, 감미옥 2차가 4667개로 가장 많았고, 모든 품종들 통틀어 감미옥 3차가 등숙 불량이 극심하게 나타났는데 상품성 있는 이삭수가 0개였다. 이는 기후 변화로 올해 옥수수 작황이 좋지 못했기 때문으로 보여진다. 충북지역 4~5월 강수량이 평년대비 31% 수준인 54mm로 줄었으며, 가뭄으로 인해 옥수수의 생장 속도가 느려지고, 병충해 피해가 심했다. 그중 미흑찰 3차가 병충해 피해를 입은 이삭수가 16개로 가장 많았다. 옥수수 재배기간(3~7월)동안의 평균기온 또한 17.36도로 생육적온인 21~25도보다 낮아 모든 품종이 평균 수량에 비해 낮게 측정되었다. 같은 품종 내에서는 미백2호 1차가 769kg, 미흑찰 2차, 감미옥 2차가 각각 851kg, 1141kg으로 수량이 가장 많았다.

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## 식이유황 처리에 따른 시금치의 품질특성변화

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**[서론]**
시금치는 비타민, 철분, 식이섬유 등 각종 영양성분이 다량 함유된 농황색 채소로, 한국인의 식탁에서 다양한 조리법으로 요리에 이용된다. 식이유황은 식용이 가능한 황으로, Methyl sulfonyl methane (MSM) 이라 하며, 티아민(비타민B1), 리보플라빈(비타민B2) 및 니아신(니코틴산)의 중요 공급원이자, 염증감소, 관절기능지원, 면역체계강화 등 신체·정신적으로 인간에게 많은 이점이 있는 것으로 밝혀져 있다. 하지만, 돼지, 가금류 등에 적용된 연구사례는 많지만, 채소 등 작물에 적용된 연구사례는 부족한 현실이다. 따라서, 천연유황 공급원인 MSM의 시용방법에 따른 시금치의 품질특성을 조사함으로써 고품질 시금치 생산의 기초자료로 활용고자 본 연구를 수행하였다.

**[재료 및 방법]**
본 시험은 경상국립대 내동 시험포장에서 '사계절시금치'를 공시하여, 2021년 10월 7일에 평휴(150cm) 직파하여 재배하였다. 기타 재배 및 시비방법은 농촌진흥청 표준재배법에 준하여 수행하였다. MSM 처리는 기비 유·무를 주구로 배치하고, 추비 시용농도를 50, 100, 200% 를 세구로 배치하였고, 엽면시비 시 1 g/평을 100% 기준으로 200배 희석하여 수확 15일 전까지 각각 10일 간격으로 4회 처리하였다. 농촌진흥청 연구분석조사기준에 준하여, 수량 및 품질특성을 조사하였고, 식물체내 비타민c 및 황 함량을 조사하였다.

**[결과 및 고찰]**
MSM 시용에 따른 시금치의 수량에서는 기비+추비200% 처리구에서 12,658 kg/10a 로 가장 많았고, 일부 시용구를 제외하면, MSM 시용량이 증가할수록 수량도 증가하는 경향을 보였다. 품질특성에서 먼저, L, a, b 값에서 기비+추비200% 처리구에서 각각 66.3, -22.0, 40.3 으로 가장 높거나, 가장 낮은 것으로 나타났다. SPAD 값에서는 기비+추비200% 처리구 및 추비200% 처리구에서 각각 60.8, 60.0 으로 가장 높게 나타났다. 수분함량에서는 수량이 가장 많았던 기비+추비200% 처리구에서 35.1% 가장 많이 나타났고, 비타민C 함량에서도 수량이 가장 많은 기비+추비200% 처리구에서 65.1 mg/100g 으로 가장 함량이 많았다. 따라서 MSM 시용은 시금치의 품질특성 및 비타민 함량에 영향을 미치는 것으로 사료된다.

**[사사]**
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PA-142

# Investigation of Changes in the Growth of Mid-Late Cultivars through the Comparison of Regional Weather Conditions in the Rice Yield Forecast Test

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**[Introduction]**

Owing to climate change, damage affecting rice production from abnormal weather, such as an increase in average temperature, temporary heat waves, and high concentration of surface ozone gas, is expected to increase. Although the average productivity of rice has recently increased compared to the early 2000s, the fluctuations in productivity due to abnormal weather are increasing. In order to respond to climate change, a yield forecast test is conducted every year to investigate growth and productivity fluctuations using rice varieties grown in 17 regions. In this test, changes in the weather conditions of 17 regions in the 2022 crop were investigated. In addition, the change of weather conditions for each growth stage of rice and its growth change were investigated. The growth analysis was conducted using mid-late rice varieties in two regions with increased growth (Naju, Daegu) and two regions with decreased growth (Andong, Yesan) compared to 2021.

**[Methods and Materials]**

The rice varieties used in the test regions are as follows. Naju (Ilmi, ShinDongjin, Saecheongmu, Mipum, Hyeonpum, Saeilmi), Daegu (Ilpoom, Saechucheong, Saeilmi), Andong (Saechucheong, Ilpoom, Saeilmi), Yesan (Samkwang, Yechan, Chindeul, Saeilmi, Saenuri). The transplanting period is as follows. Naju (June 5th), Daegu (May. 30th), Andong (May. 18th), Yesan (May. 25th). Since the cultivation method for each region is the same in 2021 and 2022, it is possible to compare the growth response according to the weather conditions in 2021 and 2022.

**[Results and Discussion]**

The average temperature from May 1 to September 15, 2022 in 17 regions increased by 0.6°C and 0.3°C, respectively, compared to the previous year (2021) and normal years (2017-2021). Hours of sunshine was 875 hours, 25.4 hours longer than the previous year (2021), and 20 hours less than the average year (2017-2021). The heading date of the three regions was delayed despite the increase in the average temperature from transplanting to the heading date. Mid-late cultivating rice responds sensitively to day-length and responds to heading. When the temperature and the Hours of shunsihne condition were analyzed by dividing the time based on the day-length (based on the time when the day-length was shorter than 14.3 hours), the temperature decreased slightly, and the Hours of shunsihne decreased significantly. In Naju and Daegu, the number of fertile grains increased significantly compared to 2021, and in Andong and Yesan, the number of fertile grains decreased significantly. In Andong and Yesan, the number of panicle (per m2) and the number of grain per panicle decreased significantly. In the reproductive growth stage, hours of sunshine was decreased in all four regions, but the decrease in Andong and Yesan was significantly larger.

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PA-143

# Growth Characteristics and Rice Yield by Planting Density of Panicle Number Type and Panicle Weight Type

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**[Introduction]**
In order to solve the problems of labor shortage and quality deterioration due to the aging of the rural population, it is necessary to revitalize rice cultivation. Low density planting cultivation reduce the number of hills planted per unit area and reduce labor input time for seedling and transplanting. Rice is divided into panicle number type and panicle weight type. The two type varieties tiller pattern is different by planting density. so this study was conducted to investigate growth and yield characteristics of the two type varieties according to planting density.

**[Materials and Methods]**
This study was conducted in the Chungcheongbuk-do Agricultural Research and Extension Services from 2021 to 2022. Samgwang and Saechilbo were used and transplanted on May 30th. Planting densities were 80, 60, 50, 37 hills/3.3m$^2$ by rice transplanter. Fertilization per 10a was N:P:K=9:4.5:5.7kg, and the nitrogen splitting ratio was divided by 50-20-30% of basal fertilization-topdressing at tillering stage-ear manuring, and other cultivation management followed the Rural Development Administration standard cultivation method. The rice growth characteristics survey was conducted in accordance with the Rural Development Administration's Agricultural Science and Technology Research and Analysis criteria.

**[Results and Discussion]**
Plant length was shorter as planting density was low in the early stage of transplanting, but became longer as the number of growing days was elapsed when the planting density was low. Tillage increased up to 65 days after transplanting at 80, 60, and 50 hill/3.3m$^2$, and lasted until 80 days at 37hill/3.3m$^2$. The change in the number of tillers according to the number of growing days was increased by 3, 4, 6, and 11 at 80, 60, 50, and 37hill/3.3m$^2$ in both varieties, respectively, and there was no difference according to the tiller ecology. The number of spikelet increased as the planting density of both varieties decreased. There was no difference between the two varieties according to the planting density, and the ripening ratio decreased as the planting density decreased. The rice yield decreased as the planting density decreased, but there was no difference between 37 hill/3.3m$^2$ and 80hill/3.3m$^2$. In Samgwang, the lower the planting density, the higher the rice yield. As farring continues at 37hill/3.3m$^2$ until release, it is judged that additional investigations such as the effective cost ratio and the rate of maturation of late farling are necessary.

**[Acknowledgement]**
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PA-144

# Growth Characteristics of the Heading Season with Transplanting Time in Chungbuk Region

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**[Introduction]**
In the Chungbuk region, the temperature increase was 0.6°C compared to the past, which was a larger increase than in the southern region, and the cultivation period was longer, but it is causing the production and quality deterioration due to high temperature ripening. Accordingly, in order to produce high-quality rice, it is necessary to change the cultivation period according to the cultivation area and the type of water source. This study was conducted to investigate the change in the growth characteristics during the seeding season when the transplanting time was controlled.

**[Materials and Methods]**
This study was conducted at Chungcheongbuk-do Agricultural Research and Extension Services in 2022. For the test cultivars, Odae of early maturing cultivar, Cheongpum of mid-maturing cultivar, and Samgwang of mid-late maturing cultivar were used. The transplanting period was from May 20 to June 20, each of which was transplanted 4 times. The standard cultivation method for each region was followed, and the planting distance was 30×15cm. Using a slow-release fertilizer, the nitrogen application amount per 10a was applied at 9kg.

**[Results and Discussion]**
There was no difference in the leaf color value of the early-maturing variety according to the transplanting period, the mid-maturing variety increased as the transplanting time was delayed, and the mid-late maturing variety decreased as the transplanting period was delayed. The fresh weight at the heading season increased as the transplanting time was delayed for early-maturing variety, and the mid-maturing variety and mid-late maturing variety decreased with the same dry weight. The dry weight of the ears at the heading season decreased as the transplanting time was delayed, but increased on June 20th for mid-late maturing variety and June 30th for early maturing variety. It is judged that additional investigations are needed to analyze the correlation between the growth rate and yield during the heading season.

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PA-145

# Rice Quality of Ripening Period with Transplanting Time in Chungbuk Region

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**[Introduction]**

In the Chungbuk region, rice cultivation zones are divided into the central plains, the central northern mid-mountainous regions, and the southern mid-mountainous regions. In the Chungbuk region, the temperature increase was 0.6°C compared to the past, which was a larger increase than in the southern region, and the cultivation period was longer, but it is causing the production and quality deterioration due to high temperature ripening. Accordingly, in order to produce high-quality rice, it is necessary to change the cultivation period according to the cultivation area and the type of water source. This study was conducted to analyze the temperature change and quality characteristics of the ripening period through the control of the planting period.

**[Materials and Methods]**

This study was conducted at Chungcheongbuk-do Agricultural Research and Extension Services in 2021. For the test cultivars, Odae of early maturing cultivar, Cheongpum of mid-maturing cultivar, and Samgwang of mid-late maturing cultivar were used. The transplanting period was from May 20 to June 20, each of which was transplanted 4 times. The standard cultivation method for each region was followed, and the planting distance was 30×15cm. Using a slow-release fertilizer, the nitrogen application amount per 10a was applied at 9kg. The meteorological and microscopic characteristics of each region were investigated.

**[Results and Discussion]**

In the range of 21-23°C, which is the average ripening temperature for 40 days after seeding, early and mid maturing cultivars were transplanted on June 30 and mid-late maturing cultivar on June 20, which exceeded the heading limit. There was no difference in the protein content according to the transplanting time between the mid-late and mid-maturing varieties, and the late-early maturing varieties decreased as the transplanting time was delayed. The perfect grain ratio increased as the transplanting time of all three cultivars was delayed. Early-maturing varieties with a high average temperature during the ripening period had a higher rate of damaged grain as the transplanting period was earlier, and mid-maturing varieties and late-maturing varieties had a higher rate of chalky kernel.

**[Acknowledgement]**

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PA-146

# Rice Yield and Quality Characteristics by Harvest Day With Planting Density in Chungbuk Region

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**[Introduction]**
In order to increase rice price competitiveness, it is essential to reduce production costs, and in order to solve the problem of labor shortage caused by the aging of rural areas, it is necessary to increase the viability of rice cultivation. Rare transplanting cultivation can reduce the number of plants per unit area, reducing the time required for seedling and transplanting. This study was conducted to confirm the yield and rice quality by harvest days and planting density.

**[Materials and Methods]**
This study was conducted at Chungcheongbuk-do Agricultural Research and Extension Services in 2021. Samgwang was used for the test variety, and the planting densities were 80, 60, 50 and 37hill per 3.3m$^2$, and machine transplanted on May 30th. Harvest days were 60 days, 63 days, and 66 days after heading. The amount of fertilization per 10a was N:P:K=9:4.5:5.7kg, and the nitrogen splitting ratio was divided by 50-20-30% of basal fertilization-topdressing at tillering stage-ear manuring, and other cultivation management followed the Rural Development Administration standard cultivation method. Rice yield and yield component were investigated according to the Rural Development Administration's research and analysis criteria. The rice quality were analyzed using Kett's RN-600 and Foss's Infratec.

**[Results and Discussion]**
The heading date was August 14 for 80 hills/3.3m$^2$, August 15 for 60hills/3.3m$^2$ and 50hills/3.3m$^2$, and August 16 for 37hills/3.3m$^2$. The average temperature during the ripening period was 23.8°C for 80hills/3.3m$^2$ and 23.5°C for 37hills/3.3m$^2$. Thousand grain weight decreased at 80hills/3.3m$^2$ and 37hills/3.3m$^2$ as the number of harvest days was delayed, and there was no difference according to the number of harvest days in 60hills/3.3m$^2$ and 50hills/3.3m$^2$. The yield of rice decreased as the number of harvest days was delayed, regardless of planting density, and the ripening rate also decreased. Protein content and amylose content did not differ according to the number of harvest days. The perfect grain ratio decreased at 80hills/3.3m$^2$ and 37hills/3.3m$^2$ as the number of harvest days was delayed, and increased as the number of harvest days was delayed for 60hills/3.3m$^2$ and 50hills/3.3m$^2$. As a result that 55 to 60days after heading would be appropriate for the harvest.

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PA-147

# Study on Bioactive Property of a Naked Oat Cultivar, Daeyang (*Avena sativa* L.), Which is Enhanced by Spring Seeding

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**[Abstract]**
This study was aimed to investigate the content of avenanthramides(AVNs) and other phenolic compounds in the grains of a naked oat cultivar, Daeyang, which were seeded in the fall and spring, and examine the effects of alcohol extracts from the grains on natural killer(NK) cell activity in vitro. The content of AVN-A, AVN-B, and AVN-C in the spring-seeded oat grains was 2.2 folds higher than the fall-seeded oat grains on average. Among these AVNs, the content of AVN-C was 1.9-folds higher in the spring-seeded oat grains(66.1㎍/g), comparing to the content in the fall-seeded oat grains(34.8㎍/g). The content of other phenolic compounds, such as phenolic acids and flavonoids in the spring-seeded oat grains was 1.1 ~4.7-folds higher than the fall-seeded oat grains. In particular, sinapinic acid was the most abundant phenolic acid in the spring-seeded oat grains(50.0㎍/g) and its content was 2.4-folds higher than its content in the fall-seed oat grains. Furthermore, NK cell activity in vitro treated with the spring-seeded oat grain extracts was 158%, and it was 18%p higher than NK cell activity treated with the extracts from the fall-seeded oat grain extracts. Our finding suggest that the bioactive properties of naked oat grains would be enhanced by spring seeding.

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PA-148

# Effect of Light Emitting Diode Irradiation on Functional Properties of a Purple-Colored Wheat 'Arriheuk' Wheatgrass

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**[Abstract]**
This study was aimed to evaluate the antioxidant activity and bioactive property of extracts from a purple-colored wheat variety 'Arriheuk' (*Triticum aestivum* L.) wheatgrass, affected by light emitting diode irradiation (LED). The wheatgrass was cultivated for 10 days after sowing in a growth chamber under the following LED conditions: R1B1 (Red:Blue = 1:1), R7B3 (Red:Blue = 7:3), and R3B7 (Red:Blue = 3:7). We examined antioxidant activity of the hot water extracts of wheatgrass using DPPH and ABTS free radicals scavenging assays. At the concentration of 10,000 $\mu g$/ml, the extract from R1B1 showed the highest DPPH free radical scavenging activity(79.29%), but its ABTS free radical scavenging activity was the lowest(32.0%). To evaluate bioactive property of the wheatgrass, we examined the change of natural killer (NK) cell activity affected by the wheatgrass extracts in vitro. At the concentration of 500$\mu g$/ml, NK cell activity was most highly enhanced by the extract from R1B1(181.6%), and the activity was 176.1% (R7B3) and 144.6%(R3B7), respectively. These results suggest that the functional property of 'Arriheuk' wheatgrass would be enhanced by LED irradiation condition.

**[Acknowledgement]**
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PA-149

# Effect of Sunshine Hours to Ripened Grain Ratio and Grain Weight of Processing Rice Cultivars in North Central Area of Korea

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**[Introduction]**

Cheorwon has shorter rice growing period which is located in northernmost and inland region in major rice fields of Korea. Ripening environment after heading have a greater impact on rice yield than that of before heading, so about 74% carbohydrate is made of photosynthesis after heading. Especially, there was a big difference in sunshine hours between 2020 and 2021, and it had a big impact on ripened grain ratio and grain weight of rice. Therefore this study was conducted to evaluate the effect of sunshine hours of 2020 and 2021 to yield components of processing rice cultivars in north central area of Korea.

**[Materals & Methods]**

17 processing rice(5 glutinous, 7 colored, 3 flavor, 2 special use) cultivars were transplanted on May 20 in 2020 and 2021 by 30×12㎝ planting density. And we checked weather change after heading of rice and variation of yield components chiefly ripened grain ratio and grain weight. And we investigated the weather change from 1991 to 2021 to measure the effect of weather conditions of 2020 and 2021.

**[Results]**

Compared to little sunshine hours in 2020 owing to frequent rain from August, sunshine hours increased greatly in 2021 because of little precipitation after mid-July. Mean temperature during 50 days after heading(July 20, July 25, August 1, August 10, August 15) from 1991 to 2021 gradually decreased(23.8℃→20.9℃), but cumulative sunshine hours continuously increased(275hr→307hr) in later heading date. Compared to mean sunshine hours from 1991 to 2021, it were -15.1%, -11.8%, -11.1%, 8.3%, 10.6% in 2020, but it increased 51.0%, 42.7%, 30.9%, 19.0%, 16.3% in 2021 in each heading date. So rice cultivars which headed in late July in 2021 were ripened in highest sunshine hours condition.

The ripened grain ratio of rice cultivars which headed before and after August 10 were 64.4% and 76.0% in 2020. but it increased 85.0% and 86.8% in 2021. The 1,000 grain weight of rice cultivars which headed before and after August 10 were 19.7g and 18.0g in 2020. but it increased 21.0g and 20.3g in 2021.

The cultivars which showed big difference in ripened grain ratio between 2020 and 2021 were Joeunheugmi, Seonhyangheugmi, Jeogjinjuchal. The cultivars which showed big difference in 1,000 grain weight between 2020 and 2021 were Seonhyangheugmi, Joeunheugmi, Hongjinju.

**[Acknowledgement]**

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PB-1

# Genome-wide Association Analyses for Resistance to *Phytophthora sojae* and *Pseudomonas amygdali* pv. *tabaci* in Soybean

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**[Abstract]**
Phytophthora root and stem rot (PRSR) and wildfire disease (WFD) of soybean are frequently observed in the field of South Korea. The most environmentally friendly way to control PRSR and WFD is to use soybean varieties with resistance to *Phytophthora sojae* (*P. sojae*) and *Pseudomonas amygdali* pv. *tabaci*. Plant germplasm is an important gene pool for soybean breeding and improvement. In this study, hundreds of soybean accessions were evaluated for the two pathogens, and genome-wide association analyses were conducted using 104,955 SNPs to identify resistance loci for the two pathogens. Of 193 accessions, 46 genotypes showed resistance reaction, while 143 did susceptibility for PRSP. Twenty SNPs were significantly associated with resistance to *P. sojae* on chromosomes (Chr.) 3 and 4. Significant SNPs on Chr.3 were located within the known *Rp*s gene region. A region on Chr. 4 is considered as a new candidate resistance loci. For evalation of resistance to WFD, 18, 31, 74, 36 and 34 genotypes were counted by a scale of 1-5, respectively. Five SNP markers on Chrs 9, 11, 12, 17 and 18 were significantly associated with resistance to *P. amygdali* pv. *tabaci.* The identified SNPs and genomic regions will provide a useful information for further researches and breeding for resistance to *P. sojae* and *P. amygdali* pv. *tabaci*.

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Agriculture Science & Technology Research and Development Program (Project No. PJ01416804), Rural Development Administration, South Korea

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PB-2

# Characterization of Purple-discolored, Uppermost Leaves of Soybean; QTL Mapping, Hyperspectral Imaging, and TEM Observation

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**[Abstract]**

Purple-discoloration of the uppermost leaves has been observed in some soybean cultivars in recent years. The purpose of this study was to characterize the novel phenotypic changes between the uppermost and middle leaves via multiple approaches. First, quantitative trait loci mapping was conducted to detect loci associated with the novel phenotype using 85 recombinant inbred lines (RILs) of the 'Daepung' x PI 96983 population. 180K SNP data, a major quantitative trait locus (QTL) was identified at around 60 cM of chromosome 6, which accounts for 56% of total phenotypic variance. The genomic interval is about ~700kb, and a list of annotated genes includes the *T*-gene which is known to control pubescence and seed coat color and is presumed to encode flavonoid 3'-hydroxylase (F3'H). Based on Hyperspectral imaging, the reflectance at 528~554 nm wavelength band was extremely reduced in the uppermost leaves compared to the middle (green leaves), which is presumed die to the accumulation of anthocyanins. In addition, purple-discolored leaf tissues were observed and compared to normal leaves using a transmission electronic microscope (TEM). Base on observations of the cell organelles, the purple-discolored uppermost leaves had many pigments formed in the epidermal cells unlike the normal middle leaves, and the cell wall thickness was twice as thick in the discolored leaves. The thickness of the thylakoid layer in the chloroplast the number of starch grains, the size of starch all decreased in the discolored leaves, while the number of plastoglobule and mitochondria increased.

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PB-3

# Transcriptomic Profiling of Resistant and Susceptible Soybean Genotypes Following Inoculation of *Phytophthora sojae*

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**[Abstract]**

Our previous study identified a resistance locus to *Phytophthora sojae* (isolate 2457) in an interval of 3.8-4.7 Mbp on chromosome 3 via genetic mapping using a 'Daepung'×'Daewon' recombinant inbred population. Since differential gene expression between Daepung (susceptible) and Daewon (resistant) after inoculation of *P. sojae* is unknown, RNA sequencing was carried out to compare transcriptomic changes between the two genotypes following inoculation with *P. sojae* isolate 2457. The two varieties were inoculated using hypocotyl inoculation at the VC stage and stem tissue of 1 cm above and below of the inoculated site were sampled at 0, 6, 12 hours after inoculation (hai), respectively. Differentially expressed genes (DEGs) under same cultivar in different time point and Daepung vs. Daewon in same time point were investigated. In comparison of Daepung vs. Daewon at 12 hai, a total of 3,513 DEGs were identified, including two nucleotide-binding site-leucine rich repeat (NBS-LRR) genes (Glyma.03g034800 and Glyma.03g034900) that are located in the previously reported resistance locus on chromosome 3. In addition, 14,966 DEGs were detected between 0 vs. 6 hai, containing one of candidate genes (Glyma.03g035300). This gene was upregulated by up to 4-fold in Daewon and Daepung. Additional results will be further discussed in the presentation. This study will provide valuable information for soybean crop improvement.

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PB-4

# Positive Regulator, a Rice C3HC4-type RING Finger Protein H2-3(OsRFPH2-3), in Response to Salt Stress

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**[Abstract]**
Soil salinity negatively affects plant growth, productivity, and metabolism. Rice is known to have more sensitive phenotypes than other cereal crops, such as wheat, sorghum, and barley. We characterized the molecular function of rice C3HC4 as a really interesting new gene (RING). *Oryza sativa* RING finger protein H2-3 (*OsRFPH2-3*) was highly expressed in 100 mM NaCl. To identify the localization of OsRFPH2-3, we fused vectors that include C-terminal GFP protein (35S;;OsRFPH2-3-GFP). OsRFPH2-3 was expressed in the nucleus in rice protoplasts. An *in vitro* ubiquitin assay demonstrated that OsRFPH2-3 possessed E3-ubiquitin ligase activity. However, the mutated OsRFPH2-3 were not possessed any E3-ubiquitin ligase activity. Under normal conditions, there is no significant phenotypic difference between transgenic plants and WT plants. However, *OsRFPH2-3*-overexpressing plants exhibited higher fresh weight and length under saline conditions. Also, transgenic plants maintain higher chlorophyll, proline, and soluble sugar contents and lower $H_2O_2$ and MDA contents than the wild type; these results support transgenic plants with enhanced salinity tolerance phenotypes.

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PB-5

# Comparison of *Agrobacterium*-mediated Transformation of 43 Korean Wheat Cultivars using the GUS Assay

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**[Introduction]**

*Agrobacterium*-mediated transformation (AMT) can stably insert DNA fragments into the plant genome. Transgenic plants induced by AMT contain a relatively lower copy number of transgene than transgenic plants induced by particle bombardment. Also, AMT is a simple and easy method to generate transgenic plants. Wheat transformation efficiency is relatively lower than that of other monocot plants such as Rice (*Oryza sativa* L.) and Maize (*Zea mays* L.). Cultivars 'Bobwhites' and 'Fielder' are mainly used for wheat transformation. As long as we know, there have been no reports of successful transgenic plant development using Korean wheat varieties through AMT until now. In this study, we compared the transformation efficiency of 43 Korean wheat cultivars using GUS assay to select Korean wheat cultivars suitable for AMT.

**[Materials and Methods]**

The pCAMBIA1301 vector containing *β-glucuronidase* (GUS) gene was cloned into *Agrobacterium* (EHA105). The concentration of *Agrobacterium* culture was adjusted to $OD_{600}$ of 0.5 and then incubated for 4 - 5 hours in the media containing acetosyringone (AS, 100 μM) to activate *Agrobacterium vir* genes. Immature embryos were rescued and centrifuged in wheat inoculation medium (WIM). The embryos were inoculated with *Agrobacterium* culture for at least 20 minutes at room temperature. After 2 days of co-culture, embryos were transferred to resting media for 5 days. Seven days after AMT, embryos were used for GUS assay.

**[Results and Discussion]**

GUS assay was performed to confirm the suitability of AMT in Korean wheat cultivars. The number of embryos showing at least one GUS spot was counted. 'Saeol', 'Jopum', and 'Jonong' showed 100% (the number of embryos showing GUS spot(s)/the number of embryos used for AMT) among 43 cultivars. In addition, cultivars with more than 70% were 'Saekeumgang', 'Jojung', 'Tapdong', 'Anbaek', 'Dabun', 'Sugang', 'Keumgang', 'Jeokjung', 'Seodun', 'Joeun', 'Dajung', and 'Baekjung'. It seems that the 15 cultivars above showed the possibility of using AMT. On the other hand, 'Yeonbaek', 'Goso', 'Baekgang', and 'Johan' showed less than 20% and GUS spots were not observed in 'Gru', 'Gobun', 'Milseong', and 'Shinmichal-1'. In this study, transient GUS expression seven days after AMT was investigated in Korean wheat cultivars. The initial high transient transformation efficiency might indicate subsequent high stable transformation efficiency. The Korean wheat cultivars with high transient transformation efficiency might be used for creating stable transgenic wheat.

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PB-6

# Advances of Self-incompatibility Genetics in Genus *Fagopyrum*

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**[Abstract]**
Heterostyly continues to fascinate evolutionary biologists interested in heredity, evolution, breeding, and adaptive function. Polymorphism demonstrates how simply inherited developmental changes in the location of plant sexual associations can have important consequences for population pollination and mating biology. In contrast to homozygous self-incompatibility, only a small number of mating phenotypes can be maintained in the population because insect pollinators have limitations in achieving multiple segregation sites for pollen deposition.
Field studies of pollen tube growth have shown that reciprocal style-stamen polymorphisms function to increase the capacity of insect-mediated cross-pollination. The genetic pattern of style morphs is well established in various taxa, but despite recent advances, the identity, number, and structure of the genes controlling the heteromorphic syndrome have been poorly elucidated. The phenomenon of heterostyly in buckwheat has been controlled by gene complex concentrate to *S*-locus. Homomorphic autogamous buckwheat strains were established by the interspecific hybridization. Backcrossing of this line to the common buckwheat (pin) and selecting homostylar progenies made it possible to introduce the self-compatible gene into common buckwheat. In the result, we obtained the $BC_9F_2$ generation, and defined the strong linkage between flower type and self-incompatibility by microscopic observation of pollen tube growth. This finding suggests that self-incompatibility character is not controlled by one gene. Moreover, we defined the strong linkage between flower type and self-incompatibility. It strongly supports the S supergene theory. Therefore, we have plan to elucidate the heterostyly self-incompatibility by using molecular genetics, proteome analysis and apply to exploitation of buckwheat improvement. In near future, the expression of heterozygous syndromes in genus *Fagopyrum* with single isolated heterozygous species may provide clues to early stages of polymorphic assembly and shed light on evolutionary models of heterozygous strains.

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PB-7

# Candidate Genes Related to Sugar Content in Sweetpotato using GWAS

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**[Abstract]**

Sweetpotato is rich in starch, which is converted to sugar during storage due to enzymatic hydrolysis. The sugar content of sweetpotato is a component related to taste and storability. In this study, the sugar content (fructose, glucose, maltose, sucrose and total sugar content) of 94 genotypes was evaluated and the GWAS (Genome-Wide Association Study) was conducted to search for candidate genes for sugar content. The fructose and glucose content were 0.2 ~ 8.8 and 0.2 ~ 9.4 g/100g, respectively. The maltose, sucrose and total sugar content were 0.2 ~ 9.1, 3.2 ~ 30.0 and 7.9 ~ 40.2 g/100g, respectively. The fructose and glucose showed a positive correlation (0.98). The 94 genotypes were genotyped with genotyping-by-sequencing (GBS) and aligned against the reference genome sequences of sweetpotato. The GBS libraries from 94 genotypes were sequenced on an Illumina HiSeqXten system, and 1,339,892 SNPs (Single Nucleotide Polymorphism) were generated. Filtering for < 60% missing rate and > 0.05 minor allele frequency resulted in a total of 44,255 SNPs used in GWAS. The GAPIT (Genome Association and Prediction Integrated Tool) was used to conduct based on the mean of sugar content with a Bonferroni-corrected chromosome-wide significance threshold with a $-\log_{10}(P)$ of 5.95. The significant SNPs were obtained with fructose (seven), glucose (six), maltose (four) and sucrose (nine). There were several genes related to sugar content around the significant SNPs such as sugar transport protein 8-like, probable galactose-1-phosphate uridyltransferase-like and beta-amylase. These results will contribute to understanding of sugar content and conversion in sweetpotato.

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PB-8

# A New Cowpea Cultivar 'Jang-alchan' with Mechanization Harvesting and High Yield

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**[Abstract]**
Cowpea(*Vigna unguiculata* L. Walp) has a low fat and protein content and a relatively high starch content, so it is mainly used in various ways for song-pyeon sediment, rice-cake paste, and porridge. In Yeonggwang-gun, Jeollanam-do, cowpea for seed production is being cultivated for the localization of raw material for Rice cake with ramie leave. A cowpea variety 'Jang-Alchan' was improved from the cross between IT145373 and IT145391 at the JARES in 2019. 'Jang-alchan' has an erect plant with an intermediate plant habit, light purple-colored corolla, and heart-shaped leaflets. 'Jang-alchan' has an orange-yellow seed seed-surface of faint luster, and brown and straight pods when matured. The stem length of 'Jang-alchan' was 48cm, 9cm longer than that of the control cultivar 'Okdang' and the 100-seed weight was 14.1g. The weight ratio of the seed coat for the entire seed was 11.2%, which was 0.2%p lower than that of the control cultivar. Field resistance of 'Jang-alchan' to leaf and systemic diseases was similar to that of the control cultivar. Is field resistance of 'Jang-alchan' to lodging was slightly lower than that of the control cultivar. The average yield of 'Jang-alchan' was 1.85ton per hectare, which was 14% higher than that of the control cultivar 'Okdang'. 'Jang-Alchan' does not require the installation of an espalier-net and is taller than the existing supplied 'Okdang', so it can be harvested by combine harvesting. In addition, it is expected to contribute to the localization of raw material grains for regional specialties as it can be cultivated over a large area.

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PB-9

# Gene Editing for Major Allergy Genes using Multiplex CRISPR-Cas9 System & Prime editing in Peanuts (*Arachis hypogaea* L.)

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**[Abstract]**

Recently, food-induced allergies have emerged as major global concerns. In the past ten years, it has doubled in western nations, and it has also increased in Asia and Africa. In many cases of food allergy, peanut allergy is prevalent, typically permanent, and frequently life-threatening. Therefore, we utilized gene editing techniques on the three major allergen genes in peanuts, Ara h 1, Ara h 2, and Ara h 3. Using gibson assembly and golden gate assembly, we created two vectors, the gRNA-tRNA array CRISPR-Cas9 system and Prime-editing. Using LBA4404 strain and agrobacterium-mediated transformation, the vectors were transferred to two elite Korean peanut lines. After co-cultivation and tissue culture, we extracted the tissue cultured peanut DNA amplified the hygromycin resistance gene and Cas9 gene in the T-DNA region. The integration of the T-DNA region into the host genome was demonstrated by the presence of a specific band in some samples. There have only been a few reported peanut gene editing studies. So, this study will contribute to peanut allergy and gene editing research.

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PB-10

# GWAS of Salt Tolerance and Drought Tolerance in Korean Wheat Core Collection

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**[Abstract]**

Abiotic stress is a major problem in global agriculture as it negatively affects crop growth, yield, and quality. Wheat (*Triticum aestivum*) is the world's second-highest-producing food resource, so the importance of mitigating damage caused by abiotic stress has been emerging. In this study, we performed GWAS to search for SNPs associated with salt tolerance and drought tolerance. NaCl (200 mM) treatment was performed at the seedling stage using 613 wheat varieties in Korean wheat core collection. Root length, root surface area, root average diameter, and root volume were measured. Drought stress was applied at the seedling stage, and the above phenotypes were measured. GWAS was performed for each phenotype data using the MLM, MLMM, and FarmCPU models. The best salt-tolerant wheat varieties were 'MK2402', 'Gyeongnam Geochang - 1985-3698', and 'Milyang 13', showing superior root growth. The significant SNP AX-94704125 (BA00756838) were identified in all models. The genes closely located to the significant SNP were searched within ± 250 kb of the corresponding SNP. A total of 11 genes were identified within the region. *NB-ARC* involved in the defense response, *FKS1* involved in cell wall biosynthesis, and putative *BPM1* involved in abiotic stress responses were discovered in the 11 genes. The best drought-tolerant wheat varieties were 'PI 534284', 'Moro of Sind', and 'CM92354-33M-0Y-0M-6Y-0B-0BGD', showing superior root growth. This study discovered SNPs associated with salt tolerance in Korean wheat core collection through GWAS. GWAS of drought tolerance is now proceeding, and the GWAS results will be represented on a poster. The SNPs identified by GWAS can be useful for studying molecular mechanisms of salt tolerance and drought tolerance in wheat.

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PB-11

# Assessment of Mechanization-related Traits for Korean Landrace Adzuki bean Germplasm

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**[Introduction]**
Adzuki bean is the legume grown mainly in Northeast Asia, and is the second highest cultivated and consumed legume in Korea after soybean. Nevertheless, compared to soybean, the major crop, adzuki bean is much less mechanized for cultivating and harvesting. The use of machines for growing adzuki bean greatly reduces the labor required, but the currently used adzuki bean breeding varieties are not suitable for growing and harvesting with machines. Therefore, this study tried to select germplasm necessary for the development of breeding varieties suitable for mechanization by examining and evaluating the characteristics related to mechanization of adzuki bean germplasm. In particular, only germplasm of Korean landrace was evaluated so that they could be used immediately after selection.

**[Materials and Methods]**
The adzuki bean germplasm was cultivated in the field of the National Agrobiodiversity Center in Jeonju, Jeollabuk-do, and 1,126 accessions were initially planted, but only 848 accessions were used in this study by selecting only Korean landrace. Five characteristics related to mechanization (Height with bottom pod, Plant height, Lodging score, Simultaneously maturity, Seed size) were investigated, and major traits related to the yield component (Days to flowering, Days to maturity, Number of pods per plant, Number of seeds per pod) were additionally investigated according to the RDA criteria. Descriptive statistics, Correlation analysis were conducted under the R program (R Core Team, 2022).

**[Results and Discussion]**
As a result of measuring the characteristics of adzuki bean germplasm, the average number of height with bottom pod was 7.2 cm, the average number of plant height was 60.4 cm, and the average number of 100-seed weight was 11.9 g. The highest frequency was 11~50% for lodging score and 51~75% for simultaneous maturity. The average number of flowering date and maturity date were 63.8 and 42.9 days, respectively, and the average number of pods per plant and seeds per pods were 41.2 and 7.0, respectively. Correlation analysis between each characteristic was also conducted, showing positive correlations between plant height and number of pods per plant, plant height and number of seeds per pod, maturity date and 100-seed weight (0.33, 0.28, and 0.26, respectively). There was a negative correlation between flowering date and maturity date, number of pods per plant and number of seeds per pods, and number of seeds per pods and 100-seed weight, flowering date and height with bottom pod (-0.42, -0.28, -0.24, -0.24, respectively). The results of this study will be the serve as the basis for selection of accessions for breeding adzuki bean varieties suitable for mechanization.

**[Acknowledgement]**
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PB-12

# Comparison of Gene Expression Changes in Three Wheat Varieties with Different Susceptibilities to Heat Stress Using RNA-Seq Analysis

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**[Abstract]**
Wheat is highly susceptible to heat stress, which significantly reduces grain yield. In this study, we used RNA-seq technology to analyze the transcript expression at three different time-points after heat treatment in three cultivars differing in their susceptibility to heat stress: Jopum, Keumkang, and Olgeuru. A total of 11,751, 8850, and 14,711; 10,959, 7946, and 14,205; and 22,895, 13,060, and 19,408 differentially-expressed genes (log2 fold-change > 1 and FDR (padj) < 0.05) were identified in Jopum, Keumkang, and Olgeuru in the control vs. 6-h, in the control vs. 12-h, and in the 6-h vs. 12-h heat treatment, respectively. Functional enrichment analysis showed that the biological processes for DEGs, such as the cellular response to heat and oxidative stress—and including the removal of superoxide radicals and the positive regulation of superoxide dismutase activity—were significantly enriched among the three comparisons in all three cultivars. Furthermore, we investigated the differential expression patterns of reactive oxygen species (ROS)-scavenging enzymes, heat shock proteins, and heat-stress transcription factors using qRT-PCR to confirm the differences in gene expression among the three varieties under heat stress. This study contributes to a better understanding of the wheat heat-stress response at the early growth stage and the varietal differences in heat tolerancea.

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PB-13

# Selection of Radiation-Induced Kenaf Mutant with Excess Moisture Tolerance in Paddy Field

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**[Introduction]**

Kenaf(*Hibiscus cannabinus* L. 2n=36) is a non-food herbaceous plant of the Malvaceae family, which has recently received a lot of attention due to its high above-ground biomass yield. In Korea, the surplus rice has been becoming a social problem since a long time ago. Thus, an alternate crop should be developed to keep the balance of supply and demand of rice. The main objective of this study was to generate new kenaf line with high biomass in paddy field through mutation breeding. Also, it aimed to describe genotype in regards to their morphological traits in comparison to the Control varieties, Jangdae.

**[Materials and Methods]**

The kenaf seed variety used for the Control was 'Hongma 300', being originally from China.

Approximately 100g of kenaf seeds were irradiated with 250 Gy from $^{60}$Co sources located in Korea Atomic Energy Research Institute (KAERI). Each of the 500 plants (1st generation, $M_1$) were planted in 2017, grown to maturity in an upland field, and assigned numbers at harvest time. In 2018, the 250 plants of 2nd generation ($M_2$) were planted and the mutants showing normal seed fertility were investigated on an individual plant basis. An acceleration of generation was processed from Oct. 2019 to Apr. 2020, and from Oct. 2020 to Apr. 2022. After planting in paddy field and upland on 1$^{st}$ May, various characteristics including flowering date were recorded, compared to the Control plants, Jangdae.

**[Results and Discussions]**

The one purpose of breeding new kenaf is developing new varieties that are higher yielding in paddy field of an excess moisture condition. The elite mutant with superior performances was selected through mutation breeding. Seeds of the original resource named Hongma 300 (Control) were irradiated with 250 Gy gamma-ray. The agronomic performances of the elite mutant line (JBK3183) were investigated at M10 generation in comparison with the Control. The leaf shape of the Control and the JBK3183 mutant was the same as a palmate. There was a big difference on flowering time between plants grown in upland and plants grown in paddy field. Both genotypes was flowered in July in upland condition, however, in September in paddy field condition. Some differences at stem color were observed as green at the Control and pale red at the JBK3183 in both cultivation conditions. The leaf size and width the JBK3183 was higher and larger than those of the Control. The stem diameter is directly correlated with the biomass yield. In upland condition, the stem diameter of JBK3183 was 13.6cm that is statistically higher ($p \leq 0.05$) than 11.2cm of the Control. Also, the mutant had a much higher ($p \leq 0.05$) score compared to the Control in paddy field condition. It demonstrated differentiation between the Control and mutant. Based on the results, the JBK3183 would be useful as a resource to be cultivated in paddy field.

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PB-14

# A Kenaf Mutant Showing Superior Performances in Reclaimed land and Upland

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**[Introduction]**

Kenaf(*Hibiscus cannabinus* L. 2n=36) is an unfamiliar plant to Korean. However, it is well-known for its economic importance. Its aerial part yield and $CO_2$ assimilation capacity are about 3-5 times higher than that of other plants. So, the 'green tag' is further associated with kenaf. Thus, the main objective of this study was to generate new kenaf varieties with high biomass through mutation breeding in reclaimed land and upland, describing genotypes in regards to their morphological traits in comparison to the Control varieties, Jangdae.

**[Materials and Methods]**

The kenaf seed variety used for the Control was 'Hongma 300', being originally from China.

Approximately 100g of kenaf seeds were irradiated with 250 Gy from $^{60}Co$ sources located in Korea Atomic Energy Research Institute (KAERI). Each of the 500 plants (1st generation, $M_1$) were planted in 2017, grown to maturity in an upland field, and assigned numbers at harvest time. In 2018, the 250 plants of 2nd generation ($M_2$) were planted and the mutants showing normal seed fertility were investigated on an individual plant basis. An acceleration of generation was processed from Oct. 2019 to Apr. 2020, and from Oct. 2020 to Apr. 2022. After planting in reclamed land and upland on 1$^{st}$ May, various characteristics including flowering date were recorded, compared to Control plants.

**[Results and Discussions]**

Kenaf has been used in many different fields worldwide. The elite mutant with superior performances was selected through mutation breeding. Seeds of the original resource named Hongma 300 (Control) were irradiated with 250 Gy gamma-ray. The agronomic performances of the elite mutant line (JBK3169) were investigated at M10 generation in comparison with the variety, Jangdae. The leaf shape of the Control and the JBK3169 mutant was palmate. The stem color was the same as a green between JBK4-713 and Jangdae. The JBK3169 was blooming on September 10 and 13 in reclaimed land and upland, respectively. However, Jangdae was flowering on July 4 and 23, respectively. The leaf and flower size of the JBK4-713 was larger than those of Jangdae in both test fields. At the flowering period, the stem diameter of JBK3169 in upland and reclaimed filed was 15.7cm and 20.3cm, which was much higher ($p \leq 0.05$) than that of Jangdae with 11.2cm and 10.3cm, respectively. It demonstrated differentiation between the variety and mutant. Taken together, the JBK3169 would be useful as a resource for high biomass production in Korea. This work is supported by a fund of project designated as No. 20016795, Minisrty of Trade, Industry and Energy (MOTIE), Republic of Korea.

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PB-15

# Gene Editing for Major Allergy Genes using Multiplex CRISPR-Cas9 System & Prime Editing in Peanuts (*Arachis hypogaea* L.)

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**[Abstract]**
Recently, food-induced allergies have emerged as major global concerns. In the past ten years, it has doubled in western nations, and it has also increased in Asia and Africa. In many cases of food allergy, peanut allergy is prevalent, typically permanent, and frequently life-threatening. Therefore, we utilized gene editing techniques on the three major allergen genes in peanuts, Ara h 1, Ara h 2, and Ara h 3. Using gibson assembly and golden gate assembly, we created two vectors, the gRNA-tRNA array CRISPR-Cas9 system and Prime-editing. Using LBA4404 strain and agrobacterium-mediated transformation, the vectors were transferred to two elite Korean peanut lines. After co-cultivation and tissue culture, we extracted the tissue cultured peanut DNA amplified the hygromycin resistance gene and Cas9 gene in the T-DNA region. The integration of the T-DNA region into the host genome was demonstrated by the presence of a specific band in some samples. There have only been a few reported peanut gene editing studies. So, this study will contribute to peanut allergy and gene editing research.

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PB-16

# Studies on QTLs for Bakanae Disease Resistance with Populations Derived from Crosses between Korean *japonica* Rice Varieties

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**[Abstract]**
Rice bakanae disease is a serious global threat in major rice-cultivating regions worldwide causing high yield loss. It is caused by the fungal pathogen *Fusarium fujikuroi*. Varying degree of resistance or susceptibility to bakanae disease had been reported among Korean *japonica* rice varieties. We developed a modified in vitro bakanae disease bioassay method and tested 31 Korean *japonica* rice varieties. Nampyeong and Samgwang varieties showed highest resistance while 14 varieties including Junam and Hopum were highly susceptible with 100% mortality rate. We carried out mapping QTLs for bakanae disease resistance with four F2:F3 populations derived from the crosses between Korean *japonica* rice varieties. The Kompetitive Allele-Specific PCR (KASP) markers developed in our laboratory based on the SNPs detected in Korean *japonica* rice varieties were used in genotyping F2 plants in the populations. We found four major QTLs on chromosome 1, 4, 6, and 9 with LOD scores of 21.4, 6.9, 6.0, and 60.3, respectively. In addition, we are doing map-based cloning of the QTLs on chromosome 1 and 9 which were found with Junam/Nampyeong F2:F3 population and Junam/Samgwang F2:F3 population, respectively. These QTLs will be very useful in developing bakanae disease resistant high quality rice varieties.

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**PB-17**

# Genome Wide Association Study for *Phytophthora sojae* Resistance with the Two Races Collected from Main Soybean Production Area in Korea with 210 Soybean Natural Population

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**[Abstract]**
Recently days, soybean production in paddy field is increasing, from 4,422 ha in 2016 to 10,658 ha in 2021 in Korea. It is easy for Phytophthora stem and root rot (PSR) occurring in paddy field condition, when it is poorly drained soils with a high clay content, and temporary flooding and ponding. Therefore PSR resistant soybean cultivar is required. The objective of this study is to identify QTL region and candidate genes relating to PSR resistance of the race in main soybean cultivation area in Korea. 210 soybean materials including cultivars and germplasm were used for inoculation and genome-wide association study (GWAS). Inoculation was conducted using stem-scar method with 2 replications in 2-year for the race 3053 from Kimje and 3617 from Andong. 210 materials were genotyped with Soya SNP 180K chip, and structure analysis and association mapping were conducted with QTLMAX V2. The results of inoculation showed that survival ratio ranged from 0% to 96.7% and mean 9.7% for 3053 and ranged from 0% to 100% and mean 7.6% for 3617. Structure analysis showed linkage disequillibrium (LD) was decayed below $r^2$=0.5 at 335kb of SNP distance. Significant SNPs (LOD>7.0) were identified in Chr 1, 2, 3, 4, 5, 11, 14, 15 for 3053 and Chr 1, 2, 3, 7, 10, 14 for 3617. Especially, LD blocks (AX-90455181;15,056,628bp ~ AX-90475572; 15,298,872bp) in Chr 2 for 3053 and 3067 were duplicated. 29 genes were identified on these genetic regions including *Glyma.02g147000* relating to ribosome recycling factor and defense response to fungus in Soybase.

**[Acknowledgement]**
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**PB-18**

# A Wheat Variety, "Hwanggeumal" with Good Bread Quality, Red Grain, Partial Waxy, Tolerance to PHS

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**[Abstract]**

A new winter wheat(*Triticum aestivum* L.) cultivar "Hwanggeumal" was developed by the NICS(National Institute of Crop Science), RDA(Rular Dvelopment Administraion) in 2019. It was derived from a cross of the "Jokyoung//Kauz/Rayon" and "Jopoom" in 2008. It had advanced generation through bulk and pedigree method for seven years and designated line name "Jeonju398" after AYT(Advance Yield Trial) test for two years. And " Hwangeumal " was designated variety name after RYT(Regional Yield Trial) test in eight locations around Korea for two years from 2018 to 2019. Its heading date was April 19 and maturity date was May 31, which were similar to Jokyoung. "Hwanggeumal" had shorter plant height(75 cm) and spike length(7.1 cm), spikes per $m^2$(699) and lower 1,000 grain weight(44.2 g) than "Jokyoung"(78 cm, 8.2 cm, 776, 46.6 g, respectively). "Hwanggeumal" was showed weak to winter hardiness and susceptible to powdery mildew but tolerance to PHS(Pre-harvest sprouting). The average grain yield in the AYT was 6.2 ton/ha, which were 10% more than "Jokyoung" And in the RYT was 5.1 ton/ha in upland and 4.4 ton/ha in paddy field, which were lower than "Jokyoung", respectively. "Hwanggeumal"s flour yield (71.4%) and flour lightness (91.82) showed similar to "Jokyung" and higher protein content (14.0%) and gluten content (10.3%) and SDS-sedimentation volume (60.3ml). These result showed that the "Hwanggeumal" dough strength of flour is strong than "Jokyung". "Hwanggeumal"s HMW-GS(High molecular weight gluten subunits) composition are *Glu-D1* (5+10), Granule-bound starch synthase(GBSS) composition are *Wx-A1* (a), *Wx-B1* (b), *Wx-D1* (a) and composition of Puroindolines are *Pina-D1*(a), *Pinb-D1*(b).

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PB-19

# Application of 3D-Fectin Transfection to Wheat Protoplast

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**[Abstract]**
Transformant construction using protoplasts requires less sample preparation time than particle bombardment and *Agrobacterium*-mediated transfection. There are two protoplast transfection methods: the PEG-mediated transfection method and the Lipofectamine transfection method. When Lipofectamine is mixed with DNA, Lipofectamine surrounds DNA like a cell membrane because of the positive charge of Lipofectamine. The Lipofectamine-DNA complex makes DNA insertion into cells easier. Fectin has similar functions to lipofectamine and is less expensive than lipofectamine. The 3D-fectin technology has been highlighted in animal cell transfection. Therefore, we performed PEG-mediated transfection, Lipofectamine transfection, and 3D-pectin transfection with a GFP construct. Protoplasts were isolated using the first leaf of "Bobwhite" after 4 hours of incubation in an isolation Buffer (cellulase + macerozyme). Protoplasts transformed by each method were cultured for 48 hours, and then GFP fluorescence expression was confirmed under confocal microscopy. GFP signals were detected in PEG-mediated transfection and Lipofectamine transfection. And the GFP signals were also detected in protoplasts to which 3D-fectin technology was applied, suggesting that 3D-fectin technology can be used for plant protoplast transfection.

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**PB-20**

# A Study on the Improvement Methods for Hybrid Sorghum Seeds Production

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**[Abstract]**

Sorghum (*Sorghum bicolor L.*) is a major cereal grain crop of the world and It can be cultivated under high temperature and dry condition with high adaptability to the adverse environment. It is usually eaten with rice in korea and most of domestic sorghum cultivars have been developed by pure line selection and cross breeding. In prior studies, Hybrid cultivar (F1 seed) was known to improve 30-40% in yield and resist to disease and pest than pure line varieties due to hybrid vigor. Therefore, study on the hybrid sorghum is continuously necessary. In korea, hybrid sorghum cultivar have been developed, so we need to find methods seed production technology for supply and commercialization of hybrid seed cultivar. Female inbred line(A-line) and male inbred line(R-line) are needed for hybrid seed production. This study was carried out to investigate growth characteristics and yield of hybrid sorghum according to the seedling period and planting rate between female inbred line(YSA1) and male inbred line (Sodamchal, Miryang 19). When the flowering period of two inbred groups in the process of hybrid seed production is coincides, hybrid seed production is increase. The female inbred line and male inbred lines were cultivated at Daegu in 2021. Two inbred lines were sown at intervals of 3days and 7days and were evaluated flowering period. As a result, the flowering period of the female inbred line and male inbred lines were matched at the 7days interval. To find out optimal planting rate, two inbred lines were cultivated under different plating rate (4:2, 5:2, 6:2). Yield of YSA1/Sodamchal(F1) was the highest 130(kg/10a) in the 4:2 ratio and yield of YSA1/Miryang 19 was the highest quantity of 139(kg/10a) in the 6:2 ratio. The results of this study could be helpful for hybrid Sorghum seeds production.

**[Acknowledgement]**

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**PB-21**

# Development of drought Tolerant Temperate Rice Variety by Pyramiding QTLs, *Pup1* and *DTY4.1*

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**[Abstract]**
Sustainable agriculture is a potential strategy to enable agricultural cultivation systems to feed the growing population under climate change. Sustainable agriculture consists of environment-friendly farming methods that allow the production of crops with minimal harm to the ecosystem. Early establishment in rice might be helpful to adopt sustainable agriculture with less inputs, such as water and phosphorus fertilizer. Two QTLs conferring tolerance to abiotic stress and low nutrition condition, *DTY4.1* and *Pup1,* respectively, are effective for good establishment in the early growth stage under low water and phosphorus fertilizer application. We developed 'Sechanmi' and 'MS11-DTY' harboring *Pup1* and *DTY4.1* into MS11, a *japonica* rice variety adaptable to tropical regions, using Marker-Assisted Backcrossing (MABC). MS11-PD lines were developed to meet the demand for less water and P fertilizer application throughout the growth stage of rice. In the $F_5$ generation, water-saving or rainfed cultivation was performed in different P (phosphorus) content. Irrigation was applied only when severe drought was observed one month after transplanting. There was no significant difference observed between the parents and MS11-PD lines in low P conditions. However, MS11-PD lines had more tillers in P-supplied conditions compared to that of the parents 40 and 50 days after transplanting. Under the same amount of P, MS11-PD lines might have higher phosphorus uptake capacity than the parents, increasing the number of tillers and showing better early establishment. The better vegetative growth stage is one of the factors that can potentially increase production by way of higher number of panicles. Through this breeding strategy, it is possible to attain sustainable agriculture by applying less P and water to address the need of a growing population.

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**PB-22**

# Global Transcriptome-Wide Association Studies (TWAS) Reveal a Gene Regulation Network of Eating and Cooking Quality Traits in Rice

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**[Abstract]**
Eating and cooking quality (ECQ) is one of the most complex quantitative traits in rice. The understanding of genetic regulation of transcript expression levels attributing to phenotypic variation in ECQ traits is limited. We integrated whole-genome resequencing, transcriptome, and phenotypic variation data from 84 *Japonica* accessions to build a transcriptome-wide association study (TWAS) based regulatory network. All ECQ traits showed a large phenotypic variation and significant phenotypic correlations among the traits. TWAS analysis identified a total of 285 transcripts significantly associated with six ECQ traits. Genome-wide mapping of ECQ-associated transcripts revealed 66,905 quantitative expression traits (eQTLs), including 21,747 local eQTLs, and 45,158 *trans*-eQTLs, regulating the expression of 43 genes. The starch synthesis-related genes (SSRGs), *starch synthase IV-1* (*SSIV-1), starch branching enzyme 1* (*SBE1)*, *granule-bound starch synthase 2 (GBSS2)*, and *ADP-glucose pyrophosphorylase small subunit 2a* (*OsAGPS2a*) were found to have eQTLs regulating the expression of ECQ associated transcripts. Further, in co-expression analysis, 130 genes produced at least one network with 22 master regulators. In addition, we developed CRISPR/Cas9-edited glb1 mutant lines that confirmed the role of alpha-globulin (glb1) in starch synthesis to validate the co-expression analysis. This study provided novel insights into the genetic regulation of ECQ traits, and transcripts associated with these traits were discovered that could be used in further rice breeding.

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PB-23

# A Combination of a Genome-Wide Association Study and a Transcriptome Analyses in the Response to Salt Stress in Peanuts

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**[Introduction]**
Salinity stress is one of the important abiotic stresses in crops. Although peanut (*Arachis hypogaea* L.) is considered as a moderately sensitive species to salinity stress, however a few reports on salinity tolerance in peanut have been reported.

**[Materials and Methods]**
A total of 300 peanut accessions with 58K SNPs Axiom_Arachis array were used for the genome-wide association study (GWAS) by the enriched compression mixed linear model (ECMLM) of GAPIT package. Transcriptome analysis was performed with roots of each salinity tolerance and susceptible accession with 200 mM NaCl at 0h, 12h and 24h after salt treatment. Gene differential expression analysis was performed using edgeR software. The screening criteria for DEGs distinguishing two samples were |log2 fold change| > 2 and adjusted P-value < 0.05. Quantitative real time PCR (qRT-PCR) was performed using the ABI Real-Time PCR system and Applied Biosystems SYBR Green Kit. The relative gene expression level was calculated using the $2^{-\Delta\Delta CT}$ method with a reference gene.

**[Results and Discussion]**
We identified 33 SNPs as being significantly associated with salt stress in GWAS analysis, and the 105 candidate genes significantly related to sodium ion content were detected. A total of 973 differentially expressed genes (DEGs) were identified, of which 342 were down-regulated and 631 were up-regulated genes, assigned to 233 GO terms and 29 KEGG groups. These 973 DEGs included candidate genes that are known to be involved in tolerance to salinity stress: transporters, MAPK signaling pathway and Cytochrome P450, etc.
The study was conducted to identify genomic regions related to salinity tolerance by GWAS and transcriptome analyses. The results from this study will provide a cornerstone of molecular breeding for salinity tolerance in peanut.

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PB-24

# KASP Marker Validation for Novel SNPs of *Sg-1* Gene that Determines Soyasaponin Derivatives

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**[Introduction]**

Soyasaponin is oleanane-triterpenes and are classified into group A saponins and 2,3-dehydro-2,5-dihydroxy-6-methyl-4H-pyran-4-one DDMP saponins by chemical structure. However, the proportion of DDMP saponins in soybeans is much smaller than that of group A saponins, and their chemical structure is unstable, making extraction and analysis difficult in soybeans. Therefore, we performed genome-scale profiling of group A soybean saponins, which not only induce astringency and bitterness, but also play a role in reducing the number of inflammatory cells infiltrating the liver. As a result of the last study, 13 novel SNPs were discovered by analyzing the genomic sequence variation of the candidate gene Sg-1 involved in group A saponin biosynthesis. In this study, 13 novel SNPs were converted into KASP markers to verify markers that discriminate group A saponin derivatives in soybean varieties.

**[Materials and Methods]**

In the genomic sequence of Glyma.07g254600, thirteen novel SNPs closely associated with Group A saponin content of 328 accessions were converted to KASP (Kompetitive Allele Specific PCR) SNP genotyping. The 328 resources were clustered based on the calculated genetic distance using the 131,625 SNPs that were included in the 130K SoySNP. KASP uses two fluorophores to distinguish genotypes. In this study, two 5' fluorescently labeled oligos, FAM and HEX, were used. These oligo sequences are designed to interact with the sequences of the tails of the allele-specific primers.

**[Results and Discussion]**

Thirteen SNPs variants were identified in the genomic sequence of Glyma.07g254600, of which six significant variants were converted to KASP markers. The Six KASP markers (3, 4, 5, 6, 7 and 13 SSA) genotypes were classified into reference and alternative alleles by fluorescence signals (FAM and HEX), and these genotypes discriminated 98.5 - 99.4% of the Aa and Ab derivatives. In SSA3, there was a 6bp deletion in the 5'UTR, and amino acid substitutions were made in 4, 5, 6, 7 and 13 SSA, which are non-synonymous SNPs. In addition, the contents of Aa and Ab derivatives by genotype of these six markers were significant at $p < .001$. This result is an important basis for discriminating group A saponin derivatives, and can be utilized as important data to identify the function of the derivatives in the future .

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**PB-25**

# Complete Chloroplast Genome assembly and Annotation of Milk Thistle (*Silybum marianum*) and Phylogenetic Analysis

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**[Abstract]**
*Silybum marianum* is an annual or biennial plant from the *Asteraceae* family. It can grow in low-nutrient soil and drought conditions, making it easy to cultivate. From the seed, a specialized plant metabolite called silymarin (flavonolignan complex) is produced and is known to alleviate the liver from hepatitis and toxins damages. To infer the phylogenetic placement of a Korean milk thistle, we conducted a chloroplast assembly and annotation following by a comparison with existing Chinese reference genome (NC_028027). The chloroplast genome structure was highly similar with an assembly size of 152,642 bp, an 153,202 bp for Korean and Chinese milk thistle respectively. Moreover, there were similarities at the gene level, coding sequence (n = 82), transfer RNA (n = 31) and ribosomal RNA (n = 4). From all coding sequences gene set, the phylogenetic tree inference placed the Korean cultivar into the milk thistle clade; corroborating the expected tree. Moreover, an investigation the tree based only on the ycf1 gene confirmed the same tree; suggesting that ycf1 gene is a potential marker for DNA barcoding and population diversity study in milk thistle genus. Overall, the provided data represents a valuable resource for population genomics and species-centered determination since several species have been reported in the *Silybum* genus.

**[Acknowledgement]**
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**PB-26**

# Phenotypic Characterization of Amaranth Resources for the Selection of Promising Materials

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**[Abstract]**
Amaranth is a nutritious and broadly adapted seed crop in high demand around the world. A preliminary approach for understanding the genetics of amaranth resources entails a morphologic characterization, which can provide the basis for breeding the first variety in Korea, leading to satisfying the needs of farmers and consumers. Therefore, this study aimed to evaluate the phenotypic characteristics of ten genetic amaranth accessions for the selection of outstanding accessions in terms of yield and grain quality. A randomized complete block design was used, with fifteen replications for each accession under field conditions. Five quantitative and three qualitative descriptors were evaluated with descriptive analysis. The results showed that the accessions with plant heights smaller than the average (>112.7 cm) presented lower yields and smaller seed sizes, thus decreasing the grain quality. The cluster analyses established groups of accessions with good yields (>30.1 g of seeds per plant) and stable morphological characteristics. Based on yield and morphological descriptors, the proposed selection index indicated four accessions as potential parents for amaranth breeding programs in Kora.

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**PB-27**

# Genetic Diversity and Population Structure Analyses of *SSIV-2* Gene in Rice

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**[Abstract]**
Soluble starch synthase (SS) IV-2 is one of the starch synthase gene family members and responsible for starch chain elongation interacting with other rice eating and cooking quality controlling genes (e.g., *AGPlar* and *PUL*). *SSIV-2* is mainly expressed in leaves, especially at grain-filling stage and its alleles can significantly affect rice quality. Here, we investigated the genetic diversity and population structure analyses of *SSIV-2* gene by using 374 rice accessions. This rice set was grouped into 320 cultivated bred (subsequently classified into *temperate japonica, indica, tropical japonica, aus, aromatic and admixture*) and 54 wild rice. Haplotyping of cultivated rice accessions provided a total of 7 haplotypes, and only three haplotypes are functional indicating four substituted SNPs in two exons of chromosome 5: T/A and G/T in exon 4, and C/G and G/A in exon 13. Including the wild, a highest diverse group (0.0041), nucleotide diversity analysis showed *temperate japonica* (0.0001) had a lowest diversity value indicating the origin information of this gene evolution. Higher and positive Tajima's *D* value of *indica* (1.9755) indicate a selective signature under balancing selection while *temperate japonica* (-0.9018) was in lowest Tajima's *D* value due to a recent selective sweep by positive selection. We found the most diverse genetic components of the wild in PCA but shared in some portion with other cultivated groups. Fixation index ($F_{ST}$-values) and phylogenetic analysis indicate a closer relationship of the wild with *indica* ($F_{ST}$=0.256) than to its association to both of *temperate japonica* ($F_{ST}$=0.589). Structure analysis shows a clear separation of cultivated subpopulations at every K value, but genetic components were admixed within the wild illustrating the same genetic background with *japonica* and *indica* in some proportion.

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**PB-28**

# Pre-harvest Sprouting Tolerance Test in Rice with Floury Endosperm

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**[Abstract]**
Pre-harvest sprouting(PHS) refers to germinating seeds in the mother plant before harvesting under low dormancy and humid climate, deteriorating grain quality, and rice yield. Rice varieties with floury endosperm(RFE) have been developed to boost domestic rice consumption by invigorating the processed rice industry, reducing milling and environmental cost. However, the PHS tolerance of RFE is relatively low in the rice varieties with transparent endosperm(RTE) since they soak moisture rapidly due to soft endosperm. In this study, Baromi2(BR2), floury endosperm, and Jomyeong1(JM1), PHS tolerance donor, were crossed to improve PHS tolerance. Major agronomic traits and PHS tolerance test of ten $F_7$(BR2/JM1) lines were conducted in NICS, 2022. The evaluations of PHS were carried out according to the method of RDA(2012) with slight modifications. Briefly, three panicles were treated and incubated 25°C in a growth chamber 35 days after the heading date. Ten PHS tolerance promising lines demonstrated floury endosperm. The heading date of BR2 and JM1 was 7/27 and 8/5, respectively. The heading date of promising lines was 7/23~8/10. The PHS rate of BR2 and JM1 exhibited 56.3% and 10.7%, respectively. However, the PHS rate of ten promising lines demonstrated 2.4%~52.4%, 3 lines significantly lower than BR2. Further studies such as ABA contents are necessary to elucidate the mechanism of PHS tolerance in BR2/JM1. These results may contribute to developing elite RFE lines with improved PHS tolerance.

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**PB-29**

# Disentangling Evolutionary Pattern and Haplotype Distribution of Starch Synthase III-1 (*SSIIIb*) in Korean Rice Collection

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**[Abstract]**
Soluble starch synthases (SSs) elongate $\alpha$-glucans from ADP-Glc to the glucan nonreducing ends and play a critical role in synthesizing resistant starch in the rice. A total of 10 SSs isoforms were reported in rice, including granules-bound starch synthase I (*GBSSI*), *GBSSII*, starch synthase I (*SSI*), *SSIIa* (*SSII-3*), *SSIIb* (*SSII-2*), *SSIIc* (*SSII-1*), *SSIIIa* (*SSIII-2*), *SSIIIb* (*SSIII-1*), *SSIVa* (*SSIV-1*), and *SSIVb* (*SSIV-2*). SSIII proteins are involved in forming the B chain and elongating cluster filling chains in amylopectin metabolism. The functions of *SSIIIb* (*SSIII-1*) are less clear as compared to SSs. Here, we sought to shed light on the genetic diversity profiling of the *SSIII-1* gene in 374 rice accessions composed of 54 wild-type accessions and 320 bred cultivars (temperate japonica, indica, tropical japonica, aus, aromatic, and admixture). In total, 17 haplotypes were identified in the *SSIII-1* coding region of 320 bred cultivars, while 44 haplotypes were detected from 54 wild-type accessions. The genetic diversity indices revealed the most negative Tajima's D value in the temperate-japonica, followed by the wild type, while Tajima's D values in other ecotypes were positive, indicating balancing selection. Nucleotide diversity in the *SSIII-1* region was highest in the wild group (0.0047) while lowest in temperate-japonica. Lower nucleotide diversity in the temperate-japonica is evidenced by the negative Tajima's D and suggested purifying selection. The fixation index ($F_{ST}$) revealed a very high level of gene flow (low $F_{ST}$) between the tropical-japonica and admixture groups ($F_{ST}$=−0.21) followed by admixture and wild groups (−0.04), indica and admixture groups (0. 02), while low gene flow with higher $F_{ST}$ estimates between the temperate-japonica and aus groups (0.72), tropical-japonica and aromatic groups (0. 71), and temperate-japonica and admixture groups (0.52). Taken together, our study offers insights into haplotype diversity and evolutionary fingerprints of *SSIII-1*. It provides genomic information to increase the resistant starch content of cooked rice.

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**PB-30**

# Evolutionary Analyses of *SSII-1* Gene Provides Insight into Its Domestication Signatures in Collected Rice Accessions

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**[Abstract]**
Starch synthase proteins (*SSI*, *SSII* and *SSIII*) in rice are mainly involved in amylopectin synthesis mediating its chain elongation, and the functional loss of *SSII* can increase amylose accumulation through decreasing of amylopectin chain proportions. For purposes of identifying functional haplotypes and evolutionary analyses of this gene, *SSII-1*, we investigated 374 rice accessions belonging to different subgroups of origins. We subsequently performed bioinformatic analyses on their variations through haplotyping, resequencing and structuring based on different classified populations. Haplotyping of cultivated rice accessions using genetic variations within *SSII-1* genomic region of chromosome 10 revealed a total of 8 haplotypes, representing 6 functional haplotypes by 4 non-synonymous SNPs of three different exons (1, 4 and 10), which effect on protein structure. Higher nucleotide diversity value was found in wild group (0.0055) compared to any of cultivated subpopulations, of which *aus* showed the most reduction of diversity value (0.0003). Tajima's *D* analysis exhibits the most Tajima's *D* value only in *admixture* group (0.3600) which appears to be the cause of a sudden population contraction by rare alleles scarcity. A clear separation of some wild accessions from the admixed cultivated subpopulations was observed in PCA and phylogenetic analysis. Similar admixed pattern of population structure was estimated with an increased K values of 2 to 8 where genetic components of almost all cultivated subpopulations were shared with the wild which can also be subsequently estimated by very low $F_{ST}$-values by -0.011 (wild-aromatic) and -0.003 (wild-admixture).

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**PB-31**

# Functional Haplotypes and Evolutionary Analyses of *SBE1* in Collected Rice Germplasm

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**[Abstract]**
The starch-branching enzymes (*BEs*) are responsible for synthesizing the amylopectin, which plays an important role in determining the structural and physical properties of starch granules. *BE* has two differently functioning isoforms (*BEI and BEIIa/b*) based on their difference in the chain-length pattern by the degree of polymerization (DP), which mainly contributes to the amylopectin chain length distribution in starch biosynthesis. In this study, we investigated functional haplotypes and evolutionary analyses of *SBE1* in 374 rice accessions (320 Korean bred and 54 wild). The analyses were performed based on the classified subpopulations. Haplotype analysis generates a total of 8 haplotypes, of which only four haplotypes were functional carrying four functional SNPs in four different exons of SBE1 on chromosome 6. Nucleotide diversity analysis showed a highest *pi*-value in *aromatic* group (0.0029), while the lowest diversity value was in *temperate japonica* (0.0002), indicating the signal of this gene evolution origin. Different directional selections could be estimated by negative Tajima's *D* value of *temperate japonica* (-1.1285) and positive Tajima's *D* value of *tropical japonica* (0.9456), where the selective sweeps were undergone by both positive purifying and balancing selections. Phylogenetic analysis indicates a closer relationship of the wild with most of the cultivated subgroups indicating a common ancestor for *SBE1* gene. $F_{ST}$-values indicate distant genetic relationships of *temperate japonica* from all other classified groups. PCA and population structure analysis show an admixed structure of wild and cultivated subpopulations in some proportions.

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**PB-32**

# Characterization of *PUL* Haplotypes and Its Evolutionary Analyses in Korean Rice Accessions

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**[Abstract]**
*Pullulanase (PUL)*, a debranching enzyme, has been utilized in hydrolyzing the $\alpha$-1,6 glucosidic linkages in starch, amylopectin, pullulan, as well as related oligosaccharides. It has also been indicated that PUL is a novel indicator of inherent RS (Resistant Starch) formation in rice. In this study, we performed haplotype analysis on 320 bred rice accessions, and additional 54 wild accessions were added to study genetic diversity along with other population-based analyses of the *PUL* gene. Through these investigations, we summarized a total of 10 functional (non-synonymous) SNPs from 7 different exons on chromosome 4. There were 10 haplotypes, of which only six haplotypes were functional, implicating different subpopulations. Diversity reduction was noticed in *temperate japonica* (0.0005) compared to the highest one (*aus,* 0.0154), illustrating their higher genetic differentiation by $F_{ST}$-value (0.926). The highest Tajima's *D* value was observed in *indica* (3.6613), indicating *PUL* gene domestication signature under balancing selection, while the lowest Tajima's *D* value was found in *temperate japonica* (-2.2191) which might have undergone under positive selection and purified due to the excess of rare alleles. PCA, population structure, and phylogenetic analyses provide information on the genetic relatedness between and or among the cultivated subpopulations and the wild based on *PUL* genomic region.

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**PB-33**

# Haplotyping and Evolutionary Studies on *GBSSII* Gene in Korean Rice Collection

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**[Abstract]**
*Granules-bound starch synthase II (GBSSII),* one of the isoforms of granule-bound starch synthase (GBSS), is responsible for amylose synthesis by expressing in non-storage tissues such as leaf, stem, root, and pericarp. Up to date, little is known about this gene functions and basic knowledge of heritable characteristics of this gene, *GBSSII*. We identified functional haplotypes and performed evolutionary analyses on the *GBSSII* using 374 rice accessions (320 Korean bred and 54 wild) based on the classified groups. A total of 14 haplotypes were found, and almost all haplotypes (13) were functional, carrying 19 non-synonymous SNPs in two exons (exons 1 and 2). The lowest nucleotide diversity was detected in *Tropical japonica* (0.00145), while the highest *pi*-value was in *Aus* (0.01081), illustrating the signal of this gene evolution. The highest Tajima's *D* value in *Aus (*1.6380) indicates *GBSSII* gene domestication signature under balancing selection, while the lowest Tajima's *D* value in *Temperate japonica* (-0.8243) highlights that they were under positive selection, which may be purified due to the excess of rare alleles. The highest genetic differentiation was observed between *Tropical japonica and aroma* ($F_{ST}$ = 0.921928). In contrast, the highest interbreed level was detected in *Aus-admixture* ($F_{ST}$ = -0.20157). The genetic relatedness between and or among the wild and cultivated subpopulations was revealed through PCA, population structure, and phylogenetic analyses.

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**PB-34**

# Granule-Bound Starch Synthase I (*GBSSI*): An Evolutionary Perspective and Haplotype Diversification in Rice Cultivars

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**[Abstract]**
Granule-bound starch synthase I (*GBSSI*), encoded by the *waxy* gene, is responsible for the accumulation of amylose during the development of starch granules in rice endosperm. Despite many findings on waxy alleles, the genetic diversity and evolutionary studies are still not fully explored regarding their functional effects. Comprehensive evolutionary analyses were performed to investigate the genetic variations and relatedness of the *GBSSI* gene in 374 rice accessions composed of 54 wild accessions and 320 bred cultivars (temperate japonica, tropical japonica, indica, aus, aromatic, and admixture). GBSS1 coding regions were analyzed from a VCF file retrieved from whole-genome resequencing data, and eight haplotypes were identified in the *GBSSI* coding region of 320 bred cultivars. The genetic diversity indices revealed the most negative Tajima's *D* value in the tropical-japonica, followed by the aus and temperate-japonica, while Tajima's *D* values in indica were positive, indicating balancing selection. Diversity reduction was noticed in temperate japonica (0.0003) compared to the highest one (wild, 0.0044), illustrating their higher genetic differentiation by $F_{ST}$-value (0.604). The most positive Tajima's *D* value was observed in indica (0.5224), indicating the *GBSSI* gene domestication signature under balancing selection. In contrast, the lowest and negative Tajima's *D* value was found in tropical japonica (-0.5291), which might have experienced a positive selection and purified due to the excess of rare alleles. Overall, our study offers insights into haplotype diversity and evolutionary fingerprints of *GBSSI*. It also provides genomic information to increase the starch content of cooked rice.

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**PB-35**

# Genetic Diversity and Characterization of *DPE1* Gene in Rice Germplasm

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**[Abstract]**
*Disproportionating Enzyme 1 (DPE1)* is an α-1,4-D-glucanotransferase that cleavages the α-1,4-glucosidic bonds and transfers glucosyl groups. In rice endosperm, it participates in starch synthesis by transferring maltooligosyl groups from amylose and amylopectin to amylopectin. Here, we investigated the haplotype variations and evolutionary indices (e.g., genetic diversity and population structure) for the *DPE1* gene in 374 rice accessions representing seven subgroups (*wild, indica, temperate japonica, tropical japonica, aus, aromatic, and admixture)*. Variant calling analysis of *DPE1* coding regions leads to the identification of six functional haplotypes representing/occupying 8 nonsynonymous SNPs. Nucleotide diversity analysis revealed the highest *pi*-value in *wild* group (0.0556) compared to other cultivated groups, of which *temperate japonica* showed the most reduction of genetic diversity value (0.003). A significant positive Tajima's *D* value (1.6330) of *admixture* highlights sudden population contraction under balancing selection, while *temperate japonica* with the lowest Tajima's *D* value (-1.3523) showed a selection signature of *DPE1* domestication which might be the cause of excess of rare alleles. Moreover, these two subpopulations exhibits a greater differentiation ($F_{ST}$=0.0148), indicating a higher genetic diversity. Our findings on functional *DPE1* haplotypes will be useful in future breeding programs, and the evolutionary indices can also be applicable in functional studies of the *DPE1* gene.

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PB-36

# Observation of Mitotic Chromosome behavior according to Different Treatment Methods of DNA Methylation Inhibitor

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**[Abstract]**
Chromosome breakage occurred by DNA methylation inhibitor. Zebularine is known as DNA methylation inhibitor and suitable for water solubility among different DNA methylation inhibitors as 5-Azacytidine and 5-aza-2'-deoxycytidine. We used zebularine as mutagen according to different methods by roots absorption and seed imbibition. After zebularine treatment, DNA methylation inhibitor, we observed mitotic chromosome behavior what is different according to two different treatment methods. First, seed imbibition treatment in 1,000 μM of zebularine solution for 72 hours in dark conditions. The second treatment to seedlings of Keumkang was also treated in 1,000 μM of zebularine solution for 72 hours after germination. Root and shoot showed different elongations in each treatment. Root absorption treatment(3.01±0.48, 2.00±0.26) showed the shortest elongation in root and shoot than control(8.16±0.61, 4.03±0.48) and seed imbibition treatment(4.33±0.80, 2.48±0.36). It can be explained root tip meristematic cell activity was damaged by DNA methylation inhibitor. Primary root tips were collected in DW for 24 hours at low temperature(0°C) and fixed in fixation solution for 3 days to chromosome observation in mitosis. Mitotic index, chromosome structure and chromosome aberration were observed by phase-contrast microscope. Mitotic index of the control(0.29) showed twice mitotic cells as the treated groups(imbibition 0.15, absorption 0.14). Observation of chromosomes showed some short chromosomes and loosen chromosomes affected by zebularine. It is considered because of zebularine damage DNA in mitosis. We observed "gap by chromosome breakage" in chromosomes that have loose parts between centromere and telomere. It seems demethylation of zebularine occurs chromosome breakage.

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**PB-37**

# Days to Heading and Glossiness Variation of RILs derived from Hwayeong and Wandoaengmi 6

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**[Abstract]**
Improving the taste of rice in the breeding process is one of the important goals. However, it takes a lot of time and effort to select lines with good grain quality. MAS related to rice quality can help quickly and accurately select the elite lines in breeding programs. QTL *qTV9,* derived from Wandoaengmi 6, has been reported as a marker associated with improved glossiness of rice (Park et al., 2019). To confirm the function of QTL *qTV9,* 186 RILs derived from Hwayeong/Wandoaengmi6 were cultivated on ordinary planting cultivation for five years. The average DTH of Hwayeong and Wandoaengmi 6 was not significant at 99 and 97 days, respectively, but the averages of TV (toyo value) were 72.6 and 86.0, respectively. The DTH and TV of RIL vary from year to year. In 2017–2018, the average DTH was 98 days, which was significantly higher than the other three years. In 2018 and 2021, the average TV was 79.5 and 86.5, respectively, which were significantly higher than in other years. As a result of correlation analysis, DTH in the different years showed highly significant positive correlations (r = 0.71-0.92) from 0.71 to 0.92, whereas TV showed positive but weaker correlations (r = 0.42-0.71). The correlation between DTH and TV in each year was significant but weak (r = 0.25-0.64) and there was no correlation in 2017. The TV (77.6-88.7) of RILs with QTL *qTV9* was significantly higher than that of RILs without *qTV9* (72.6–84.9) for all five years. As a result of analyzing TV by DTH group, the TV of the lines with *qTV9* in DTH groups (93-97) and (98-103) showed a significantly higher trend for all 5 years. And TV was not significant in DTH groups A, B, E, and F. This may have been influenced by factors such as insufficient populations between groups or differences in harvest timing. This study is expected to be used as data for improving the glossiness of cooked rice in breeding programs, and further study of the QTL *qTV9* marker is required.

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PB-38

# Confirmation of SSR Markers and QTLs Associated with Seed Size and Water Absorbability in Soybean (*Glycine max*) Cultivars for Fermented Product, *Saengcheonggukjang*

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**[Abstract]**

*Saengcheonggukjang,* known as Natto in Japan, is a Korean fermented soybean food that has various bioactive compounds for antioxidant and antidiabetic activity. The development of soybean (*Glycine max* L.) cultivars for *saengcheonggukjang* production relies on the selection of seed traits that influence the quality and sensory properties. One of the important traits for cultivars is seed characteristics such as seed hardness and size. In order to select the lines for breeding good quality *saengcheonggukjang* varieties, several simple sequence repeat (SSR) markers and quantitative trait loci (QTLs) related to seed quality of Korean cultivars, Pungsannamulkong, Socheongja, Pungwon, Heawon, and Hoseo, were analyzed. Based on the many studies to detect stable QTLs for seed traits, we tested several QTLs related to seed size and water absorbability using SSR markers on Korean cultivars. The results showed that two regions for water absorbability of Pungsannamulkong and one region for seed size traits of Haewon and Hoseo were identified in this study. These results could have applications to soybean breeding for seed size and hardness and it is necessary to narrow it down through further study.

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**PB-39**

# Agronomical traits of Korean Mungbean Landrace

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**[Abstract]**
Mungbean(*Vigna radiata* (L.) R. Wilczek) is one of legume cultivated in south and east Asia. It well cultivated in high temperature and drought condition. In order to establish pure line for genomic studies, the agronomical characteristics of Korean mungbean landraces were evaluated. A total of 324 acessions derived from National Agrobiodiversity Center were selfed two times in 2021 nersery. Tree times of selfed from 324 accessions were characterized. The color of seed coat was divided into three groups: green, yellow and brown. Among them green color was the most common with 91.7%. Flower colors were divided into four groups: yellow, purplish yellow, greenish yellow and purplish green. Among them purplish yellow color had the highest with 77.8%. Out of 324 resources, only 4 showed compound leaves, and all resources had a heart-shaped leaf. The days to first flowering was 31 to 78 days. About 63% of the accessions bloomed 35 to 50 days after sowing. 324 Korean landraces are expected to be used as a population of the Korean mungbean core collection and serve as a basis for genomic breeding materials for mungbean.

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**PB-40**

# Allelic Distribution of *OsPRR37*, a Major Heading Date Gene in Korean Rice Cultivars

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**[Abstract]**

Rice is a major food crop consumed by approximately half of the world's population. Heading date is one of the major agronomic traits and has a wide impact on the productivity and quality of rice. Recently, shortening the growth period of rice through modulating heading date has been emphasized as one of the most effective strategies for reducing methane emissions from paddy fields. *OsPRR37*, a major heading date gene in rice, represses flowering under both short-day and long-day conditions. Plants carrying the loss-of-function alleles of *OsPRR37* have been reported to flower approximately seven days and 20 days earlier than those carrying the functional alleles in short day and long day conditions, respectively. In this study, we investigated the nucleotide sequence variation existing in the exonic regions of *OsPRR37* and catalogued the allelic distribution in 208 Korean rice cultivars. We used four sets of primers for amplifying and sequencing the eight exons of *OsPRR37*. As a result, two types of loss-of-function alleles and four types of functional alleles were found in 208 Korean rice cultivars. Interestingly, only three cultivars (Jinbuolbyeo, Jinseolchal, and Mimyeon) carried loss-of-function alleles while 205 carried functional alleles, indicating that *OsPRR37* loss-of-function alleles have been used very rarely in Korean rice breeding programs. To generate useful information for the development of early-maturing rice cultivars, our future work will focus on analyzing the effect of different *OsPRR37* alleles on heading date and other major agronomic traits.

**[Acknowledgement]**

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PB-41

# Detection of QTLs for Dry-heat Tolerance of Rice Seed Using Recombinant Inbred Lines Derived from a Cross between 'Chamdongjin' and 'Younghojinmi'

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**[Intoroduction]**

Dry-heat tolerance (DHT) of rice seed is closely related to dormancy. Since dormant seeds show strong resistance to high temperature and drying, dry-heat treatment is sometimes used to break seed dormancy and control seed-borne pests. It was reported that DHT had a positive correlation with seed longevity and negative correlation with pre-harvest sprouting (PHS). This study was conducted to investigate the relationship between DHT and PHS and identify the quantitative trait loci (QTLs) for these traits using recombinant inbred lines (RILs) derived from a cross between 'Chamdongjin', PHS susceptible cultivar and 'Younghojinmi', PHS tolerant cultivar.

**[Materials and Methods]**

Parents and 91 RILs were used in this study. PHS rates were evaluated after incubation for 7 days at 25°C, 100% humidity using three panicles per each lines harvested at 40 days after heading. DHT were investigated by measuring the germination rates of harvested seeds after 90°C dry-heat treatment for control, 12, 24, 36 hours. Genotying was analyzed using 285 markers showing polymorphism between parents out of 771 KASP markers. QTL analysis was conducted using QTL IciMapping program.

**[Results and Discussion]**

'Chamdongjin' showed higher PHS rate (28.6%) than 'Younghojinmi' (3.1%). At all dry-heat treatment times, 'Chamdongjin' had lower DHT than those of 'Younghojinmi', and the germination rates after 36 hours treatment were 8.0% for 'Chamdongjin' and 57.5% for 'Younghojinmi'. The average PHS rate of RILs was 23.2% and the range exhibited from 0.3% to 73.6%. The average DHT rates of RILs by dry-heat treatments were 91.5% without treatment (DHT_0hr), 61.6% at 12 hours (DHT_12hr), 27.4% at 24 hours (DHT_24hr), and 21.9% at 36 hours (DHT_36hr), which fell down sharply as the treatment time increased. As a result of the correlation analysis, unlike the previously reported results, it was found that there was no relationship between PHS and DHT. On the other hand, there were very high positive correlation between DHT_12hr, 24hr, and 36hr. Through the QTL analysis, no QTL was detected for PHS, but QTLs for DHT were found on chromosome 3 (*qDHT3*) and 8 (*qDHT8*). *qDHT8* was detected in all dry-heat treatments and could explain 19.4% (12hr), 14.7% (24hr), and 18.9% (36hr) of phenotypic variation. RILs carrying 'Younghojinmi' allele on *qDHT8* showed higher DHT than those carrying 'Chamdongjin' allele. Further analysis of phenotype and genotype on RILs has being performed for precise QTL identification.

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PB-42

# Analysis of Quality- and Yield- Related Traits of Glutinous Rice Cultivar according to Cultivation Times in Honam Plain

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**[Introduction]**

In order to increase the utility of glutinous rice cultivar breeding in Korea, it is necessary to study the characteristics related to starch and pasting properties and agricultural characteristics related to yield. In addition, due to the unique characteristics of glutinous rice cultivar, there is a significant difference in various traits according to cultivation times, and systematic studies on this are continuously required.

**[Materials and Methods]**

Plant materials were transplanted into the rice field (35º50’26.8’’N 127º02’42.8’’E) of the National Institute of Crop Science, Rural Development Administration, located in honam plain. According to cultivation times, characteristics related to yield, panicle, pasting properties, and grain quality were investigated. In addition, the investigated trait characteristics were analyzed using R to confirm the interaction between various characteristics of cultivars according to cultivation times and the effect on the related traits.

**[Results and Discussion]**

The heading date increased in the order of early-, ordinary-, and late-cultivation. According to the cultivation times, the cultivar with the highest yield is ‘Boramchal’ in early planting, ‘Baegseolchal’ in ordinary planting, and ‘Sinseolchal’ in late planting. In addition, as the cultivation times were delayed, the ratio of perfect grains increased, which improved the appearance quality of rice. As for pasting properties, as cultivation times were delayed, pasting temperature, peak viscosity, trough viscosity, final viscosity, and break down decreased, and setback increased. Therefore, in the case of cultivating glutinous rice, it is suggested that an appropriate cultivar can be selected according to each cultivation time to improve the appearance quality and taste of rice while improving the yield.

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PB-43

# Characterization of Yield and Processing Quality of 'Eunsun' variety to Autumn Cultivation from 2019 to 2021

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**[Introduction]**

The consumption of potato processing food, such as potato chips, is on the rise because of changes in food consumption trends. So, the import amount of chilled fresh and frozen potatoes were up 117% from 10 years ago. Because the chip quality of potatoes cultivated in Autumn was bad, it was necessary to expand the supply of potato varieties with excellent production and processing characterization in Autumn to stable supply of processing materials. In this study, it was evaluated to autumn cultivation that yield and processing characterization of 'Eunsun' was a new double- cropping variety for processing.

**[Materials and Methods]**

'Eunsun' was cultivated in the field of HARI(Gangneung-si Ganwon-do) in Autumn and evaluated yield and processing quality from 2019 to 2021. The seed potato was planted mid in August and harvested earlier in November according to standard cultivation methods of RDA. It was investigated that yield(Total yield(TY, kg/10a), Marketable tuber rate(MTR, %) etc), physiological disorders(Growth cracking etc), quality(Specific gravity(SG), Chip color and Starch content etc). Starch content was calculated using a specific gravity value and chip color was measured Hunter's values(L, a, b) using a colorimeter(CR400/410, Konica Minolta, Japan).

**[Results and Discussion]**

The average TY and MTR in 'Eunsun' were 3,019kg/10a, and 85.6%, similar to Deji. But the rate of physiological disorder in 'Eunsun' was 9.4%(deformation), and 7.4%(Growth cracking), which was lower than 'Deji'. 'Eunsun' was a more produced marketable tuber than 'Deji'. In the case of quality, starch content in 'Eunsun' was 12.5%, which is higher than 'Deji'. Hunter's L value of potato chip in 'Eunsun' was higher than 'Deji'. It was considered that 'Eunsun' was a possible variety suitable for processing during autumn cultivation

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PB-44

# Transcriptome Profiling Identifies Genes of Waterlogging-Tolerant and -Sensitive Rapeseeds Differentially Respond to Waterlogging Stress at the Flowering Stage

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**[Abstract]**

Rapeseed is a crop that is waterlogging sensitive, and it is necessary to breed waterlogging tolerance varieties. Our study presents the comparative transcriptome changes in two rapeseed lines, i.e., waterlogging-tolerant ('J8634-B-30') and -sensitive ('EMS26') lines under control and waterlogging stress treatments at the flowering stage. RNA-sequencing analysis revealed 13,279 differentially expressed genes (DEGs) for 'J8634-B-30' and 8,682 DEGs for 'EMS26' under waterlogging stress condition compared to control. Among DEGs of 'J8634-B-30', 6,818 were up-regulated and 6,461 were down-regulated. On the other hand, among the DEGs of 'EMS26', the number of down-regulated genes (5,240) were higher than that of up-regulated genes (3,442). Gene ontology enrichment analysis showed that DEGs related to glucan metabolic, cell wall, and oxidoreductase activity were significantly changed in 'J8634-B-30'. Kyoto Encyclopedia of Genes and Genomes (KEGG)-based analysis in 'J8634-B-30' identified up-regulated DEGs being involved in MAPK signaling pathways. In addition, the DEGs belonging to mechanisms responding to waterlogging stress, i.e., plant hormones, carbon metabolism, Reactive oxygen species (ROS), Nitric oxide (NO) etc. were compared in rapeseed lines. Several DEGs including ethylene-responsive transcription factor (*ERF*), constitutive triple response (*CTR*) (in ethylene signaling pathway), monodehydroascorbate Reductase (*MDAR*), NADPH oxidase (in ROS pathway), cytochrome c oxidase assembly protein (*COX*) (in NO pathway) up-regulated in 'J8634-B-30'. These outcomes provided the valuable information for further exploring the genetic mechanism of waterlogging tolerance in rapeseed.

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PB-45

# Identification of QTLs for Chlorophyll Content Under Low Nitrogen Conditions in RILs Derived from Korean *japonica* rice

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**[Introduction]**

The flag leaf of rice supplies carbon assimilates to the panicle during the ripening stage. The high chlorophyll content of flag leaf under low nitrogen conditions could increase photosynthesis and it is one of the source traits that affect yield in rice.

**[Materials and Methods]**

RIL population consists of 88 lines derived from a cross between two Korean *japonica*, JJ625 (large grain breeding line) and Namchan (high yielding variety under low nitrogen conditions). Two parents and 88 RILs were planted by two replications at the paddy field treated with low nitrogen fertilizer (4.5kg/10a). The chlorophyll content of flag leaves was collected at the fully flowering stage using SPAD-502 plus. The genotyping of RILs was conducted using Target Capture Sequencing, and a total of 511 informative SNPs were obtained. The linkage map construction and QTL analysis were carried out by QTL IciMapping 4.2 program

**[Results and Discussion]**

JJ625 showed higher Chlorophyll contents of flag leaf and earlier heading date than Namchan. The average and range for chlorophyll contents of RILs were 39.1 and 35.2~44.1, respectively. The linkage map of RILs was constructed using 521 SNPs and represented 1841.3 cM for the total genetic length. Four QTLs for chlorophyll content were detected on chromosomes 1 and 8 and explained 70.7% of phenotypic variation. All alleles derived from JJ625 showed positive effect and *qCCF1.1* presented the highest LOD, PVE, and additive effect among four QTLs. Besides, three heading date QTLs were identified on chromosomes 1, 2, and 8. *qDTH8* was collocated with the same marker interval of *qCCF8*, and *qDTH1* was mapped on 13 cM upstream of *qCCF1.2*. This result implies chlorophyll content could be related to heading date in this population. QTLs identified in this study would be applied to improve yield potential under low nitrogen conditions.

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**PB-46**

# Genome-Wide Comprehensive Analysis of the GASA Gene Family in Peanut (*Arachis hypogaea* L.)

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**[Abstract]**

The GASA protein (Gibberellic acid-stimulated Arabidopsis) are family of small cysteine-rich peptides found in plants. These GASA gene family mainly involved in biotic/abiotic stress responses and plant development. Despite being present in a wide plant species, their action and functions still remain unclear. In this study, using the in-silico analysis method we identified 41 GASA genes in peanuts (*Arachis hypogaea L.*). Based on the phylogenetic analysis 41 GASA genes are classified in the four major clusters and subclades. Mainly, clusters IV and III comprise the majority of GASA genes 15 and 11 genes respectively, followed by cluster I and cluster II with 9 and 6 genes respectively. Additionally, based on in-silico analysis we predicted the post-transcriptional and post-translational changes of GASA proteins under abiotic stresses such as drought and salt stress would aid our understanding of the regulatory mechanisms. Hence, a further study is planned to evaluate the expression of these GASA genes under stress in different plant tissues to elucidate the possible functional role of GASA genes in peanut plants. These findings might offer insightful data for peanut advancement.

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**PB-47**

# LC-MS Analysis According to the Combined Treatment of *Paenibacillus yonginensis* DCY84$^T$ and Silicon in Rice

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**[Abstract]**
We reported in our recent studies that the combined treatment of *Paenibacillus yonginensis* DCY84$^T$ (DCY84$^T$) and Silicon (Si) promotes initial plant growth and increases resistance to biotic and abiotic stress. To understand the molecular background of these phenotypes, Liquid Chromatography Mass Spectrometry (LC-MS) analysis was performed, and it was confirmed that unsaturated fatty acid metabolites such as oleic acid and linoleic acid decreased in response to the combined treatment of DCY84$^T$ and Si. The stearoyl-acyl carrier protein desaturase (SACPD) introduces the cis double bond into the acyl-ACPs at C9, resulting in the production of unsaturated fatty acid. We identified *OsSSI2* encoding SACPD in rice and found that the expression of *OsSSI2* was reduced under DCY84$^T$ and Si treatment. Furthermore, qRT-PCR analysis revealed that the expression of *OsWRKY45*, which is downstream of *OsSSI2*, was upregulated in response to DCY84$^T$ and Si treatment. These results enable the speculation that activation of the salicylic acid (SA)-responsive gene, *OsWRKY45,* may contribute to enhancing biological stress resistance. Based on this, we propose a probable model for the rice defense pathway following DCY84$^T$ and Si treatment. This model retains a WRKY45-dependent but NH1(NPR1)-independent SA signaling pathway.

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PB-48

# Construction of an Analysis System Using Digital Breeding Technology for the Selection of *Capsicum annuum*

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**[Abstract]**
As the world's population grows and food needs diversify, the demand for horticultural crops for beneficial traits is increasing. In order to meet this demand, it is necessary to develop suitable cultivars and breeding methods accordingly. Breeding methods have changed over time. With the recent development of sequencing technology, the concept of genomic selection (GS) has emerged as large-scale genome information can be used. GS shows good predictive ability even for quantitative traits by using various markers, breaking away from the limitations of Marker Assisted Selection (MAS). Moreover, GS using machine learning (ML) and deep learning (DL) has been studied recently. In this study, we aim to build a system that selects phenotype-related markers using the genomic information of the pepper population and trains a genomic selection model to select individuals from the validation population. We plan to establish an optimal genome wide association analysis model by comparing and analyzing five models. Validation of molecular markers by applying linkage markers discovered through genome wide association analysis to breeding populations. Finally, we plan to establish an optimal genome selection model by comparing and analyzing 12 genome selection models. Then We will use the genome selection model of the learning group in the breeding group to verify the prediction accuracy and discover a prediction model.

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**PB-49**

# System for Improvement of Soybean Using Gene Editing Technology

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**[Abstract]**
Gene-editing is currently one of the most popular technologies in recent years. Development of the new crop using the gene editing have advantage of improved accuracy and efficiency compared with conventional breeding. Soybean (*Glycine max* L.) is one of the most important crops worldwide used as food and forage. We tried to establish a system for breeding improvement of soybean through gene-editing technology. For the gene-editing system of soybean, i) selection of efficiency gRNA of targeted gene, ii) efficient genetic transformation of the selected gRNA, iii) selection of trans-clean mutant is essential. First of all, we investigated the selection conditions of gRNA with high editing efficiency of targeted gene using isolated protoplast of soybean. Furthermore, we performed the *Agrobacterium*-mediated genetic transformation of various soybean cultivars. We identified the tissue culture ability in 23 soybean cultivars for genetic transformation of soybean. The six cultivars with high tissue culture ability were selected and confirmed the transgenic plants in four cultivars. Finally, we established a speed-breeding system as a powerful tool for the fast selection of trans-clean mutants from transgenic plants. Our laboratory will provide the valuable system for improvement of soybean by the gene-editing technology.

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PB-50

# The Prediction Ability of Genomic Selection in the Wheat Core Collection

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**[Abstract]**
Genome selection is a promising tool for plant and animal breeding, which uses genome-wide molecular marker data to capture large and small effect quantitative trait loci and predict the genetic value of selection candidates. Genomic selection has been shown previously to have higher prediction accuracies than conventional marker-assisted selection (MAS) for quantitative traits. In this study, the prediction accuracy of 10 agricultural traits in the wheat core group with 567 points was compared. We used a cross-validation approach to train and validate prediction accuracy to evaluate the effects of training population size and training model.As for the prediction accuracy according to the model, the prediction accuracy of 0.4 or more was evaluated except for the SVN model among the 6 models (GBLUP, LASSO, BayseA, RKHS, SVN, RF) used in most all traits. For traits such as days to heading and days to maturity, the prediction accuracy was very high, over 0.8. As for the prediction accuracy according to the training group, the prediction accuracy increased as the number of training groups increased in all traits. It was confirmed that the prediction accuracy was different in the training population according to the genetic composition regardless of the number. All training models were verified through 5-fold cross-validation. To verify the prediction ability of the training population of the wheat core collection, we compared the actual phenotype and genomic estimated breeding value using 35 breeding population. In fact, out of 10 individuals with the fastest days to heading, 5 individuals were selected through genomic selection, and 6 individuals were selected through genomic selection out of the 10 individuals with the slowest days to heading. Therefore, we confirmed the possibility of selecting individuals according to traits with only the genotype for a shorter period of time through genomic selection.

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**PB-51**

# Identification of QTLs for Flooding Tolerance Using RIL Population in Rice (*Oryza Sativa* L.)

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**[Introduction]**

Rice (*Oryza sativa* L.) is one of the most important staple food crops grown worldwide. In rainfed lowlands and flood-prone areas worldwide, rice farmers commonly encounter flooding after seeding, which results in partial to complete crop failure because the high sensitivity of rice to the flooding conditions caused considerable losses in grain production each year by flooding during germination. In this study, we identified candidate quantitative trait loci (QTLs) associated with flooding tolerance during germination using recombinant inbred lines (RILs).

**[Materials and Methods]**

To analyze QTLs for flooding tolerance, we evaluated the survival rate under flooding conditions of RIL populations with their parental lines. Genotypic analyses were performed using single nucleotide polymorphisms (SNPs) markers.

**[Results and Discussion]**

A linkage map of 1134.9 cM was constructed using 1313 polymorphic SNPs markers. Five putative QTLs were detected on chromosomes 1 (*qSUB1*), 3 (*qSUB3*), 4 (*qSUB4*), 7 (*qSUB7*), and 11 (*qSUB11*), explaining from 5.3 to 15.4% of the phenotypic variation, and with LOD scores of 2.82−7.53.

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PB-52

# Whole Genome Sequencing and Gene Prediction of *Cynodon transvaalensis*

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**[Abstract]**
*Cynodon transvaalensis* belongs to the warm-season grasses and is one of the economically and ecologically important crops. Cynodon species with high heterozygosity are difficult to assemble, so genome research has not been actively conducted. In this study, hybrid assembly was performed by sequencing with Illumina and PacBio. As a result of the assembly, the number of scaffolds and the length of N50 were 1,392, 928 kb, respectively. The completeness of the assembly was confirmed by BSUCO at 98.3%. In addition, as a result of estimating the size of the assembled genome by K-mer analysis (k=25), it was approximately ~413 Mb. A total of 37,060 cds sequences were annotated in the assembled genome, and their functions were identified through blast. After that, we try to complete the assembled genome into a pseudochromosome-level genome through Hi-C technology. These results will not only help to understand the complex genome composition of african bermudagrass, but also provide a resource for genomic and evolutionary studies of grass and other plant species.

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PB-53

# Fine-mapping of Pre-harvest Sprouting Quantitative Trait Locus through the Whole-Genome Sequencing in Rice (*Oryza sativa* L.)

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**[Introduction]**

Rice (*Oryza sativa* L.) is one of the most important food crops as it is the main staple food for more than half of the world's population. Climate change entails higher temperatures, and the predicted above-average temperatures will diminish rice crop yields. Pre-harvest sprouting (PHS), one of the adverse effects of climate change on crops, was reported to become a serious threat to rice production. In this study, we identified candidate genes associated with PHS using segregation populations.

**[Materials and Methods]**

To analyze quantitative trait loci (QTLs) and fine-mapping for PHS tolerance, we evaluated PHS under field and growth chamber conditions of $F_{2:3}$ and $F_{3:4}$ populations with their parental lines. Genotypic analyses were performed using single nucleotide polymorphisms (SNPs) and InDel (Insertion & deletion) markers designed in re-sequencing data.

**[Results and Discussion]**

*qPHS1*$^{FC}$ and *qPHS1*$^{GC}$ were detected on chromosome 1, and the QTL regions were narrowed down from 237 Kbp to 50 Kbp. The five candidate genes *Os01g0111200*, *Os01g0111300*, *Os01g0111400*, *Os01g0111500*, and *Os01g0111600* were detected in this 50 Kbp region, and *Os01g0111400* and *Os01g0111600* were confirmed to contain SNP and an InDel.

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PB-54

# Application of *Agrobacterium*-mediated Transformation of Korean White-grain Wheat (*Triticum aestivum*) Varieties

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**[Introduction]**

The *Agrobacterium*-mediated transformation method is frequently used in plant gene editing since single-copy transgene integration is relatively high in *Agrobacterium*-mediated transformation compared to particle bombardment. However, there are still obstacles such as low embryogenic callus induction and unoptimized inoculation conditions in applying *Agrobacterium*-mediated transformation to Korean wheat varieties. Therefore, research to improve the efficiency of *Agrobacterium*-mediated transformation of Korean wheat varieties is essential. This study investigated the possibility of applying wheat transformation technology to Korean white-grain wheat varieties. In addition, the *GRF-GIF* chimera gene, which was recently reported to increase the regeneration efficiency, was cloned and applied from cv. Keumgang, the most produced variety in Korea.

**[Materials and Methods]**

The spikes were collected from 8 Korean white-grain wheat varieties (Yeonbaek, Dahong, Jokyeong, Baekjung, Hanbaek, Baekchal, Jeokjung, and Keumgang) grown in a greenhouse at Kongju University. The immature embryos were isolated from the collected immature grain and used for *Agrobacterium*-mediated transformation. The *Zm*Ubi promoter::GRF-GIF::tNOS cassette was cloned into a pCAMBIA1300-based vector and inserted into *Agrobacterium* strain EHA105. The efficiency of wheat transformation was confirmed by measuring the transgene integration rate through PCR analysis.

**[Results and Discussion]**

After *Agrobacterium* inoculation with immature embryos, callus induction was performed in a medium containing hygromycin antibiotic for 4 weeks. After the selection for 4 weeks, 1 callus in cv. Baekjung and 4 calli in cv. Jeokjung survived. For other varieties, callus induction was additionally performed for 4 weeks after subculture, but callus did not grow. The calli derived from cv. Baekjung and Jeokjung were transferred to the regeneration medium to induce shoots for 4 weeks. A total of 10 shoots were regenerated in cv. Jeokjung, but no shoot was regenerated in cv. Baekjung. Leaves were collected from the 10 putative transformants and used for PCR to confirm transformants. As a result of PCR analysis, 5 putative transformants derived from 2 calli showed a positive reaction. The transformation efficiency of cv. Jeokjung was 1.16% (2/172). The putative transformants were transplanted into the soil after root induction, and the copy number will be confirmed later through Southern blot. This study can be useful information for the development of the transformation system using Korean wheat varieties.

**[Acknowledgement]**

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PB-55

# Genome-wide Analysis of the F-box Protein Genes in Winter Crops

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**[Introduction]**
Genes of the F-box family play specific roles in protein degradation by post-translational modification in several biological processes, including flowering, the regulation of circadian rhythms, photomorphogenesis, seed development, leaf senescence, and hormone signaling.

**[Materials and Methods]**
HMM profiling of the F-box proteins was conducted with the HMM files of F-box (PF00646), F-box-like (PF12937), F-box-like2 (PF13013), FBA1 (PF07734), FBA2 (PF07735), FBA3 (PF08268), and FBD (PF08387) domains, against a protein database of the wheat, barley, and rye genome using the HMMER3 tool with default parameters. Genome wide transcriptome analysis of wheat, barley, and rye were performed under cold stress condition in seedling, and gene ontology and enrichment analysis of KEGG analysis were conducted by gene set enrichment analysis and KOBAS, respectively.

**[Results and Discussion]**
We have identified a total of 1796, 511, 1127 F-box genes in wheat, barely, and rye genome, respectively, and these F-box genes were further divided into various subgroups based on specific domains. Gene ontology, KEGG, and KOG analysis of F-box genes of winter crops were investigated. Transcriptome and digital expression analysis revealed differential expression patterns of F-box genes from winter crops. Though F-box genes from different species showed high sequence homology, the expressed pattern of them did not corresponded to cold stress condition. The genome-wide analysis of F-box genes provides new opportunities for characterization of candidate F-box genes and elucidation of biological roles in winter crop under cold stress responses.

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PB-56

# Efficient Determination of Genomic Variants from Sorghum Genetic Resources by HPC

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**[Abstract]**
In the digital age, a lot of agricultural R&D is based on data. However, genetic resources are still essential for basic research and agricultural development. Accordingly, many countries are making great efforts to secure various genetic resources. In Korea, the National Agrobiodiversity Center (NAC) has more than 270,000 plant genetic resources so far as part of its efforts. In order to efficiently use the resources for agricultural R&D, it is essential to determine the genotypes of the resources. For this, it is essential to build a system for mass genotyping. For this, sorghum were selected as a model crop considering the genome size, the high-quality reference genome, and the number of resources. To efficiently determine the genotype data from many genetic resources, we developed a GATK pipeline that works efficiently on HPC. The pipeline efficiently and rapidly determined 769 genotypes of 410 genetic resources. Going forward, our team will continue to work to determine genotypes of over a thousand sorghum resources, and the data will be released at the National Agricultural Biotechnology Information Center (NABIC) in order to be used in agricultural R&D.

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**PB-57**

# Constructing Reference Transcriptome Sets of *Codonopsis lanceolata*(Deodeok) and *Ixeridium dentatum*

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**[Abstract]**
As the aging population increases and interest in well-being increases, the importance of developing special crops increases. Natural medicine based on the special crops has been mainly used as an adjunct therapy for many diseases and symptoms based on culture, traditional medicine, and experience. In particular, it is attracting attention as a new resource to develop new drugs such as Artemisinin, a treatment for malaria. In order to efficiently use crops, it is essential to establish omics data such as genomes, transcriptomes, and metabolites of special-purpose crops. However, many special-purpose crops have large, heterogeneous and polyploid genomes that require high cost and long time to reference genome sequencing. Therefore, we built an inexpensive, fast, but very useful reference transcriptome as the first step. We constructed high-quality reference transcriptom sets of *Codonopsis lanceolata* and *Ixeridium dentatum* with PacBio data. Our team will continue to construct reference transcriptoms of more special-purpose crops, and the data will be released by the National Agricultural Biotechnology Information Center (NABIC) in order to be widely used in agricultural as well as medical R&D.

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PB-58

# Single-trait GWAS of Leaf Rolling Index with the Korean Rice Germplasm

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**[Abstract]**
Leaves are an important organism for photosynthesis and transpiration. The shape of leaf is crucial factor affecting plant architecture. V-shape leaf rolling is enhancing canopy photosynthesis by increasing the $CO_2$ penetration and the light capture by reducing the shadow between the leaves. Therefore, moderate leaf rolling is thought to more high grain yield per area than flat leaf. We investigated 278 KRICE_CORE accession's Adaxial Leaf Rolling Index (LRI) in first heading using the following equation.
For each accession, genomic DNA was used for sequencing. We sequenced the genomics with ~8 X coverage to detect SNPS. Raw reads were aligned against the rice reference (IRGSP 1.0) for SNP identification and genotype calling. To generate genotype data for GWAS, SNPs were filtered with minor allele frequency 0.05. Finally, 841,134 high-quality SNPs were used for our GWAS.
The significant threshold was -log10(P) > 7.23. From the results, 2 significance SNP were detected. Considering the LD block of 250kbp, 60 candidate gene were selected including Hypothetical gene and Conserved gene. In this poster, we analyzed candidate gene affecting adaxial Leaf Rolling through single-trait GWAS.

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PB-59

# Comparison of Characterization of Yield and Browning of Potato breeding Lines for a New Variety in Single Cropping

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**[Introduction]**

Domestic Potato*(Solanum tuberosum L.)* production was around 0.56 Mt, and the 'Sumi' variety that occupies 65~70% of cultivation area in Korea was 'Sumi'. Recently, production and quality in 'Sumi' was decreased due to high temperature and drought environments. The browning by peeling or cutting in 'Sumi' progresses rapidly, and it was insufficient for a fresh cut. it is necessary to breed varieties with adaptability to environmental stress and good fresh cut quality.

**[Materials and Methods]**

We carried out preliminary(PYT) and replicated yield trials (RYT) using spring and summer cultivations in each trial in Gangneung(8m) and Pyeongchang(770m) fields of the HARI. We used 17 lines in PYT and 10 lines in RYT in 2021 and used 'Sumi' for Control. the breeding lines were cultivated according to standard cultivation by cropping seasons. 10 plants per line were harvested after 100 days after planting and evaluated for production(Tuber weight per plant(g/plant), etc), and physiological disorder (Growth crack, etc). it was measured Hunter's value(L, a, b) of browning over time after grinding(0, 1, 3, 6 h) using a colorimeter (CR400/410, Konica Minolta, Japan) for fresh cut quality

**[Results and Discussion]**

We evaluated potato breeding lines in PYT and RYT in 2021. 'S17005-2' and 'S17033-1' were selected in PYT, and the tuber weight per plant of these lines was 715.7g/plant and 734.8g/plant. The Physiological disorders rate was lower, and Hunter's L value of 6h after grinding in 'S17005-2' and 'S17033-1' was 46, and 52, higher than 'Sumi'. Tuber weight per plant of 'S16004-7' was selected in RYT was 924.1g/plant, similar to 'Sumi'. But this line had a good fresh cut trait that browning is slower than 'Sumi' after grinding. The breeding lines selected in PYT and RYT in 2021 are being evaluated in the RYT and regional adaptability field test in 2022. It was expected to have new varieties with good production and fresh cut trait.

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PB-60

# Discovery of SNP Related to Salinity Stress on Heading Stage in the Korean Wheat Core Collection by GWAS Analysis, Comparison of Culm Length on Kongju National University Field and Reclaimed Land

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**[Introduction]**
Due to global warming, the temperate climate has been changing to a subtropical climate in South Korea. Also, drought and torrential rains occur from spring to summer due to climate change. The representative varieties of Korea were early mature wheat, and most of them are harvested before about the middle of June. It is considered important because abiotic stress negatively affects flowering and ripening stage, the plant decreased seed potential. In order to cope with these circumstances, we explored the Koran wheat core collection for salt stress resistance and calculated the difference between what culm length of Kongju national university field (KNU field) and reclaimed land.

**[Materials and Methods]**
Phenotype data that core collection was evaluated chlorophyll, soil EC and pH, have treated on salt stress and control. And culm length was measured from wheat grown in KNU field and in reclaimed field. For genotyping, a total of 22,775 SNP probes that the 35,143 SNP markers were removed using Beagle v5.2. were sorted to minor allele frequencies < 0.05 and missing data > 10%. GWAS estimated the associated SNP locations for analyzed phenotype and genotype data by using FarmCPU that statistical model of the GAPIT.

**[Results and Discussion]**
Accession number 165 (Milyang 22) was selected as the best growth resource at high chlorophyll content on salt treatment and resource is belong to highest 30 accessions at ratio culm length. In reproductive stage, 3 SNP codes (AX-94645681:chr5D / AX-94871926:chr6D / AX-94788541:chr1B) were selected candidate transcript location by GWAS for salt stress. In the future, exploring SNP related to culm length for GWAS at ripening stage.

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PB-61

# Transcriptome and proteome Co-profiling of Molecular Mechanisms of Pre-harvest Sprouting (PHS) in Common Wheat (*Triticum aestivum* L.)

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**[Introduction]**

Wheat (*Triticum aestivum* L.) is mankind's major food crop consumed worldwide. Food security is emerging issue due to the abnormal climate and global economic instability. In particular, pre-harvest sprouting (PHS) reduces the value of wheat and is one of the abiotic stresses caused by frequent rainfall during the harvest season. The PHS trait in wheat has been studied for a long time. However, the mechanism of PHS is not clearly understood. In this study, molecular mechanisms under PHS were analyzed in two Korean cultivars, 'Keumgang' (PHS-sensitive) and 'Woori' (PHS-resistant). RNA-seq analysis was performed to identify the DEGs associated with the PHS response and tolerance mechanism. Proteomic analysis using LC-MS/MS analysis was also performed in 'Keumgang' and 'Woori' independently, to identify DEPs at the protein level.

**[Materials & Methods]**

The PHS experiment was performed by artificial rainfall treatment for 7 days on two cultivars, and samples were obtained before (K0, W0) and after (K7, W7) under PHS treatment. RNA-seq analysis was performed on an Illumina NovaSeq6000 platform (Illumina, CA, USA). And LC-MS/MS analysis was conducted using an UltiMate 3000 RSLCnano system and an Orbitrap Eclipse Tribrid mass spectrometer (Thermo Fisher Scientific, MA, USA). During the chromatographic separation, the mass spectrometer was operated in data-dependent mode, automatically switching between MS1 and MS2.

**[Results & Discussion]**

A PHS induction experiment was performed in two Korean cultivars. In the germination rate analysis, 171 out of 202 'Keumgang' seeds germinated, showing high PHS sensitivity (at 84.65%). On the other hand, in 'Woori', only 6 out of 206 seeds germinated, resulting in high PHS resistance(at 2.91%). A total of 13,154 differentially expressed genes (DEGs) and 706 differentially expressed proteins (DEPs) were identified in four comparison groups between the susceptible/tolerant cultivars. DEGs/DEPs functional annotation for each control group showed similar expression in 'spliceosome' and 'proteasome' related functions, showing an increase in expression by more than 70% in 'Woori' (W7) compared to 'Keumgang' (K7). This study suggests that differences in PHS sensitivity/tolerance may be related to 'spliceosome' and 'ubiquitin-proteasome', which have various effects in response to abiotic stress. In addition, co-profiling analysis between transcriptome and proteasome improved the reliability of transcriptome studies. Our findings contributed to improving basic information and understanding of the PHS mechanism in wheat.

**[Acknowledgement]**

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PB-62

# Transcriptome Analysis of Korean Wild Soybean (*Glycine soja)* Under Flooding Stress

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**[Introduction]**

The collection, research, and conservation of native wild species are essential researches for food security and increase in species diversity of crops. Soybean was domesticated and has been cultivated for a long time. Soybean breeding based on mendelian genetics has accelerated a decrease in genetic diversity. Soybean is exposed to flood stress due to intensive summer rains in Korea. *Glycine soja* is known as the origin of soybean cultivars and is widely found in East Asia such as Korea, Japan, and China. *G. soja* has a high genetic variation and is known to be very resistant to various biotic and abiotic stresses compared to cultivated soybeans. In this study, a high-throughput transcriptome analysis was conducted by applying water stress to *G. soja* through flooding treatment.

**[Materials and Methods]**

*G. soja* was germinated in a greenhouse environment and transplanted into pots with the same bed soil and moisture content. Flood treatment was performed for 7 days during V3 (third trifoliolate) period, and the control group did not receive any treatment. The top part of *G. soja* was sampled in 3 replicates, respectively, for the control group and the comparison group. Total RNA was extracted from all samples and used for RNA-seq. DEGs, GO, and KEGG analyses were performed. Additionally, the expression of candidate DEGs were validated by qRT-PCR.

**[Results and Discussion]**

A total average of 58,180,604 mapped reads including control were obtained from the shoots of *G. soja*, of which 61,010,639 (78-81%) were obtained in the flooding treatment. By performing DEGs analysis from the mapped reads, 524 up-regulated DEGs and 292 down-regulated DEGs were selected by cut-off based on log2FC > |2| and FDR < 0.05. GO and KEGG analyses were performed on the selected DEGs for functional annotation. Genes that can explain various mechanisms related to water stress were identified from the results of GO and KEGG analyses. The structural change mechanisms for cell wall expansion, alcoholic fermentation under anaerobic conditions, and aerenchyma development were high. In addition, qRT-PCR was performed by selecting the top 10 up-and down-regulated genes, respectively, from among the DEGs expressed by more than log2FC > |4|. Genes highly involved in flooding stress were identified. Through the above results, this study will contribute to improving the basic understanding of water stress resistance in Korean wild soybean and can be applied to cultivated soybeans.

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PB-63

# Haplotype-based Association Analysis of the Genes related to Biosynthesis of Isoflavone and Soyasaponin in Korean Soybean Core Collection

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**[Introduction]**

Soybean is important food resource because they contain a variety of secondary metabolites in addition to vegetable protein sources. The secondary metabolites are primarily composed of isoflavone and soyasaponin in soybean. The biosynthesis pathway of isoflavone and soyasaponin are well known, but the genetic factors for their biosynthesis regulation still needs to be further studied. We performed haplotype analysis, using re-sequencing data to detect mutation in Korean soybean core collection. The natural mutations identified their relationship with the content of secondary metabolites. The genotype grouping by haplotype analysis is expected to explain the change of the secondary metabolite content.

**[Materials and Methods]**

We performed haplotype analysis using re-sequencing data of Korean soybean core collection (424 samples). Twenty-six genes related to biosynthesis of the isoflavones (twenty genes) and soyasaponins (six genes) were selected for the haplotype analysis. The isoflavones and soyasaponins contents were analyzed using a UHPLC (Dionex Ultimate 3000, Thermo Scientific) instrument equipped with an Acclaim$^{TM}$ RSLC Polar Advantage II (2.2 μm, 2.1 mm×150 mm) column.

**[Results and Discussion]**

Natural SNPs of the twenty-six genes were identified in Korean soybean core collection. Some SNPs showed high correlation between the genotype and phenotypes (isoflavones and soyasaponins) by the haplotype based association analysis. In the case of soyasaponin, it was confirmed that the change in total soyasaponin content was significant according to the haplotype of the *CYP93E1* gene. The soyasaponin content of group1 ($Val^{361}$) and group2 ($Leu^{361}$) were 118.33 mg $kg^{-1}$ and 129.21 mg $kg^{-1}$, respectively, and the *p*-value was <0.05. The five genes were selected according to a significance test between isoflavones content and related gene haplotype. Non-synonymous mutations and indels in *GmCHS2*, *GmCHS9*, *GmCHR1*, *GmCHS2* and *GmCHR5* were closely related to total isoflavone content. The significant changes in the content of soyasaponin and isoflavone were confirmed according to the genotypes classified by haplotype analysis. The haplotype-based association analysis is expected to be used for the development of molecular markers and genes related to various secondary metabolites in soybean.

**[Acknowledgement]**

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PB-64

# Evaluation of Promising Population for Breeding High Lignan and Non-Shattering Sesame

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**[Introduction]**

Since sesame cultivation is highly dependent on human resources, it is difficult to supply and demand stably. So, the production and cultivation area of domestic sesame have been decreasing recently. Currently, most of the sesame consumption depends on imported products such as China and India, and there is no significant difference in quality from domestic sesame, so it is necessary to differentiate it from imported sesame seeds. Lignan is a representative antioxidant contained in sesame seeds and is known for various effects such as anticancer and anti-inflammatory. It is also important to develop shattering tolerance varieties that can be harvested by machine to reduce labor. Therefore, this study bred promising population to develop high lignan and shattering tolerance varieties, and evaluated the lignan content and shattering tolerance of each lines.

**[Materials and Methods]**

Geonbeak/YCS1809 (GXY), Miryang61/MSL16038-4B-30-1 (M61XMSL16038) and Miryang61/Miryang73 (M61XM73) were crossed in 2019. Geonbeak and Miryang61 have phytophthora blight resistance and high yield, YCS1809 and MSL16038-4B-30-1 are genetic resources with high lignan, and Miryang73 has a high lignan content and strong shattering tolerance. For the next two years, the generation progressed to F4 in the greenhouse, and the F5 generation was planted in the field. The lignan content of the F6 generation seeds was than analyzed by HPLC for 721 lines in the GXY, 343 lines in the M61XMSL16038, and 478 lines in the M61XM73. In addition, the high-lignan lines of M61XM73 were genotyped through KASP marker that could identify shattering tolerance.

**[Results and Discussion]**

As a result of the lignan analysis of GXY, M61XMSL16038, and M61XM73, the lignan content ranges were 1.2-14.2 mg/g, 4.6-17.3 mg/g, and 3.6-17.9 mg/g and the average were 7.3±2.26 mg/g, 9.9±2.49 mg/g, and 9.5±2.64 mg/g, respectively. All three cross combinations showed a normal distribution. For the cultivation of high lignan varieties, lines with a lignan content of 12.0mg/g or more were selected. So, 17 lines of GXY, 72 lines of M61/MSL16038, and 85 lines of M61XM73 were selected. In addition, as a result of analysis using the KASP marker that can determine shattering tolerance for 85 high lignan lines selected from M61XM73, 41 lines were evaluated as shattering tolerance. The selected lines with high lignan and shattering tolerance will be planted in the field in 2022 to evaluate disease resistance and yield.

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PB-65

## 북방지역 생태적응 춘파재배 밀 가공 용도별 품종 선발

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**[서언]**
농작물의 부가가치 향상 모델 개발은 남북한 교류 또는 통일대비 한반도 식량안보 강화와 통일비용 경감에 중요한 요소이다. 북한 북부 내륙 중산간 지대 및 동해안 청진이남, 서해안 남포이남 춘파재배지대 기상생태에 적응하는 가공용 적합 춘파적응 밀 품종을 선발하고 필요시 공급 가능한 생산-가공 체계의 구축을 위하여 접경 인접 지역인 연천지역에서 실험을 추진 하고, 그 중간 결과를 보고한다.

**[재료 및 방법]**
본 시험은 2020/21년 2개년간 접경지역인 연천지역에서 수행하였다. 시험재료는 1년차(2020)국내에서 2000년 이후 육성한 밀 34품종과 대비품종으로 중국 및 북한 육성 6품종을 대상으로 생태적으로 적응하는 17품종을 선발하고, 2년차(2021)는 이들 품종을 동일지역에서 생산력검정 예비시험 수준으로 생태적응성, 재배안정성 및 예비 수량성평가를 수행하고 가공용도별 적응성 검정결과를 종합하여 '조경' 등 9품종을 선발하였다. 3년차(2022)에는 선발된 9품종과 대비품종 등 12품종을 생산력 검정 수준에서 재배 안전성 및 생산성을 평가하였다. 파종시기는 2021-2022년은 02월 25일, 기타 재배방법은 국내 표준재배법에 준하여 실시하였다.
<시험장소 : 경기도 연천군 신서면 도신리 144-8 (38°10'14N, 127°6'2E, 해발고도 80m)>

**[결과 및 고찰]**
2021년 생태적응성, 재배안정성 및 수량성평가를 수행하고 가공용도별 적응성 검정결과를 종합하여 '조경' 등 9품종을 선발하였다. 이들 선발된 9품종과 대비품종 3품종 등 12 품종을 3년차(2022)에 동일 지역에서 재배안전성 및 생산성 평가를 추진한 결과를 요약하면 아래와 같다.
춘파재배 공시품종들의 출수기는 5/17~5/26, 성숙기는 6/22~7/6일 범위였으며, 조경, 조중, 백강, 황금이 숙기가 빠른 편이었고, 풍7과 길춘23은 숙기가 늦은 경향이었다. 간장은 45~83cm 범위로 풍7, 길춘23에서 키가 컸으며, 알찬은 가장 키가 작았다. 수장은 6.5~11.9cm로 풍7, 길춘23, 태중에서 11cm 이상으로 길었으며, 알찬, 조한, 황금에서 가장 짧았다. 수당립수는 34~54개로 풍7, 길춘23, 태중에서 50개 이상으로 많았음. 천립중은 32~50g으로 금강, 풍7, 길춘23, 조경, 백강, 태중, 황금에서 45g 이상으로 무거웠으며, 청계와 알찬에서 각각 32g과 36g 으로 가장 가벼웠다.
수량성은 219~430 kg/10a 범위로 대조품종 금강(333kg) 이상이거나 비슷한 수량을 보인 품종은 태중(430kg), 풍7(365kg), 황금(344kg), 길춘23(316kg) 이었으며, 조경, 청계, 알찬, 적중, 조중, 백강, 조한 품종은 상대적으로 수량이 적었다.

**[사사]**
본 연구는 농촌진흥청 공동연구사업(PJ01480603)의 지원에 의해 이루어진 결과로 이에 감사드립니다.

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PB-66

## 북한 서남부 평야지대 적응 가공용 벼 품종 선발

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**[서론]**
북한의 농작물 부가가치 향상 모델 개발은 남북한 교류 또는 통일 대비 한반도 식량안보 강화와 통일비용 경감에 중요한 요소이다. 그러므로 북한 서남부평야의 수양산 이남·북 지역 기상생태에 적응하는 가공용 특수미 품종을 선발하고 필요시 생산-가공 체계의 구축을 위하여 접경지인 강화도에서 실험을 추진하고 그 중간결과를 보고한다.

**[재료 및 방법]**
본 시험은 2000년 이후 국내에서 육성한 가공 특수미(찰벼, 유색미, 향미, 초다수성 등) 45품종과 중국과 북한 3품종을 대비로 북한 서남부 평야지역과 기후조건이 유사한 강화도에서 3개년간 수행하였다. 1년 차(2020)는 45품종을 대상으로 예비선발시험으로, 2년차(2021)는 1년 차 선발품종을 생산력검정예비시험수준으로, 3년 차(2022)는 2년 차 선발품종을 생산력검정시험수준에서 검토하고 있다. 이앙기, 재식거리, 시비 등 재배방법과 포장관리는 국내 표준재배법에 준하였다.
<시험장소 : 인천광역시 강화군 화도면 덕포리 (N37°37’35“, E126°27’22”, 고도 4m)>

**[결과 및 고찰]**
1년 차에는 출수기(8월1일~20일), 등숙기간(35~45일), 생육일수(10월초 수확 만한)를 선발지표로 북한 서남부 평야지대 적응 가능한 출수생태형을 가진 가공용 벼 ‘해평찰’ 등 17품종을 선발하였다. 선발된 품종의 2년 차 시험에서 주요 형질의 년차간 변이로 출수기는 6일 빨라졌고 간장은 6cm 길어졌다. 재배안전성, 수량성 및 가공연구진의 가공적성 성적을 고려하여 ‘해평찰’, ‘선향흑미’, ‘적진주찰’, ‘향미벼2호’, ‘남일’, ‘다산’ 등 6품종을 선발하였다. 3년 차에 이들 6품종을 대상으로 재배안전성 및 생산성 평가를 추진하고 있으며 현재까지의 시험결과를 요약하면 다음과 같다. 시험품종들의 금년도 평균 출수기는 8월 13일로 1년 차보다 1일 빨랐으나 2년 차보다 6일 늦었으며, 출수기 차이가 작은 품종은 ‘향미벼2호’(+1일)와 ‘다산’(+2일)등 인디카품종이었다. 시험품종의 등숙기간은 37일~50일로 대부분이 선발지표(35~45일)내에 속하여 수확만한기인 10월 초까지 안전하게 수확이 가능할 것으로 추정된다. 재배안전성은 선향흑미는 본답 초기에 적고가 발생하였고 성숙기에 도복이 일부 발생하였다. ‘향미벼2호’, ‘다산’ 및 ‘선향흑미’에서 최고분얼기에 흰잎마름병이 다소 발생하였다.

**[사사]**
본 연구는 농촌진흥청 공동연구사업(PJ01480603)의 지원에 의해 이루어진 결과로 이에 감사드립니다.

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PB-67

# Multi-environment Trial Analysis for Yield-related Traits of Early Maturing Korean Rice Cultivars

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**[Abstract]**
Genotype-by-environment interaction (GEI) refers to the comparative response of genotypes to different environments conditions. Thus, understanding GEI is a fundamental component for selecting superior genotypes for breeding programs. The significance of utilizing early maturing cultivars not only provides flexibility in planting dates, but also serves as an effective strategy to reduce methane emission from the paddy fields. In this study, we conducted multi-environment trials (METs) to evaluate yield-related traits such as culm length, panicle length, panicle number, spikelet per plant, and thousand grain weight. A total of eighty-one Korean commercial rice cultivars categorized as early maturing cultivars, were cultivated in three regions, two planting seasons for two years. The genotype main effect plus genotype-by-environment interaction (GGE) biplot analysis of yield-related traits and grain yield explained 70.02–91.24% of genotype plus GEI variation, and exhibited various patterns of mega-environment delineation, discriminating ability, representativeness, and genotype rankings across the planting seasons and environments. Moreover, simultaneous selection using weighted average of absolute scores from the singular value decomposition (WAASB) and multi-trait stability index (MTSI) revealed six highly recommended genotypes with high stability and crop productivity. The winning genotypes under specific environment can be utilized as useful genetic materials to develop regional specialty cultivars, and recommended genotypes can be used as elite climate-resilient parents to improve yield-potential and reduce methane emission as part to accomplish carbon-neutrality.

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PB-68

# Comprehensive Expression Analysis of Triterpenoid Biosynthesis Genes Using Pac-Bio Sequencing and rnaSPAdes assembly in *Codonopsis lanceolata*

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**[Abstract]**

*Codonopsis lanceolata* (*C. lanceolata*) has been widely used in East Asia as a traditional medicine to treat various diseases such as bronchitis, convulsions, cough, obesity, and hepatitis. *C. lanceolata* belonging to Campanulaceae contains bioactive compounds such as polyphenols, saponins, and steroids. However, despite the pharmacological significance of *C. lanceolata*, the genetic information of this plant is limited and there are few studies of its transcriptome. In this study, we constructed a unigene set of *C. lanceolata* using Pac-Bio sequencing. Furthermore, the reads generated from Pac-bio and Illumina sequencing were mixed and assembled using rnaSPAdes. All genes involved in the triterpenoid pathway, a major bioactive compounds of *C. lanceolata*, were searched from the two unigene sets and the expression profiles of these genes were analyzed. The results showed that lupeol, beta-amyrin, and dammarenediol synthesis genes were activated in the leaves and roots of *C. lanceolata*. In particular, the expression of genes related to lupeol synthesis was relatively high, suggesting that the main triterpenoid of *C. lanceolata* is lupeol. Transcriptome studies related to lupeol synthesis in *C. lanceolata* have been rarely reported. Lupeol has been reported to have pharmacological effects such as anti-inflammatory, anti-cancer, and anti-bacterial. This study suggests the importance of *C. lanceolata* as a lupeol producing plant.

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PB-69

# Application of Pac-Bio Sequencing, Trinity, and rnaSPAdes Assembly for Transcriptome Analysis in Medicinal Crop *Astragalus membranaceus*

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**[Abstract]**

*Astragalus membranaceus* (*A. membranaceus*) has traditionally been used as a medicinal plant in East Asia for the treatment of various diseases. *A. membranaceus* belongs to the legume family and is known to be rich in substances such as flavonoids and saponins. Recent pharmacological studies of *A. membranaceus* have shown that the plant has immunomodulatory, anti-oxidant, anti-cancer, and anti-inflammatory effects. However, knowledge of major biosynthetic pathways in *A. membranaceu* is still lacking. Recently developed sequencing techniques enable high-quality transcriptome analysis in plants, which is recognized as an important part in elucidating the regulatory mechanisms of many plant secondary metabolic pathways. However, it is difficult to predict the number of transcripts because plant transcripts contain a large number of isoforms due to alternative splicing events, which can vary depending on the assembly platform used. In this study, we constructed three unigene sets using Pac-Bio isoform sequencing, Trinity and rnaSPAdes assembly for detailed transcriptome analysis in *A. membranaceus*. Furthermore, all genes involved in the flavonoid biosynthetic pathway were searched from three unigene sets, and structural comparisons and expression profiles between these genes were analyzed. The isoflavone synthesis was active in most tissues. Flavonol synthesis was mainly active in leaves and flowers, and anthocyanin synthesis was specific in flowers. Gene structural analysis revealed structural differences in the flavonoid-related genes derived from the three unigene sets. This study suggests the need for the application of multiple unigene sets for the analysis of key biosynthetic pathways in plants.

**[Acknowledgement]**

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PB-70

# Variation of Soymilk Quality of Soybean Varieties Using Small-scale Evaluation Method

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**[Introduction]**
Soybean is mainly used as raw materials for processed foods such as tofu and soymilk in Korea. Since soymilk is a suspension from which the water-soluble solids of soybeans are extracted, the seed composition plays an important role in processing characteristics. In the previous study, we developed a method for processing soymilk with a small amount of soybean seeds. The purpose of this study was to investigate the variation of soymilk processing characteristics of domestic varieties using the method developed in previous study.

**[Materials and Methods]**
32 domestic soybean varieties were used to make soymilk. Soymilk was prepared in the following method; Firstly, soybean powder was made by grinding each soybean variety, and then soaked in water (v:v=1:12) and sonicated for an hour. After then, the residue was separated by centrifugation at a speed of 2,000 rpm for 2 minutes. Finally, the soymilk obtained after separation of residue was boiled in a water bath for 30 minutes. The soymilk made after residue separation was sufficiently cooled to 4°C, and then the volume and soluble solid content were measured. The yield of soymilk was calculated by dividing the volume of the produced soymilk by the amount of seed powder added (%), and the solid content was measured with a refractometer (brix). The solid content recovery rate was calculated by dividing the solid content remaining in the soymilk by the amount of seed powder added (%).

**[Results and Discussion]**
The soymilk yield was in the range of 1,095 to 1,170%, with ‘Taecheong’ showed the highest, and ‘Pungwon’ had the lowest yield. The solid content ranged from 5.3 to 6.2 brix, ‘Taecheong’ showed the highest content among the varieties, and ‘Shinhwa’ and ‘Socheongja’ showed the lowest. The recovery rate of solid content was found to be in the range of 59.6 to 72.8%, and ‘Taecheong’ was also found to be the highest among the varieties used in the study. Considering the results, the variety that showed the best characteristics for soymilk processing was ‘Taecheong’, which had the highest yield, solid content, and solid content recovery rate.

**[Acknowledgement]**
This research was supported by the RDA Agenda Project (No. PJ016054)

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PB-71

# QTL Analysis for Seed Protein Concentration in Soybean with two RIL populations

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**[Introduction]**
Soybean seeds having unique seed composition consist of approximately 40% protein, 20% oil, 35% carbohydrate and 5% ash. Among them, seed protein and sugar concentrations are important traits that affect the quality of soyfoods. Therefore many studies and breeding programmes have been conducted to find QTL related to protein and sugar concentrations and develop cultivars with high protein and sugar content. The objective of this study was to identify QTL related to seed protein and sugar concentrations using two RIL populations and high-density SNP markers.

**[Materials and Methods]**
A total of 426 lines and three parents from two RIL populations derived from crossing between 'YS2035-B-91-1-B-1' and 'Saedanbaek' (YS), and 'Saedanbaek' and 'Ilmi' (SI) were used for SNP genotyping and QTL analysis. The protein concentration was determined by the Dumas method using Rapid N Cube. The parents and RILs were genotyped using a 180K SNP chip array. Linkage map construction and QTL analysis were conducted using QTL IciMapping software V4.1.

**[Results and Discussion]**
Out of the total 180,375 SNP markers, 27,896 and 27,724 were polymorphic between the parents. After removing the redundant markers, a total of 3,443 and 2,329 markers were finally utilized to construct the linkage map construction. The linkage maps snapped a total length of 6,234 and 6,053 cM with an average of 1.87 cM and 2.85 cM. QTL for seed protein concentration were detected on ten chromosome (2, 3, 5, 8, 11, 13, 15, 17, 18, and 20) YS population and six chromosome (8, 9, 13, 15, 19 and 20) in SI population. The LOD values of the QTL ranged from 3.2 to 43.1, and PVE by QTL ranged from 1.7 to 49.6%. Among them, major QTL (PVE > 10%) were detected on chromosome 13, 15 and 20. Our results could be useful to further understand the genetic research on soybean seed composition and applied in breeding programmes.

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PB-72

# The change of *Phytophthora infestans* Populations in South Korea using Traditional Markers and Genome Analyses

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**[Abstract]**
Late blight, caused by the hemibiotrophic oomycete pathogen *Phytophthora infestans*, has been the most important disease limiting potato production worldwide. *P. infestans* undergo major population shifts in agricultural systems via the successive emergence and migration of asexual lineages. The phenotypic and genotypic bases of these selective sweeps are largely unknown but management strategies need to adapt to reflect the changing pathogen population. Here, we used molecular markers to divide the 86 South Korea isolates into six clonal lineages: KR_1_A1, KR_2_A2, SIB-1, US-11, SIB-1 like, and KR-2 like. We documented the emergence of a new lineage, termed SIB-1 like, and KR-2 like, and their rapid replacement of other lineages to exceed 35% of the pathogen population across South Korea. Genome analyses of the Korean *P. infestans* populations revealed extensive genetic polymorphism, particularly in effector genes. Importantly, SIB-1 like isolates carry an intact *Avr8* effector gene that triggers resistance in potato carrying the corresponding R immune receptor gene *R8* cloned from *Solanum demissum*. These findings point toward a strategy for deploying genetic resistance to mitigate the impact of the SIB-1 like lineage and illustrate how pathogen population monitoring, combined with genome analysis, informs the management of devastating disease epidemics. Further study is being done on pathogenicity of the SIB-1 like isolates on cultivated potatoes and changes in expression patterns of disease effector genes within the SIB-1 like isolates

**[Acknowledgement]**
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PB-73

# Fine Mapping of *Stv-b* derived Rice Stripe Virus Resistance Gene

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**[Introduction]**

Rice Stripe Virus (RSV) disease, transmitted by the leafhopper (SBPH; *Laodelphax striatellus*), is one of the major biotic constraints in rice production. Plants infected with RSV develop typical symptoms such as chlorosis, weak newly emerged leaves, white and yellow spots, streaks on the leaves, and necrotic and wilted leaves, and stunted plant growth. In the process, plants experience oxidative stress, which may lead to oxidative damage and culminate to programmed cell death (PCD), and eventually plant necrosis in severe epidemics. In this study, we used the rice variety Zenith that carries *Stv-b*, to examine novel RSV genes by fine mapping. For fine mapping, we employed a $BC_3F_2$ NILs population (n=659) derived from a cross between Zenith (donor parent, RSV resistant) and Ilpum (recurrent parent, RSV susceptible). The localization of $qSTV11^Z$ provides useful information that could be used for marker-assisted selection and developing genetic resources for rice breeding.

**[Materials and Methods]**

The population was developed in the experimental fields of the National Institute of Crop Science of the Rural Developmental Administration in Miryang, Korea. The $BC_3F_2$ NILs population (n=659) was used for fine mapping. The bioassay was performed using the method described by Kwon et al. (2012)

**[Results and Discussions]**

Mapping RSV-resistant quantitative trait loci (QTLs), *Stv-a*, *Stv-b*, and *Stv-bi* using various resistant varieties has so far revealed one RSV-resistant gene, *OsSOT1*. We narrowed downxd the position of $qSTV11^Z$ region that harbors *Stv-b* and covers a region of approximately 129kb between the InDel markers Indel9 and Indel8 using newly selected two separate lines (61005-1-78 and 61005-2-69). From this results, we could not conclusively determine whether Stv-b and Stv-bi are allelic or independent genes,

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**PB-74**

# DNA Sequence Variation of Candidate Gene for Salt Tolerance in Soybean Mutant

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**[Abstract]**
Soil salinity is a major factor that reduces crop yields. The amount of soil affected by salinity is about 83 million hectares (FAO 2000), which is increasing due to the effects of climate change. In soybean [*Glycine max (L.) Merr.*], nutritional properties such as protein, starch, and sucrose content together with biomass and yield tends to reduce due to excessive salt. As a result of QTL mapping using the 169 $F_{2:3}$ population from the KA-1285 (salt-tolerant) x Daepung (salt-sensitive) in a previous study, two major QTLs (Gm03_39796778 and Gm03_40600088) related to salt tolerance were found on chromosome 3. In this study, the CDS region of the Gmsalt3 gene was analyzed using the ABI 3730xl DNA Analyzer (Macrogen, Korea). The sequence of Gmsalt3 gene in KA-1285 was compared with Williams 82.a4.v1 and PI483463 (*Glycine soja*). Two transversions were found at exon6 in KA-1285 and PI483463. Currently, whole genome sequencing and variation analysis using the Illumine Novaseq 6000 machine (Illumina, USA) are in progress. The results of this study can provide useful molecular markers for the selection of salt-tolerant soybeans and can be used as basic data for future salt-tolerant gene research.

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**PB-75**

# Mapping of *qBK4*$^{T}$ Derived Bakanae Disease Resistance in Rice

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**[Introduction]**

Bakanae disease, caused by several Fusarium species, is a major threat to the productivity of rice across the globe. The incidence of this disease has been shown to increase, particularly in major rice-growing countries. Thus, the use of highly resistant rice cultivars offers a comparative advantage, such as being cost effective, and could be preferred to the use of fungicides. In this study, we employed a Genome-Wide As-sociation Study (GWAS) to investigate novel genetic loci associated Bakanae disease resistance using a population of 145 $BC_1F_{7:8}$ NILs derived from a cross between Ilpum × Tung tin wan hien1.

**[Materials and Methods]**

The experiments were conducted using a $BC_1F_{7:8}$ population (n = 145) derived from a cross between Tung Ting Wan Hien1 (bakanae disease resistant) and Ilpum (bakanae disease susceptible), and the resultant phenotype was used for QTL analysis. Rice bakanae disease pathogen, CF283, was mainly used inoculation and evaluation of disease was performed with the method of the large-scale screening method developed by Kim et al. (2014). Statistical differences between means were analysed using Duncan's multiple range test in SAS 9.4 program (SAS Institute Inc., Cary, NC, USA).

**[Results and Discussions]**

A localization of *qBK4*$^{T}$ was delimited at an approximate 324kb interval in the physical map between AX-116847364 (33.12 Mb) and AX-115752415 (33.44 Mb). Previous studies reported QTLs controlling Bakanae disease on chromosome 4 but different loci, such as qBK4.1 and qBK4_31750955. Therefore, this study provides new insights for R-gene-specific marker development, which could be useful for downstream Bakanae disease-resistant breeding and R-gene pyramiding. Further characterization of the R-gene would be helpful to unveil the mechanism underlying Bakanae disease resistance in rice.

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**PB-76**

# Transcriptome Profiling of Differentially Expressed Genes in Cowpea (*Vigna unguiculata* L.) Under Salt Stress

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**[Abstract]**
Cowpea [*Vigna unguiculata* (L.) Walp] is one of the most important grain legumes that enhance soil fertility and is well-adapted to various abiotic stress. Also, it is cultivated worldwide as a tropical annual crop, and the semi-arid regions are known as the main cowpea-produced regions. However, accumulation of soil salinity induced by low rainfall in these regions is reducing crop yields and quality. In general, plants exposed to soil salinity cause an accumulation of high ion chloride, which leads to the degradation of root and leaf proteins. In this study, we identified candidate genes associated with salinity tolerance through an analysis of differentially expressed genes (DEGs) in four cowpea germplasms with contrasting salinity tolerance. A total of 553,776,035 short reads were obtained using the Illumina Novaseq 6000 platform for RNA-Seq, which were subsequently aligned to the reference genome of cowpea Vunguiculata v1.2. A total of 9,806 DEGs were identified between NaCl treatment and control of four cowpea germplasms. Among these DEGs, functions related to salt stress such as calcium transporter and cytochrome-450 family were associated with salt stress. In GO analysis and KEGG analysis , these DEGs were enriched in terms such as the “phosphorylation”, “extracellular region”, and “ion binding”. These RNA-seq results will improve the understanding of the salt tolerance of cowpea and can be used as useful basic data for molecular breeding technology in the future.

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PB-77

# Development of Real-time PCR-based Molecular Markers to detect *A. cordata* that can be Mixed and Consumed in Processed *O. elatus* Medicine Products

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**[Introduction]**

The stems of the tree *Oplopanax elatus* and the roots of *Aralia cordata* have been widely used as medicines. According to the National Academy of Forest Sciences in 2019, *O. elatus* is an endangered species worldwide and is being sold at a higher price than *A. cordata*. However, the medicinal name and morphological appearance of *O. elatus* are like *A. cordata*, so there is a possibility that *O. elatus* mixed with impurities *A. cordata* may be sold. Therefore, DNA-based species-specific PCR markers are needed to differentiate these two plants to ensure consumer rights.

**[Materials and Methods]**

DNA-based real-time analysis molecular markers were developed to detect *A. cordata* mixed as an impurity in each *O. elatus* medicinal product. Species-specific primers were developed by selecting chloroplast genes such as *accD, rpoC2*, *atpB*, and *petB*. Ten commercial medicinal products used in the study were purchased from local markets. DNA obtained from commercial food was extracted using a CTAB-based DNA extraction method.

**[Results and Discussion]**

Developed primer sets were evaluated by efficiency and practicality test. The efficiency of each primer set ranged 90-110%. A linear correlation ($R^2$>0.99) was obtained between the crossing point values and log DNA concentration. We determined the Ct value of 10 pg of the target species as the cut-off line and the Ct value of all non-target species amplified later than this cut-off line. Then, we evaluated the compatibility of the designed species-specific markers using 10 commercial medicine products. As a result of the test, all species-specific markers detected only the target species. Therefore, we expect that the real-time PCR analysis of this study will be usefully used to distinguish between *O. elatus* and *A. cordata.*

**[Acknowledgement]**

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PB-78

## 국내 자생 물봉선속(*Impatiens* L.)의 항산화활성 및 생리활성물질 함량 차이 비교

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**[초록]**
물봉선속(*Impatiens* L.)은 일년생 또는 다년생 초본으로 우리나라에 5-7종이 분포한다. 물봉선의 화장품용 항산화제 및 천연 방부제로서의 유용성이 밝혀졌으며, 최근 항염, 항산화 등 생리활성에 대한 연구가 국내 자생하는 물봉선 및 노랑물봉선을 대상으로 수행된 바 있으나 이하 분류군에 대한 연구는 미비한 실정이다. 본 연구에서는 국내 자생하는 물봉선속 분류군들의 항산화 활성과 생리 활성물질의 함량을 분석하고 지역 간 분류군별 차이를 확인하고자 하였다. 따라서 국내 자생하는 물봉선속 분류군들의 항산화 활성을 검정하기 위하여 DPPH, ABTS, TPC, TFC 4가지 방법을 이용하여 분석하였다. 국내 자생하는 물봉선속 5분류군 가야물봉선(*Impatiens atrosanguinea* (Nakai) B.U.Oh & Y.P.Hong), 노랑물봉선(*Impatiens noli-tangere* L), 물봉선(*Impatiens textorii* Miq), 미색물봉선(*Impatiens noli-tangere* var. *pallescens* Nakai), 처진물봉선(*Impatiens furcillata* Hemsl)이 12개 지역에서 수집되었으며, 잎 추출물(70% 에탄올)에 대해 분석되었다. 물봉선속 분류군들의 잎 추출물의 DPPH 라디칼 소거 활성 검정 결과 가야물봉선(4.91 ± 3.00 mgAAE/g)이 가장 높았고 처진물봉선(1.77 ± 0.55 mgAAE/g)이 가장 낮았으며, ABTS의 경우 가야물봉선(3.14 ± 1.35 mgAAE/g)로 가장 높았고 미색물봉선(1.87 ± 0.16 mgAAE/g)이 가장 낮았다. TPC의 경우 미색물봉선(5.48 ± 1.05 ugGAE)이 가장 높았고 노랑물봉선(2.78 ± 1.98 ugGAE)이 가장 낮았으며, TFC의 경우 물봉선(0.70 ± 0.20 ugGAE/g)이 가장 높았고 노랑물봉선(0.45 ± 0.08 ugGAE/g)이 가장 낮게 나타났다. 수집지역별로는 각각 DPPH와 ABTS의 경우 노랑물봉선, TPC의 경우 가야물봉선, 노랑물봉선, 물봉선, TFC의 경우 처진물봉선이 지역별 차이를 보였다. 이번 연구 결과를 토대로 국내 자생하는 물봉선속 분류군 별 항산화활성과 생리활성물질 차이를 확인할 수 있었고 추후 유용 소재로써의 이용과 우수 개체선발에 도움이 될 것으로 사료 된다.

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PB-79

# Heat-sterility Resistance Effect of N22-derived Heat Tolerance QTL in the Genetic Background of *japonica* rice

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**[Introduction]**

Rice is one of the staple crop in the world and also Korea's major food crop. This study focused on developing heat-tolerance *japonica* rice line to prepare irregular high temperature due to future climate change. ABL(Advanced Backcross Line) was developed by crossing Korea's elite *japonica* rice cultivar "Saeilmi" as a recurrent parent, and heat-tolerant rice cultivar "N22" as a donor parent. MAS(Marker Assisted Selection) was conducted using DNA markers around the region harboring qHTSF4.1, a heat-sterility resistance QTL located on chromosome 4 derived from N22.

**[Materials and Methods]**

We sowed 12 seeds of 3 Saeilmi×N22 $BC_2F_5$ lines(donor parent: N22, recurrent parent: Saeilmi) and parental lines, Saeilmi and N22 on 72-hole seed box tray in triplicate. Plants that reached flowering stage was placed in thermo-gradient tunnel covered with PVC film for heat-stress treatment. High temperature above 38°C lasted about 30 minutes per day in the tunnel. Three plant sets were treated heat stress for 0, 4, 7 days each. 45 days after flowering, fertility of 6 panicles from each ABLs and parents was investigated.

**[Results and Discussion]**

The average fertility of Saeilmi was 20.7%, 13.6%, and 8.8% after 0, 4, 7 days of heat stress treatment, and fertility of N22 was 17.6%, 6.7%, 6.0% after same treatment of saeilmi. Ye et al.(2012) reported *qHTSF4.1*, the heat sterility tolerance QTL on chromosome 4 derived from N22 can be distinguished into tolerant type and susceptible type by detecting a SNP located on 17.69Mbp. By designing InDel markers on the region including the SNP, we could select heat sterility tolerant lines harboring N22-type *qHTSF4.1* in Saeilmi×N22 backcross population. SNABL3 and SNABL4 has N22-type *qHTSF4.1* and the average fertility range was 51.1~75.1%, 50.5~83.0% each, when treated heat stress for 0, 4, 7 days in flowering stage. SNABL2 has more narrowed N22-type segment on chromosome 4 harboring N22-type SNP on 17.69Mbp, and the average fertility 70.4~74.5%, after treatment of heat stress for 0, 4, 7 days. The three recombinant lines had improved heat tolerance in flowering stage even than heat stress tolerant parent N22. We suggest that the synerge effect between qHTSF4.1 from N22 and regional suitability of Saeilmi resulted increased heat sterility tolerant in progeny lines. Further study of the heat tolerance including background genotyping of the three ABLs is necessary to investigate the genetic reason and mechanism of heat tolerance induced by *qHTSF4.1*.

**[Acknowledgement]**

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PB-80

# Variation of Days to Heading and Association Study for Different Location of Some Rice Genetic Resources

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**[Abstract]**
Increased temperature caused by global warming has become a significant problem for the growth and production of crops. A high temperature has a direct or an indirect effect on crops, leading to a significant yield loss. The damage of a high temperature stress to rice depends on its developmental stage. In present study, we performed evaluate the heading date in different location, Yeoju and Miryang, during growth of Korean rice core set. The heading date for the 223 rice accession were evaluated in Yeoju City (37°23′, 127°57′) and Miryang City (35°50′, 128°72′) located on middle and southern part of Korea, respectively. The average temperature of a day was higher in Miryang during entire growth stage. Here, total 222 KRICE-Core set was analyzed by GWAS for the high temperature effect. GWAS results revealed the Chr07_26954556, a lead SNPs were significantly associated with delaying heading date of KRICE-Core set. Significance threshold was set with $6.0 > -\log10(P)$, and Cross-Validation (CV) error suggested an optimal K value of 5 for the population based on the lowest cross-validation error K = 5.

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PB-81

# Agricultural Characteristics of an Early-maturing, Multiple Resistant and High Quality Rice variety Cheolweon109

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**[Abstract]**
The outbreaks of blast, bacterial blight and viral diseases have been increasing in early maturing rice cultivating areas in the central northern regions, recently. As the occurrence of sudden insects pests and disasters increases due to global climate warming, it is urgent to develop a variety of disaster-tolerant, high-quality varieties in response. This study was carried out to elucidate the characteristics of early-maturing, high-quality and multiple disease resistant rice variety, Cheolweon109 that was adapted to cultivation in the mid-mountainous regions of the central northern regions. Cheolweon109 was derived from a cross between Suweon546, medium maturing variety, and Sangju44 which is early maturing and resistant to blast, bacterial blight and rice stripe virus. The heading date of Cheolweon109 was July 30, 3 days later than Odae. The culm length of Cheolweon109 was 79 cm, which was about 5 cm taller than Odae, and the ripening ratio was 85.1%, which was 10% higher than that of Odae. This variety had 5.54 MT/ha of milled rice productivity, which was 99% of the Odae. Although Cheolweon109 was tall, it was strong against lodging. It was strong against bacterial blight (K1, K2, K3 race), rice stripe virus, and the pre-harvest sprouting which rate was 2.4%. The appearance of the grains of rice was clean, the glossiness was 70.6, and the head rice ratio was 95.3% high. Because Cheolweon109 had superior disease resistance, disaster resistance, and high quality than Odae, it was expected that can be used to expand the diversity of early maturing and high-quality rice varieties in central northern regions.

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**PB-82**

# Epistatic Interaction Analysis of Two Dull Genes, *wx-mq* and *du1*, Affecting Amylose Content Using Nearly Isogenic Lines in Rice

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**[Abstract]**
Glutinous rice is a key grain quality trait occupying an important part during rice processing in most rice growing areas. Amylose content (AC) of rice determine eating quality which is one of the major traits in rice breeding program.
In this study, a gene pyramiding approach was used to introduce two dull genes, responsible for low amylose contents, for glutinous rice breeding using marker assisted selection (MAS). Two dull genes were located on chromosome 6 (*wx-mq*, AC:12.7%) and chromosome 10 (*du1*, AC:10.3%), respectively. To test whether these two dull genes have an epistatic interaction, we developed an $F_2$ population by crossing two nearly isogenic lines(NILs) harboring *wx-mq* and *du1*. Gene based marker and KASP marker were used to select NILs(NIL-*nor*, NIL-*wxmq*, NIL-*du1*, and NIL-*wxmq/du1*) from the F2 population. A two-way ANOVA revealed an epistatic interaction between the two genes in the F2 population. The mean of Amylose contents for NIL-*nor*, NIL-*wxmq*, NIL-*du1*, and NIL-*wxmq/du1* were 17.3%, 12.5%, 9.7%, and 7.2%, respectively. This interaction was confirmed by an analysis of NILs indicating that both genes are involved in the same genetic mechanism controlling amylose contents. This result will be useful for rice breeding related to amylose content.

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**PB-83**

# QTL Mapping for Protein Content Derived from a Cross between *oryza sativa* and Weedy Rice

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**[Abstract]**
Protein is a major nutrient of food and has long been studied for nutritional and utility value. Among them, rice protein is attracting attention because of its hypoallergenic characteristics and nutritional value.
Mutant DM225 with increased protein content was selected by EMS treatment on the weed rice Dharial. QTL analysis of Protein content was carried out using $BC_2F_2$ populations derived from a cross between “Hanareum2” as a recurrent parent and “DM225” as a donor parent. The protein content of populations was between 5~11%, with an average of 7.7%. To identify QTLs related to Protein content, 117 KASP markers(polymorphic ratio: 15%) showing polymorphisms between the parents were genotyped for the $BC_2F_2$ population. One QTL was detected between markers SK07_06 and SK07_10 on chromosome 7(LOD: 28.1). This QTL explained 71.4% of the phenotypic variance for Protein content. This QTL will be useful for protein-related rice breeding program.

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**PB-84**

# Improvement of Pre-harvest Sprouting Resistance in Korean *japonica* Varieties through a Precision Marker-based Breeding

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**[Abstract]**
Pre-harvest sprouting (PHS) on rice panicles is getting problematic in recent several years in Korea due to climate changes such as high temperature and more frequent typhoons during harvesting season. PHS negatively affects grain quality severely and also yield. Genetic improvement of Korean varieties (*Oryza sativa* ssp. *japonica*) through a marker assisted-backcross breeding (MAB) with the known PHS resistant genes must be one of ideal solutions. However, the final breeding products of MAB occasionally exhibit unwanted traits, especially the cross between genetically distant parents. This might be caused by linkage drag and/or presence of the gene-unlinked donor introgressions, resulting that the final products could not be released to the farmers. The major PHS resistance gene, *Sdr4* (*Seed dormancy 4*) originated from an *indica* cultivar, Kasalath was selected as a donor gene. In order to avoid unexpected phenotypes in the breeding products, we performed a precision marker-based breeding (PMBB) consisting of foreground, recombinant, and background selections (FS, RS, and BS) which aim to develop 'single small introgression lines' (~100 kb introgression). Korean varieties (Ilpum and Gopum) were crossed with Kasalath. We developed *Sdr4*-allele specific markers for FS and a set of polymorphic flanking markers near the *Sdr4* (-350kb and +420kb) for RS. To minimize linkage drag, the small introgression (< 125kb) containing *Sdr4* was selected in Ilpum background ($BC_2F_4$) through 1st RS with ~1,200 $F_2$ or $BC_1F_2$ plants (one side trimmed) and then 2nd RS with ~1,000 progenies from the 1st RS selected plants (another side trimmed). After RS, the selected lines were genotyped by using Infinium 7K SNP chip to detect other donor introgressions and the lines were backcrossed. Currently BS is on-going from the backcross-derived progenies with BS markers to remove residual introgressions. During the PMBB process, genetic effect of *Sdr4*-Kasalath allele was confirmed in Ilpum and Gopum backgrounds by PHS phenotyping using the segregating $BC_2F_3$ or $BC_1F_4$ materials. The *Sdr4* PMBB lines in Ilpum background (< 125kb introgression) will be valuable genetic resources to improve PHS resistance in modern popular temperate *japonica* varieties.

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PB-85

# Genome-wide Association Study for Flowering Date in Soybean Core Collection

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**[Introduction]**
Flowering date is one of the main agricultural characteristics and is closely related to latitude, photoperiod response, maturity, and yield. It is known that when soybeans are exposed to a long photoperiod after flowering, the R3-R6 phases are extended, and the number of seeds is increased. Currently, eight major genes have been identified in soybeans to be associated with flowering date, but their genetic factors for flowering are influenced by the ecological environment or multiple gene networks involved in biological processes. Therefore, we conducted a genome-wide association studies in consideration of the morphological characteristics of soybean to identify various genetic factors associated with flowering date

**[Materials and Methods]**
In 2021, 409 accessions (soybean core collection) were cultivated in the experimental field of NICS (National Institute of Crop Science), and the main agricultural characteristics such as flowering date, pubescent color, leaf shape, and growth type were investigated. The genome of the core collection was analyzed using Axiom®180k SoyaSNP. The markers associated with flowering were mapped using a linear mixed model, and candidate genes were identified within ±100 kb.

**[Results and Discussion]**
Soybean flowering date was found to be significantly affected by morphological characteristics ($p < 0.001$). The average flowering date of soybean varieties with gray pubescent, round leaf and determinate type was the latest with 41.5 days, and those with tawny, round leaf and indeterminate type had an earlier with 32.5 days on average. Therefore, two markers associated with the flowering date was mapped on chromosome 6 in consideration of the morphological characteristics, and candidate genes involved in transcription factor and O-fucosyltransferase were identified based on significant markers. In the future, these genes need to be verified through haplotype and functional analysis. These results are meaningful in that it tried to find the genetic factors associated with the flowering date in consideration of the morphological characteristics in soybeans.

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PB-86

# Impaired Root Hairs Development in a Glabrous Rice (*Oryza sativa* L.) Mutant Line

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**[Introduction]**

For several decades, rice breeding programs mainly targeted yield-related traits in part due to the increasing demand of rice for food following the growing population growth rate pattern. Of these traits, number of panicle per plant, number of spikelets per panicle, grain filling ratio, and thousand grain weight, as well as grain shape attributes such as grain thickness, grain width, grain length, and grain length–width ratio are the most studied. Recently, there has been a growing interest in exploring the interplay between genetic factors controlling major yield traits of rice under various environmental conditions. A number of reports suggest the existence of a correlation between the shoot and the root development. Roots are indispensable plant organs that allow the plant to acquire nutrients. Root hairs play an important role in delivering oxygen to the rhizosphere for soil microorganisms. During gas exchange, plants release oxygen to the root rhizosphere via aerenchyma, and by the same means they take up gases such as carbon dioxide ($CO_2$) and methane ($CH_4$), which are conveyed through the vessels and emitted to the atmosphere.

**[Materials and Methods]**

A set of rice mutant lines were grown at the experimental field of the National Institute of Crop Science, Department of Southern Area Crop Science, Rural Development Administration, Miryang, Korea. Plants were grown under normal rice cultivation season (in Korea) a regular fertilization regime was applied. Through visual observation and by physical hand touch, plants were evaluated for their potential differential phenotypes compared with the wild type (WT) Milyang365.

**[Results and Discussion]**

We identified a glabrous rice mutant line (529189) characterized by a smooth (hairless) adaxial and abaxial leaf surfaces. The preliminary phenotypic characterization revealed that the glabrous mutant had hairless spikelets (hull). In addition, the number of seeds per panicle of the 529189 mutant line was fewer than that of the WT Milyang365. Furthermore, the mutant showed reduced branching phenotype of panicles. Further observations of the root system revealed that the glabrous mutant line 529189 presented a root hairless-like phenotype compared with the WT. Moreover, both the mutant and the WT had differential grain shapes, length, width, and thickness. Roots hairs play a preponderant role in plant nutrient acquisition. They also contribute to the gas exchange between the shoot and the root rhizosphere. By the same means, GHGs such as $CH_4$ is conveyed by the plant through aerenchyma and vessels, and released to the atmosphere. In this regard, it is of paramount importance to explorer the interplay between genetic factors controlling root hairs development in order to comprehend the molecular mechanism underlying the possible relationship between root hairs development and gas exchange-mediated GHG emissions in agriculture.

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PB-87

# Development of Rainfed-adapted, Fertilizer-efficient Temperate Rice Varieties by *Pup1* Introgression

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**[Abstract]**
Water and phosphorus (P) fertilizer are two of the most critical inputs in rice cultivation. Under climate change scenarios and urbanization, irrigation and fertilizer are becoming limiting factors often leading to significant decrease in yield whenever supplied scarcely. It has been shown that the *Pup1* QTL confers tolerance to P starvation and improved early-stage root vigor in *indica* rice grown in the tropics. However, whether the QTL works in *japonica* rice genetic background grown in temperate regions remains to be elucidated. Here, we have introgressed the *Pup1* QTL into three temperate rice varieties MS11, TR22183, and Dasan using marker-assisted backcrossing and next generation sequencing. The selected lines all harbored the full *Pup1* QTL with recurrent parent genome recovery rates ranging from 66.5% to 99.8%. Evaluation of the introgression rice lines grown in South Korea under low inputs of P and water revealed early vegetative growth advantage relative to that of the recurrent parents. Under rainfed condition, *Pup1* introgression lines had yield advantage ranging from 7.2 to 19.9% and 24 to 26% in P non-supplied soil and P-supplied soil, respectively compared to that of the recurrent parents suggesting that *Pup1* confers enhanced yield under low P and water inputs in temperate rice genetic background grown in temperate climate. In terms of early vegetative growth, temperate *Pup1* introgression lines showed a similar trend on the extent to which *Pup1* promotes yield advantage in temperate rice in comparison with *indica* control *Pup1* introgression line IR64-Pup1.

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PB-88

# Development of Wheat breeding Resources for improving Metabolic Disorders and Replacing Imported Wheat

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**[Abstract]**
The increasing number of Westernized eating patterns based on wheat flour in Korea has led to an increase in the rate of diseases such as obesity and diabetes, which has become a social problem. Wheat consumption is increasing due to changes in eating habits, but domestic wheat has low price competitiveness and has stagnated recently, so it is necessary to secure new resources to differentiate from imported wheat. Resistant starch, a newly created resource in domestic wheat, can act as a prebiotic similar to dietary fiber in the body, inducing microbial changes in the gut and having beneficial effects on metabolic syndrome. Wheat research on resistant starch was carried out based on the breeding of high amylose. A genome-wide association study (GWAS) was used to perform SNP identification and expression analysis related to wheat amylose through phenotype and genotype. 561 wheat core collection gene sources were investigated for amylose content in wheat, and related genes were extracted and analyzed. In the GWAS analysis, the model formulas BLIMK, FarmCPU, GLM, MLM, and MLMM were used to derive results such as QQ plots and Manhattan plots through phenotypic data. Among these models, BLAST was conducted to find the association between the SNPs identified using FarmCPU and genes related to starch, and 15 were found. Using the identified markers, it becomes easier to develop and browse related wheat cultivars according to their amylose content.

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**PB-89**

# Screening of Possesing Developed Nitrogen Use Efficiency Haplotype Germplasm in Rice

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**[Introduction]**

The major greenhouse gasses in agronomic field are methane(CH4), nitrous oxide ($N_2O$)and carbon dioxide(CO2). Especially in rice paddy, methane and nitrous oxide are main greenhouse gasses. In rice paddy, methane is emitted on anaerobic condition by methanogens. Emitted grreenhouse gasses are 2$^{nd}$ of agronomic field duing rice cultivation about 28.2%. Kim et al. (2019) repoted that when reduce 50% of nitrogen fertilization on paddy, greenhouse gasses were decreased about 11.3%. However, it is hard to encourage reduce fertilization to farmer because if reduce fertilization. rice yield is highly decreased. Therefore, this study screened germplasms using InDel markers and KASP markers having more efficient haplotype of nitrogen use effiencieny genes which were already reported.

**[Materials and Methods]**

Using reported genes that have mere efficient nitrogen use efficient haplotype, searched sequences using Rice genome annotation project and Oryzabase databases. Using searched physical position of SNPs, annotated on NCBI for match different cultivars which uploaded on database. Made KASP markers and InDel markers using that SNPs.

**[Results and Discussion]**

*OsNGR5*(Wu et al. 2020), *OsAAP6*(Peng et al. 2014), *OsARE1*(Wang et al. 2018), *OsABC1*(Yang et al. 2016), *OsNPF6.1*(Tang et al. 2019) are already reported genes. *OsNGR5* is inducing tiller on low nitrogen condition, *OsAAP6* is increasing efficeincy of metabolism of amino acid. *OsNPF6.1* is increasing nitrate uptake efficiency. *OsARE1* and *OsABC1* are increasing efficient of GS/GOGAT cycle. Using KASP and InDel markers, screened germplams, there is no germplasm that is *OsNGR5*, 93-11 and IR46 has *OsAAP6* SNP, Milyang23 and IR46 have *OsARE1* SNP, Suweon664 and Ganzaoxian58 have *OsNPF6.1* SNP, Milyang 315, Milyang334, IR46 have *OsABC1* SNP. We expect that make mitigated greenhouse gasses rice variety by increasing nitrogen use efficency and reducing fertiliation using this information

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PB-90

# Genetic Analysis of Wheat for Plant Height by RNA-seq Analysis of Wheat Cultivars 'Keumkang' and 'Komac 5'

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**[Abstract]**
One of the most widely grown food crops in the world, wheat, is increasing more lodged since for increased rains and winds caused by abnormal climate. During the Green Revolution, shorter wheat cultivars were bred using many *Rht* genes to increase lodging resistance. However, since only some *Rht* genes were used for breeding shorter wheat, it may have had a limited impact on wheat breeding and reduced genetic diversity. Therefore, it is essential to search for genes that have breeding potential and affect dwarfism in order to increase the genetic diversity of dwarf characteristics in wheat. In this study, we performed the RNA-seq between 'Keumkang' and 'Komac 5' ('Keumkang' mutant) to analyze the difference in plant height. Differentially expressed genes (DEGs) analysis and Gene function annotation were performed using 265,365,558 mapped reads. Cluster set analysis was performed to compress and select candidate gene DEGs affecting plant height, stem and internode. Gene expression analysis was performed in order to identify the functions of the selected genes by condensing the results of the DEG analysis into a cluster set analysis. This analysis of these plant height-related genes could help reduce plant height, improve lodging resistance, and increase wheat yield. Its application to wheat breeding will also affect the increased genetic diversity of wheat dwarfism.

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PB-91

# Phenotypic and Genetic Effects of Dwarfing Genes on Plant Height and Some Agronomic Traits in Wheat

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**[Abstract]**
Wheat is one of the most widely grown food crops worldwide. Extreme precipitation and wind disturbances increased due to the abnormal climate, which resulted in increased lodging. Introduction of dwarf genes in wheat significantly increased lodging resistance and productivity in wheat breeding. In this study, we performed the genotyping of dwarfing genes between 'Keumkang' and 'Komac 5' ('Keumkang' mutant). In addition, we investigated the relationship between plant height and several phenotypic characters using $F_2$ segregation populations derived from crosses between the two varieties. There was no significant difference in phenotypic characters between the two varieties except for plant height. In the genotyping analysis using dwarfing genes, mutations of two dwarfing gene were found to be induced between the two varieties. The four genotypes of the $F_2$ populations from a crossing between 'Keumkang' and 'Komac 5' were used to compare and evaluate the effects of two dwarfing genes. Plants with two single mutant dwarfing gene and double mutant dwarfing gene revealed reduced plant heights than control plants by 4.5%, 6.9%, and 33.2%, respectively. The phenotype analysis showed that double mutant dwarfing gene affected wheat stem growth as the length decreases from the second node, resulting in decreased plant height. However, there were no significant differences in the agronomic traits between mutant plants and control plant. These results may provide novel information about the effect of double mutant dwarfing gene on plant height, and may help improve lodging tolerance and wheat yield.

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PB-92

# Selection of Low Lignin-high Biomass Whole Crop Silage Rice Elite Line for the Improvements of Forage Digestibility and Fermentation

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**[Abstract]**
Lignin modification has been a breeding target for the improvements of forage digestibility and fermentation in whole crop silage(WCS) rice. In rice, gold hull and internode 2 (*gh2*) was identified as a lignin-deficient mutant. *gh2* exhibits a reddish-brown pigmentation in the hull and the internode is located on the short arm of chromosome 2 and codes for cinnamyl-alcohol dehydrogenase (CAD). To develop WCS rice variety improved digestibility and fermentation, we measured acid detergent fiber (ADF), lignin and total digestible nutrient (TDN) calculated from ADF (TDN=88.9-(0.79% × ADF) and performed marker-assisted selection using CAD(Os2g0187800) gene first intron region specific marker with 55 Jungmo1038/J.collection lines. Those lines had lignin content range from 0.82 to 6.61%, ADF from 15.8 to 45.8%, TDN from 52.7 to 78.8 compared to 'Jungmo1038'(1.53, 20.7, 72.6), 'J.collection'(0.98, 12.8, 78.8%) and *gh2* were introgressed into 44 lines. Considering on these genotype and low-lignin phenotype, we finally selected 2 elite lines(Suweon668, Suweon669). Suweon668 and Suweon669 line are high biomass-low lignin lines that the ADF content is relatively low, even though the dry matter weight is high. Also they have lodging and shattering resistance and glabrous leaf and hull important to improve cattle palatability. Our results will provide that rice can be improved for forage digestibility and fermentation with low lignin concentration.

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PB-93

# Cold Tolerance Characteristic Test of High Yield Tongil-type Rice Breeding Lines for Processing

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**[Abstract]**
Recently, the yield potential of high yield Tongil-type rice varieties has greatly increased, reaching 817kg/10a(Geumgang No.1). Moreover, in order to promote rice consumption and strengthen the competitiveness of the rice processing industry, the R&D of high yield Tongil-type rice varieties for each processing purpose, such as rice noodles, grain feed and industrial materials, has been continuously carried out. However, because Tongil-type rice varieties or lines are generally very vulnerable to cold damage, cold tolerance test can be said to be absolutely necessary to improve the cultivation safety. This study is the result of the seedling and field cold tolerance characteristic tests carried out in 2021 of high yield Tongil-type rice breeding lines. For the cold tolerance characteristic test of seedlings, total 303 high yield rice breeding lines for processing were treated in cold water of 13°C and irrigation depth of 4cm for 10 days from the third-leaf age, then it was evaluated by comparing the degree of discoloration and withering with the checked varieties(Boramchan, Hanahreum No.2). Also, for the test of field, total 186 high yield rice breeding lines for processing were treated in cold water of 17°C by keeping pouring day and night from 30 days after transplanting to ripening stage, then it was evaluated by comparing the degree of discoloration, delay of heading, shortening rate of stem length and percent of fertile grain etc. with the checked varieties. And the cold tolerance evaluative criteria were classified as strong(1~3), medium(4~6) and weak(7~9) in overall cold tolerance. (Seedling test) As for the degree of cold tolerance of the check variety, 'Boramchan' and 'Hanahreum No.2' showed a response of 'medium' and 'weak', respectively. However, there was no 'strong' line in the high yield rice breeding lines, 2 lines showed a 'medium' response, and 301 lines showed a 'weak' response. Therefore, except for a few lines(0.7%), most lines(99.3%) showed a 'weak' response. (Field test) In terms of the overall cold tolerance of the check variety, both 'Boramchan' and 'Hanahreum No.2' showed a 'medium' response. Similarly, there was no 'strong' line in the case of high yield rice breeding lines, 20 lines showed a 'medium' response, and 166 lines showed a 'weak' response. Therefore, except for some(10.8%) lines, most(89.2%) lines showed a 'weak' response. From the above results, we selected about 100 individuals with less seed shattering and degeneration of the ear tip, and with a relatively high percent of fertile grain, and are continuing to select lines with improved cold tolerance in the $F_4$~$F_5$ group in this year. As such, most of the Tongil-type rice varieties have poor cold tolerance and thus have low cultivation safety at low temperatures. However, it is important to select improved lines through generational progress because there are some lines that still have a certain level of cold tolerance among them.

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**PB-94**

# Grain Size Relate Gene in CNDH, and Identification Of Shape Based on QTL Mapping in Rice

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**[Abstract]**
Rice is 34% of the world's population used as a staple food. But the world population is increasing. Food security is not well protected. Improving cultivar development can address food security. Quantitative trait locus (QTL) mapping is a statistical analysis using both phenotypic and genotypic dates. The purpose of QTL mapping is to determine a gene. Increasing grain size is a way to increase yield in rice. Grain size-related genes were mapped using CNDH population obtained by cross-breeding Cheongcheong (*Indica*) and Nagdong (*Japonica*) through anther culture. Grain harvested from experimental field of Kyungpook National University in Gunwi in 2021. Genes related to grain length were detected between RM5964-RM12285, RM20924-RM20967 in chromosome 1, 7. LOD score is 5.88 and 5.6. Genes related to grain width was detected between RM289-RM18130 in chromosome 5. LOD score is 4.57. Genes related to grain length/width ratio were detected between RM5459-RM3482, RM5699-RM1211 and RM3838-RM3381 in chromosome 1, 2, 5. LOD score is 3.75, 3.14 and 3.41. 4 genes was detected in chromosome 1 and 2 genes was detected in chromosome 2 and 7 genes was detected in chromosome 5. 2 genes related to grain shape and quality were detected. 4 genes related to grain length were detected. 4 genes related to grain size were detected. 1 gene related to grain size and weight was detected. 2 genes related to grain length and weight were detected. By finding the gene related to grain size, it provides food to people threatened by food security and solves the food shortage.

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PB-95

# Identification and Functional Analysis of a Major QTL and Related Genes for Tiller Angle in Rice Using QTL Analysis

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**[Abstract]**
Tiller angle, defined as the angle between the main stem and its side tillers, is one of the main target traits selected inbreeding to achieve the ideal plant type and increase rice yield. Therefore, the discovery and identification of tiller angle-related genes can provide architecture and yield. In the present work, using QTL analysis hence a total of 8 quantitative trait loci (QTLs) were detected based on the phenotype data of tiller angle and tiller crown width in two years. Among them, four QTLs (*qTA9*, *qCW9*, *qTA9-1*, *qCW9-1*) were overlapped at marker interval RM6235-RM24288 on chromosome 9 with a large effect value regarded as stable major QTL. Twenty tiller angle-related genes were selected from the target region and the relative gene expression levels were checked in five compact type lines, five spreading type lines, and their parental lines. Finally, *OsSAURq9* which belongs auxin-responsive SMALL AUXIN UP RNA (SAUR) protein family was selected as a target gene. Overall, this work will help broaden our understanding of the genetic control of tiller angle and tiller crown width, and this study provides both a good theoretical basis and a new genetic resource for the breeding of ideal-type rice.

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**PB-96**

# QTL Analysis of Plant Height in Rice Using CNDH Population

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**[Abstract]**
Rice is a staple crop used by more than 50% of the world's population. However, in rapidly changing climates such as abnormal high temperatures and typhoons, the food security of rice is greatly threatened. Plant factories have the advantage of being able to grow crops regardless of climate change, so they can be a response to climate change. However, in plant factories, crops are grown by placing the culture bed vertically, so shorter crops are more efficient. Therefore, in order to search for genes related to the height of rice, QTL analysis was performed by investigating the plant height of Cheongcheong/Nagdong doubled haploids from 2017 to 2021. Plant height of rice investigated for five years showed a normal distribution, meaning that genes related to rice height are quantitative traits. As a result of QTL analysis, a total of 12 QTLs were detected, and QTLs overlapped for 5 years in RM12285-RM212 on chromosome 1. Also, The QTLs of plant height detected in 2019 has a LOD score of 17.64 in RM12285-RM212 region of chromosome 1. As a result of QTL analysis, 44 height-related genes were searched from the detected chromosomes, and among them, *Os01g0757200* in RM12285-RM212 on chromosome 1 region, named *OsGA2ox3q1*, were selected as genes related to the height of rice. The relative gene expression level of *OsGA2ox3q1* was highly expressed in cultivar with short culm lines, and was low expressed in cultivar with long culm lines. *OsGA2ox3q1* can be used to breed semi-dwarf cultivar in rice more efficiently.

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# Mapping Quantitative Trait Loci Associated with Arsenic Toxicity Stress in a Double Haploid Population of Rice (*Oryza sativa* L.)

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**[Abstract]**
Arsenic (As) is a toxic heavy metal that affects the major rice-growing regions of the world and can cause cancer in humans. Rice paddy fields in South Asia are mostly dependent on arsenic-contaminated water sources due to which rice takes up the arsenic from the soil through roots and accumulates it in plant different parts. Here, we present a quantitative trait locus (QTL) mapping study to find out candidate genes conferring As toxicity tolerance in rice (*Oryza sativa* L.) at the seedling stage. Three weeks old, 120 double haploid CNDH lines derived from a cross between the *Indica* variety Cheongcheong and the *Japonica* variety Nagdong and their parental lines were used by treating with 25 μM As. After 2 weeks of As stress, 5 traits such as; shoot length (SL), root length (RL), shoot fresh weight (SFW), root fresh weight (RFW), and chlorophyll contents (CHC) were measured. A linkage map of 12 rice chromosomes was constructed from genotypic data DH lines using 778 SSR markers. The linkage map covered a total genetic distance of 2121.7 cM of the rice genome with an average interval of 10.6 cM between markers. A total of seventeen QTLs (LOD>2) were mapped on chromosomes 1, 2, 3, 6, 7, 8, 9, 11, and 12 using composite interval mapping with trait-increasing alleles coming from both parents. Five QTLs for SL, Two QTLs for RL, Five QTLs for SHL, Three QTLs for RFW, and Two QTLs for CHC were detected. The QTLs related to CHC were selected for further study.

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# Molecular Identification and Fine Mapping of a Major Quantitative Trait Locus, *OsGPq3* for Seed Low-Temperature Germinability in Rice

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**[Abstract]**
Abiotic stresses such as high/low temperature, drought, salinity, and submergence directly or indirectly influence the physiological status and molecular mechanisms of rice which badly affect yield. Especially, the low temperature causes harmful influences in the overall process of rice growth such as uneven germination and the establishment of seedlings, which has become one of the main limiting factors affecting rice production in the world. It is of great significance to find the candidate genes controlling low-temperature tolerance during seed germination and study their functions for breeding new rice cultivars with immense low-temperature tolerance during seed germination. In this study, 120 lines of Cheongcheong/Nagdong double haploid population were used for quantitative trait locus analysis of low-temperature germinability. The results showed significant difference in germination under low different temperature conditions. In total, 4 QTLs were detected on chromosome 3, 6, and 8. A total of 41 genes were identified from all the 4 QTLs, among them, 25 genes were selected by gene function annotation and further screened through quantitative real time polymerase chain reaction. Based on gene function annotation and level of expression under low-temperature, our study suggested *OsGPq3* gene as a candidate gene controlling viviparous germination, ABA and GA signaling under low-temperature. This study will provide a theoretical basis for marker-assisted breeding.

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# Extrinsic Role of Gibberellin Mitigating Salinity Effect in Different Rice Genotypes

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**[Abstract]**
The overall effects of gibberellic acid (GA3) with NaCl on different rice genotypes are inadequately understood. The present study determines the effect of different GA3 concentrations on the morphophysiological, molecular and biochemical effects of 120 mM NaCl salt stress in rice seedlings. Salt stress reduced germination percentages and seedling growth and decreased bioactive GA content. It also downregulated the relative expression of α-amylase-related genes - *OsAmy1A*, *OsAmy1C*, and *OsAmy3C* in the salt-sensitive IR28 cultivar. Salt stress differentially regulated the expression of GA biosynthetic genes. Salt stress increased antioxidant activity in all rice genotypes tested, except in IR28. GA3 (50 and 100 μM) mitigates the effect of salt stress, rescuing seed germination and growth attributes. GA3 significantly increased bioactive GA content in Nagdong and pokkali (50 μM) and Cheongcheong and IR28 (100 μM) cultivars. The α-amylase genes were also significantly upregulated by GA3. Similarly, GA3 upregulated *OsGA2ox1* and *OsGA2ox9* expression in the Cheongcheong and salt-sensitive IR28 cultivars. The present study demonstrated that salt stress inactivates bioactive GA - inhibiting germination and seedlings growth - and decreases bioactive GA content and GSH activity in IR28 and Pokkali cultivars. Further, GA3 significantly reversed the effects of 120 mM NaCl salt stress in different rice genotypes. The current study also suggests if we know the coastal area water NaCl concentration we can apply the exogenous GA3 accordingly. Thus, we would be able to grow rice cultivars near the coastal area and reduce the rice damage by salinity.

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**PB-100**

# Breeding of Early Heading Date with High Yield Using CRISPR/Cas9 in Rice

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**[Abstract]**
Recent unpredictable climate change is a major cause of rice yield loss. In particular, methane is a key factor in global warming. Therefore rice breeders are trying to breed the reducing-methane gas emission rice using the crossbreeding method. However, the traditional crossbreeding method takes 8 to 10 years to breed a cultivar, and the anther culture method developed to shorten the breeding cycle also takes 6 to 7 years. On the other hand, CRISPR/Cas9 accurately edits the target trait and can rapidly breed rice cultivars by editing the target trait as a homozygous in 2-3 years. In addition, exogenous genetic elements such as *Cas9* can be isolated from the $G_1$ generation. Therefore, the flowering time was regulated by applying CRISPR/Cas9 technology, and *OsCK*q1 genome-editing (*OsCK*q1-G) rice with early flowered and high yield was bred in the field. Genome-editing of *OsCK*q1 applied CRISPR/Cas9 technology up-regulates the expression of the flowering promotion gene *Ehd1* under long-day conditions induces early flowering and increases the yield by increasing the 1,000-grain weight. And as the generations advanced, each agricultural trait indicated a low coefficient of variation. As a result, indicated that *OsCK*q1 plays an important role in regulating the flowering time and is related to the trait determining yield. Therefore, *OsCK*q1-G can suggest a breeding strategy for the Net-Zero national policy for reducing-methane gas emission rice by shortening the breeding cycle with the early flowered, and high-yield rice. CRISPR/Cas9 technology is a rapid and accurate breeding technology for breeding rice cultivars with important characteristics.

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PB-101

# Strategic Use of QTL Mapping to Improve the Palatability of Rice

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**[Abstract]**
The properties of starch play an important role in determining the palatability of rice. In addition, the gelatinization temperature (GT) of rice starch is an important factor in determining the quality of rice because it is related to the cooking time and texture of rice. For the development of high-quality rice, it is important to understand the genetic basis of palatability-related traits, and QTL analysis is an effective method to explain the genetic basis of variation in complex traits. QTL mapping related to alkali digestion value (ADV) of brown and milled rice was performed using the 120 Cheongcheong/Nagdong double haploid (CNDH) line. As a result, 12 QTLs related to ADV were detected, and 20 candidate genes were selected from the RM588-RM1163 region of chromosome 6 through screening by gene function analysis. The comparison of the relative expression level of candidate genes showed that *OsSS1q6* is highly expressed in CNDH lines with high ADV in both brown rice and milled rice. In addition, *OsSS1q6* has high homology with starch synthase 1 protein, and interact with various starch biosynthesis-related proteins, such as GBSSII, SBE, and APL. Therefore, we suggest that *OsSS1q6* identified through QTL mapping could be one of the various genes involved in the GT of rice by regulating starch biosynthesis. This study can be used as basic data for breeding high-quality rice and provides a new genetic resource that can increase the palatability of rice.

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**PB-102**

# *OsF3H* Gene Increases Insect Resistancy in Rice through Transcriptomic Changes and Regulation of Multiple Biosynthesis Pathways

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**[Abstract]**
In this study, we analyze RNA-seq data from *OxF3H* and WT at several points (0 h, 3 h, 12 h, and 24 h) after WBPH infection. A number of the genes were further validated by RT-qPCR. Results revealed that highest number of DEGs (4,735) between the two genotypes detected after 24 h of infection. Interestingly, many of the DEGs between the WT and *OsF3H* under control conditions were also found to be differentially expressed in *OsF3H* in response to WBPH infestation. These results indicate that significant differences in gene expression between the "*OxF3H"* and "WT" exist as the infection time increases. Many of these DEGs were related to oxidoreductase activity, response to stress, salicylic acid biosynthesis, metabolic process, defense response to pathogen, cellular response to toxic substance, and regulation of hormones level. Moreover, genes involved in salicylic acid (SA) and Ethylene (Et) biosynthesis were upregulated in *OxF3H* plants while jasmonic acid (JA), Brassinosteroid (Br), and abscisic acid (ABA) signaling pathways were found downregulated in OxF3H plant during WBPH infestation. Interestingly, many DEGs related to pathogenesis such as *OsPR1*, *OsPR1b, NPR1*, *OsNPR3* and *OsNPR5* were found significantly upregulated in *OxF3H* plants. Additionally, genes related to MAPKs pathway, and about 30 *WRKY* genes involved in different pathways were found upregulated in *OxF3H* plants after WBPH infestation. This suggests that overexpression of the *OxF3H* gene leads to multiple transcriptomic changes and impact plant hormones, pathogenic related and secondary metabolites related genes and enhancing the plant resistance to WBPH infestation.

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PB-103

# CRISPR/Cas9 is New Breeding Strategy for Improving Agronomic Characteristics of Rice Response to Climate Change

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**[Abstract]**
Rice is an important staple in the world. And drought is one of the important constraints that negatively affect yield loss and grain quality of rice. CRISPR/Cas9 is a new breeding strategy that can improve the characteristics of rice quickly and accurately. CRISPR/Cas9 is a novel approach that can reliably harvest rice yields in response to a rapidly changing climate. In addition, there is no externally inserted DNA left in genome-editing rice, and it is receiving attention as being able to take responsibility for future food because its characteristics are continuously improved. In the future, high levels of drought resistant in water-constrained environments will be required, which will reduce yield loss. *OsSAP* was genome-editing with CRISPR/Cas9 in rice. A different line number was assigned to each panicle, and the generation advanced by applying the ear-to-row method. Genome-editing rice has improved drought resistance in drought conditions. Also, in genome-editing rice, the target sequence was homozygous in the 0 generation, and the coefficient of variation of heading date, number of tiller, and 1,000-grain weight was very small in 2 generation. In the era of rapidly changing climate change, CRISPR/Cas9 presents a new breeding strategy that can rapidly and accurately improve agronomic traits of major food crops as well as rice. CRISPR/Cas9 is applied together with traditional breeding to develop into a new breeding strategy, it is suggested that food can be obtained stably in response to climate change.

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**PB-104**

# Profiling Metabolites Expressed Corn Root Under Waterlogging

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**[Abstract]**
Waterlogging tolerance of corn is one of the important factor for cultivate in paddy soil condition to increase cultivation area and self-sufficiency of corn in Korea. In order to develop elite waterlogging tolerance corn, the new corn lines bred by crossing wild corn, Teosinte, and cultivated corn inbred lines. Five accessions among the 2 species, *Zea mays sub* spp. *mexicana* and *Zea mays* spp. *parviglumis*, of 81 Teosinte were selected through the waterlogging treatment. The waterlogging treatments were implemented for 7 days at the seedling(V3) stage. The inbred lines were developed by crossing 5 teosinte accessions and cultivated corn lines and they were estimated waterlogging tolerance. It was screened and analyzed the metabolites extracted from roots of 19KT-32(KS141 x teosinte) that was treated waterlogging. We selected 8 of 180 metabolites like as $\gamma$-aminobutyric acid(GABA), putrescine, citrulline, Gly, and Ala that expression was remarkably changed over 2.5-times, 7 metabolites increased and 1 metabolite decreased in waterlogging, respectively. Glutamate decarboxylase(GAD) catalyzing GABA accumulation gene have 10 haplotypes, and exon1 was highly conserved, but identified to 135 SNPs after the first intron. Among the 135 SNPs, the number of transversion mutations (52) surpassed the number of transition mutations (38). Most of metabolites were related to abiotic stress in plant that it regulated to pH, osmotic pressure $K^{+}/Ca^{++}$ and ATPase activity. We are analyzing the association using these results for increase breeding efficiency.

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**PB-105**

# Powdery Mildew Resistance Phenotype Test & Genotype Test in *C. moschata*

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**[Abstract]**

Powdery mildew is known to be one of the serious diseases in C. moschata cultivation. Plants infected with powdery mildew cause damage to cultivation areas such as occurrence of deformity fruit and decrease in quantity. also, it has been reported that many farms have difficulties in controlling powdery mildew due to the outbreak under various conditions throughout the year. Therefore, this study intends to perform a phenotype test and a genotype test for C. moschata 60 lines grown in Jenong S&T. *Podospareaxanthii*, known as a pathogen that causes powder mildew disease in pumpkins in Korea, was collected and used as an inoculation source. phenotype test was performed by examining the infection area rate(%) of powdery mildew disease that occurred in leaves 25 days after inoculation. It was determined that 0% of the infection area rate was in the first stage, 1 to 5% in the second stage, 6 to 15% in the third stage, 16 to 30% in the fourth stage, and 31% or more in the fifth stage, The first and second stages were judged as resistance, the third as moderate resistance, and the fourth and fifth stages as sensitivity. As a result of the phenotype test, it was confirmed that the resistance was 21 points, moderate resistance was 14 points, and sensitivity was 25 points. After searching for the genes related to powdery mildew resistance resistance, *pm-0, CmbHLH87, and LOC111453072,* 21 points of resistance and 9 points of moderate resistance identified through phenotype tests were identified through gel electrophoresis after polymerase chain reaction(PCR) using 5 primers related to 3 genes. As a result of genotype testing of a total 30 points, the *CmbHLH87 and LOC111453072* gene were found to be resistant bands in all points, PMR1 was identified as 20 points for resistance, 4 points for moderate resistance, and 6 points for sensitivity, PMR2 was not identified in the entire band, and PMR5 was identified as 18 point for resistance, 3 points for moderate resistance, and 9 points for sensitivity. As a result, when comparing the phenotype test results and genotype test results, *CmbHLH87 and LOC111453072* genes was 100% consistent in resistance and moderate resistance, PMR1 was 95.2% in resistance, 44.4% in moderate resistance, and PMR5 was 90% in resistance and 33.3% in moderate resistance, PMR2 was not consistent in resistance and moderate resistance. Therefore, it is expected that more accurate PMR test will be possible by using molecular markers(PMR1, PMR5) and by developing *CmbHLH87 and LOC111453072* gene-related molecular markers.

**Keywords:** *C. Mostchata*, Powdery mildew, phenotype test, genotype test, *Podospareaxanthii*

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PB-106

# Comparison of Yield and Growth Characteristics of New Orchardgrass Lines for Pasture

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**[Introduction]**
Orchardgrass has good forage crop for productivity and permanence of pasture but its cultivation area has been reduced to pasture of Korea because of the effect of increasing temperature and irregular rain, Thus, in Korea, improvement of quality and adaptability in Orchardgrass is very important to increase the productivity and to expand the cultivation area. therefore, we bred a new Orchardgrass polycross three lines with high quality and permanence variety in Korea.

**[Materials and Methods]**
This study was conducted in the subtropical livestock research institute, National Institute of Animal Science, RDA, Korea. Orchardgrass Fve lines were sown in narrow strips in plots 2m by 3m in Randomized block design on 12$^{th}$ October 2021 in Jeju experiment field. Winter field survial was checked in early spring. Five Orchardgrass lines were harvested in heading time of variety for evaluating on fresh and dry matter productivity.

**[Results and Discussion]**
Plant height of composite 49 was 90 cm and heading date of composite 49 was on 29 April and showed high dry yield (10,745kg/ha) compared to check variety ‘Amba’(9,188kg/ha). Heading date of composite 49 was 3 days early than check variety ‘Amba’.

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**PB-107**

# Analysis of Gene-specific Molecular Markers for Biotic and Abiotic Stress Resistance in Tropically adapted Japonica Rice Varieties

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**[Abstract]**
Since 1992, the Rural Development Administration (RDA), Republic of Korea in collaboration with International Rice Research Institute (IRRI) has developed 6 japonica rice varieties(MS11, Japonica 1, 2, 6, 7 and Cordillera 4) that are adaptable to tropical regions. However, these varieties show moderate resistance or susceptibility to certain biotic and abiotic stress. The development of varieties with more stable forms of resistance is highly desirable, and this could be possibly achieved through rapid introgression of known biotic and abiotic resistant genes. In this study, we analyzed the allele types of major biotic stress resistant genes including *Xa5, Xa13, Xa21* and *Xa25* for bacterial leaf blight, *Pi5, Pi40, Pish* and *Pita2* for blast, *tsv1* for rice tungro spherical virus, and *Bph6, Bph9, Bph17, Bph18* and *Bph32* for brown planthopper by using gene-specific molecular markers. In addition, seed quality related genes *Sdr4* for preharvest sprouting and *qLG-9* for seed longevity were also analyzed. The results revealed that *Xa5* and *Xa25* resistance alleles showed in all varieties while *Pi5* resistance allele showed only in MS 11. The *Pish* resistance allele were present in five varieties except for Japonica 1. Meanwhile, for the rest of the genes, no presence of resistance alleles found in six varieties. In conclusions, most of tropical japonica varieties are lack of the major biotic stress resistant genes and seed quality genes (*Sdr4* and *qLG-9*). Moreover, the results indicated that rapid deployment of a few major genes in the current tropical japonica rice varieties is urgent to increase durability and spectrum of biotic stress resistance and also seed dormancy/longevity which are essential traits for tropical environments.

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PB-108

# Development of Wheat Breeding Material Mediated wide Hybridization Response to Climate Change

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**[Abstract]**
This study is to develop new wheat breeding material through wide hybridization with wild species harboring useful characteristics such as salt, heat, and drought tolerance. *Leymus mollis*, wild rye was used to improve wheat genetic quality. *L. mollis*, is a perennial plant harboring tolerance against salt, heat, and drought because *L. mollis* distributes on the seaside. The $F_1$ hybrids were produced by crossing between common wheat (*Triticum aestivum* L., Chinese Spring) and *L. mollis*. Genomic in situ hybridization revealed that the $F_1$ hybrids have *L. mollis* genome. For the evaluation of salt and drought tolerance, seeds from the $F_2$ were used. Under 2% NaCl solution, the $F_3$ wheat-*Leymus* addition plants with salt tolerance showed more tillering and longer roots than other $F_3$ plants without salt tolerance. Also, the $F_3$ plants with salt tolerance showed better shallow-rooted than other $F_3$ plants without salt tolerance. Finally, the $F_3$ plants with salt tolerance made seed-setting under 2% NaCl condition, but other $F_3$ plants without salt tolerance were not. Under drought conditions, the $F_3$ plants with drought tolerance showed longer culm and spike length than other $F_3$ plants without drought tolerance and even those of Chinese Spring under well-water conditions. We evaluated and selected the $F_3$ plants with salt or drought tolerance for generation advancement.

**[Acknowledgement]**
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PB-109

# Expression Patterns of SQS in Different Tissues in Amaranth Grains (*Amaranthus cruentus* L.)

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**[Abstract]**

To date, there have been no reports on the cloning and characterization of a gene encoding SQS from Amaranthus, although there have been some reports on methods of extracting and purifying squalene from Amaranthus seeds. In this study, we monitored the expression pattern of the amaranth SQS gene in seeds at different developmental stages and in different tissues. The transcript expression pattern of the SQS gene was investigated using total RNA isolated from seeds at different stages of development. There were low levels of SQS transcripts at the early stage of seed development, and the levels remained low until the middle developmental stage. The expression of SQS increased rapidly to reach a peak at the mid-late developmental stage, and then declined dramatically. This pattern of expression was consistent with the results of RT-PCR analyses. All RNA samples generated a fragment of the expected size (183-bp). The amaranth SQS was expressed at low levels during the initial to middle stages of seed development, and its expression level increased at the mid-late development stage. Also The tissue-specific expression of amaranth SQS was determined by quantifying its mRNA in total RNA isolated from the leaves, petioles, stems, and roots of seedlings at the four- and six-leaf stages. Using qRT-PCR and RT-PCR analysis, we detected amaranth SQS transcripts in some of the tissues at the six-leaf stage, but in none of the tissues from plants at the four-leaf stage. SQS transcripts accumulated in almost equal amounts in stems and roots, while a lower level accumulated in leaves and petioles during seedling development at the four- to six-leaf stages. This study provides useful information about the molecular characterization of the SQS clone isolated from grain amaranth. A basic understanding of these characteristics will contribute to further studies on the amaranth SQS.

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PB-110

# CRISPR/Cas9-targeted Mutagenesis of *Flowering Promoting Factor 1* Gene to Induce Brachytic Dwarfing trait in Tomato

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**[Introduction]**

Brachytic dwarfing (also known as brachytic or brachytic dwarf) is characterized by a shortening of only the internodes with little or no effect on other tissues and organs. Short plant height is especially beneficial for management practices in fresh-market tomatoes in the USA. Fruit size is an important standard in fresh-market tomatoes in the USA. Fruits greater than 5.715 cm in diameter are screened as marketable fruit. CRISPR/Cas9 system has been broadly used for CRISPR/Cas9-mediated genome editing in plants including tomato. To develop tomato with short plant height and no reduction in fruit size, brachytic dwarfing tomatoes were induced by CRISPR/Cas9-targeted mutagenesis.

**[Materials and Methods]**

Two gRNAs specifically targeting *flowering promoting factor 1* gene (*FPF1*, Solyc01g066980) were designed and two *Agrobacterium* strains containing gRNA1 or gRNA2 were prepared and used for *Agrobacterium*-mediated transformation. Mutants were identified by Sanger sequencing. Transgene-free mutants were screened by PCR using primers targeting *Cas9* gene or *hph* gene. Homozygous mutants were screened by analyzing chromatograms. Potential off-targets were searched using whole genome re-sequencing data. Homozygous transgene-free mutant lines with no off-target were grown in a greenhouse and tomato field at the University of Florida. Phenotypes, including internode length and fruit size, were investigated. In addition, two paralogues (Solyc01g066950 and Solyc01g066970) of *FPF1* were used for CRISPR/Cas9-targeted mutagenesis.

**[Results and Discussion]**

The mutation efficiency of gRNA1 and gRNA2 was 50% and 53.8%, respectively. We obtained 2 homozygous transgene-free mutant lines with no off-targets. On *FPF1*, *br.8.1*$^{CR}$ has a 7 bp deletion induced by gRNA1 and *br.8.2*$^{CR}$ has a 2 bp deletion induced by gRNA2. The mutant lines showed internode length reduction by 35.07% and 29.1% in *br.8.1*$^{CR}$ and *br.8.2*$^{CR}$, respectively. The *br.8.1*$^{CR}$ and *br.8.2*$^{CR}$ lines showed no remarkable reduction in fruit size, which is a typical characteristic of brachytic dwarfing. However, yield reduction was observed in both mutant lines (by 34.36% and 46.83%). In addition, we obtained Solyc01g066950 and/or Solyc01g066970 mutant lines. On Solyc01g066970, *br.7*$^{CR}$ has a mutation. On both Solyc01g066950 and Solyc01g066970, *br.57.1*$^{CR}$ and *br.57.2*$^{CR}$ have mutations. All the three mutants showed internode length reduction, and dosage effect was observed in *br.57.1*$^{CR}$ and *br.57.2*$^{CR}$. We developed a new plant material that contains an agriculturally favorable and an unfavorable trait simultaneously through CRISPR/Cas9-targeted mutagenesis.

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PC-1

# Comparison of Milling and Flour Quality Characteristics of Foreign Wheat and Korean Wheat

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**[Abstract]**

This study was investigated to compare the milling and physicochemical characteristics of six Korean wheat cultivars (Keumkang, KK; Jokyung, JK; Goso, GS; Joongmo2008, JM; Baekkang, BK ; Saekeumkang, SKK) and five foreign wheat classes (Australian standard white wheat, ASW; Australian hard, AH; US northern spring, NS; US hard red winter, HRW; Soft wheat, SW). Korea and foreign wheat grains were milled using a Buhler MLU-202. Flour moisture, ash, protein, gluten, sedimentation, particle size, solvent retention capacity (SRC) and dough properties of flour were analyzed. Results showed that the hard wheats had a greater total flour yield and reduction fraction yield than the soft wheats regardless of the country. However, there were in the milling characteristics between the US and Korean soft wheats. GS, a soft wheat in Korea, had the lowest flour yield (59.6%) and the highest bran fraction yield (21.4%). The particle sizes of flour by milling fraction were B1>B2>B3 for the largest, and the R1<R2<R3 for the smallest. Particle size, ash, protein contents and the values of lactic acid SRC showed highly correlated with flour yield. The gluten-performance-index (GPI) is the ratio of the lactic acid SRC value to the sum of sodium carbonate and sucrose SRC values, and it has been used as a quality indicator for overall performance potential of flour. GPI values differed depending on the wheat variety or class, JM (0.82) was the highest value, and SKK (0.56) and SW (0.59) were low. The curve pattern of the Mixolab result also gives a quality indication of the flour sample. JM and NS flour had similar pattern at water absorption and gluten strength parameters and BK and HRW had similar viscosity patterns. These results will enable further study for blending Korean wheat cultivar to improve the flour quality.

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PC-2

# Evaluation of Grain Zinc and Iron Contents of Wheat Germplasm

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**[Abstract]**
Wheat is the staple food crop in the word, but wheat products have a low bioavailability of iron and zinc. So in the developing world, where wheat is a staple food, it suffers from micronutrients deficiency. This study was conducted to generate wheat varieties with enhanced grain Zn and Fe contents. Sixty wheat resource were cultivated over 2 years (2019-2021) in the field of NICS, Jeonju, Republic of Korea, to identify agronomic traits. Wheat grains were ground using grinder and analyzed whole wheat flour protein contents and Fe and Zn contents using ICP-OES. The average contents of Zn and Fe grain were 4.6 mg/100g (2.4~8.8 mg/100g) and 4.5 mg/100g (2.4~7.9 mg/100g), respectively. The contents of Fe and Zn in the wheat grain had a positive correlation with the protein content of whole wheat flour, but there was no correlation with heading date (4.22~5.27) and the thousand kernel weight (21.3~ 57.5 g). Although there was year variation, six resources with high contents of Fe (>5.2 mg/100 g) and Zn (>5.3 mg/100 g) grain in 2 years were selected. These results provide information for selecting breeding materials for biofortified wheat, and further studies on germplasms genetic variations and bioavailability are needed.

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PC-3

# The Relationship between Hardness and Vitreousity of Korean Wheat Cultivars

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**[Abstract]**

Milling is an important process that determines the quality of flour and is affected by milling machine type, scale, and tempering conditions. In addition, seed hardness is an important factor in determining the amount of tempering water and has been reported to affects flour yield and flour quality. There are reports that vitreousity is used as a measure to distinguish between soft and hard seeds, and the higher the vitreousity, the higher the protein contents. However, there is no established system for measuring viterousity of seeds and studies on the vitreousity and quality characteristics of flour are insufficient. Therefore, in this study, vitreousity, hardness, and milling characteristics were evaluated for 46 major domestic varieties, and their relationship was confirmed. After cutting the seeds using a seed cutter, vitreousity was measured, and seed hardness and flour particle size was measured using SKCS and PSI, respectively. As for the seed hardness index, ‘Joa’ was the lowest with 11.6, ‘Yeonbaek’ was the highest with 78.7. As for the milling yield, ‘Saeol’ had the lowest at 58.1%, and ‘Hojoong’ had the highest at 88.6%. Seed hardness index and wheat flour production showed a high positively correlation, showing a similar to that of previous studies. Also, in flour particle size, ‘Gobun’ was the largest at 75.5 μm, and ‘Joa’ was the smallest at 43.1 μm. Flour yield and flour particle size showed a high positively correlation. As a result of vitreousity, ‘Hwangeumal’ (55.2%), ‘Saekeumkang’ (59.1%), ‘Baekkang’ (52.3%), ‘Goso’ (44.6%), and ‘Joa’ (19.2%) were showed. Seed hardness and vitreousity showed a high positively correlation. Also as the vitreousity increased, the flour yield also showed a tendency to increase. In addition, as the seed hardness increased, particle size of the flour yield also showed a tendency to increase. It is thought that this result can be used as a measure to determine the quality of flour with vitreousity. However, further analysis of wheat varieties and methods of analyzing vitreousity are needed.

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PC-4

# The Change of Arabinoxylan, Phytic Acid and Vitamin E Contents Whole Wheat Flour depends on the Millig Rate Milling Rate in the Korean Wheat Cultivar 'Saekuemkang'

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**[Abstract]**

Whole wheat is rich in dietary fiber and contains various biological activity substances such as arabinoxylan, phytic acid and phenolic compounds. However, excessive fiber contents of whole wheat has a negative effect on dough formation, making it difficult to process. In this study, we tried to improve the usability of whole wheat by suggesting an appropriate degree of purification of whole wheat from 'Saekeumkang', a domestic wheat cultivar containing protein and gluten suitable for noodle production. The contents of arabinoxylan, phytic acid, and vitamin E were measured in the polishing rate range of 5-20% of whole wheat flour. As the milling ratio increased, the flour properties improved. The arabinoxylan and phytic acid content of whole wheat were 67.95 mg/g and 0.87 mg/g, but when milled at 20%, arabinoxylan and phytic acid were 60% and 80% of whole wheat, respectively. And as the milling ratio increased, the vitamin E content tended to decrease (whole wheat: 4.063 mg/100 g, 20% milled: 2.96 mg/100 g), However, the vitamin E composition ratio did not change. On the other hand, α -tocopherol showed the greatest than other vitamin E isomers. Therefore, further studies needed to optimize milling rate to improve the final product while maintaining the approximate nutritional and functional value of the whole wheat.

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PC-5

# Screening Wheat Germplasm for high Amylose Content

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**[Abstract]**

Wheat (*Triticum* spp.) is an important source of food worldwide and the focus of considerable efforts to identify new combinations of genetic diversity for crop improvement. In particular, wheat starch composition is a major target for changes that could benefit human health. Starches with increased levels of amylose are of interest because of the correlation between high amylose content and elevated levels of resistant starch, which has been shown to have beneficial effects on health for combating obesity and diabetes.

In this study, high amylose wheat germplasms from other countries were collected and cultivated in Korea, and then the content of amylose was evaluated. we examined amylose content in 614 wheat germplasm. Furthermore, amylose content was validated using several milling processes such as roller, hammer, and grinding mill. As a result, the amylose content distribution was divided into five groups. The range of the amylose levels in whole wheat flour was 18.3% to 29.6%. In addition, the mutant lines were screened for high amylose, and two mutant lines (WX-1046 and WX-1074) exhibited a comparable amylose content to Keumkang whole wheat (19.6%). It has been established that high amylose indicated SS Ⅱa null and necessitate GBSS.

Based on these findings, it may be helpful to develop high amylose wheat germplasm and production techniques, particularly in Korea.

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PC-6

# Effect of Nutritional Difference between Soy Milk and Mung Milk on Fermentation

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**[Abstract]**
Dairy products are important diet source for human because of their balanced essential nutrients along with various vitamins and minerals. However, lactose in milk can result in diarrhea to some consumers with lactose intolerance. Soy milk has no lactose and is suitable as a substitute for diary milk in accordance with recent trend of replacing animal food with vegetable food. However, polysaccharides in soy milks are difficult for humans to digest, leading to flatulence. These polysaccharides can be decomposed into monosaccharides by lactic acid bacteria, and fermentation can improve food quality. Because mungbean has higher carbohydrate content than soybean, mung milk can be easily fermented than soy milk, resulting in vege yogurt with higher contents of lactic acid. In this study, fermentation characteristics of vege yogurt were analyzed with different ratio of soy milk and mung milk (0%, 25%, 50%, 75%, 100% and 0%+sucrose) and different fermentation time (0, 8, and 16 hours). In general, pH decreased as fermentation time increased. Overall, pH significantly decreased when the mung milk content in yogurt increased. All samples showed higher titratable acidity after fermentation and soy yogurt (mungbean 0%, 16 hours) with sucrose showed the highest value (6.825%). As fermentation time increase, viscosity increased. In 8 and 16 hours, mung milk yogurt (mungbean 100%) showed the lowest viscosity while soy milk yogurt (soybean 100%) with no sucrose showed the highest viscosity after 16 hours of fermentation. The contents of crude protein, crude fat and ash were measured for nutritional analysis. Soy milk (mungbean 0%, 0 hours) had the values of crude protein 2.9g, crude fat 1.8g, and ash 0.3g, and mung milk (mungbean 100%, 0 hours), showed the values of crude protein 1.7g, crude fat 0g, and ash 0.3g. To analyze the effect of the differences in the contents of nutrition between soy milk and mung milk on fermentation, the changes in sugar contents, and antioxidant capacity will be conducted depending on fermentation time. Our results will provide the information in researching plant beverages.

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PC-7

# Effects of Rain Frequency on Wheat Grain Quality After Maturity

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**[Introduction]**

Wheat (*Triticum aestivum* L.) is one of the most important cereal crop in Korea in terms of consumption. Double cropping including wheat following paddy rice is widely adopted in southern region of Korea, and this leads to wheat harvest coinciding with the rainy season in mid-June. High humidity and untimely rainfall trigger germination, by activating the enzyme α-amylase, which cleaves long starch chains in the endosperm into shorter pieces. However, relatively little information exists concerning wheat grain quality affected by rain after maturity. The objectives of this study were to evaluate the effects of rainfall frequency on grain quality in two Korean wheat cultivars.

**[Materials and Methods]**

In 2021-2022, a single field experiment was conducted in Dep. of Southern Area Crop Science, NICS, Miryang. Two wheat cultivars, Jokyong and Baekkang were planted in October 28 using broadcasting method(row width × row length of 150 cm × 120 cm, seeding rate of 16kg/10a). Spikes were harvested on May 31(control, after 29 days without precipitation), June 7(a day after 1$^{st}$ rain), 16(a day after 2$^{nd}$ rain), and air-dried until seed moisture content reached approximately 14%. Samples were threshed using a thresher and ground with a Buhler mill to pass a 2.2 mm sieve.

**[Results and Discussion]**

A decrease in the vitreous kernel rate was observed depending on rainfall frequency. Color differences between the samples were evaluated in individual parameters (L* a* b*), and in total color difference ($\Delta E^*_{ab}$), using Spectrophotometer. Values of the L* parameter increased from control to 2$^{nd}$ rain, showing that frequent rain after maturity affects the occurrence of chalky grain. The SDS-sedimentation volume was significantly decreased in the 2$^{nd}$ rain samples, compared with the control, whereas protein, gluten content, and falling number had no significant results. MPTi (Midline peak time) was increased, and MPV (Midline peak value), MPW (Midline peak width), MTxW (Midline time x=8 min width) were decreased as the rainfall frequency increases, showing that dough stability decreases as grain absorbs water after maturity. A scanning electron microscope (SEM) was used to examine the type A and B starch granules in the endosperm, and accumulation of large amount of starch granules and storage proteins were observed in the control. As rainfall frequency increases, starch granules were expanded and proteins were degraded. This result was coincide with wheat proteomic analysis study during seed germination(Dong et al., 2015). Although there are many studies related to pre-harvest sprouting, it is not suitable for the domestic situation. This study will be useful information for setting wheat quality standard in Korea.

**[Acknowledgement]**

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PC-8

# Multivariate Analysis of Agronomic Characteristics of Wheat (*Triticum* spp.) Germplasm

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**[Abstract]**
The purpose of this study was to evaluate agronomic characteristics and identify the useful traits to utilize the wheat genetic resources for breeding programs by understanding the phenotypic variation among germplasm through multivariate analysis. In this study, a total of 394 wheat accessions were characterized for 15 agronomic traits using the National Agrobiodiversity Center (NAC) descriptor list, of which 31 accessions from 6 species and 363 unidentified accession (*Triticum spp.*) available at the NAC, Rural Development Administration (RDA), Korea. Growth characteristics such as leaf width, culm length, spike length, spikelet length, solid stemmed, days to heading, days to maturity, grain-filing period, and also seed characteristics such as width, height, area, perimeter, circle, solidity, and germination percent were studied. Among the 15 agronomic characteristics, the germination percent showed the smallest variation between resources (CV = 0.4%), and the spikelet length (CV = 66.5%) showed the highest variation. A strong positive correlation was found between seed traits such as seed height and seed area (r = 0.90), seed height and seed perimeter (r = 0.87) and seed length and width (r = 0.80). Principal component analysis (PCA) was conducted and the first five principal components comprised 76.7% of the total variance. Among the first five PCs, PC1 accounted for 28.5% and PC2 for 20.0%. Wheat resources (394) were classified into four clusters based on cluster analysis, consisting of 215 resources(Ⅰ), 117 resources(Ⅱ), 48 resources(Ⅲ), and 14 resources(Ⅳ). Among the clusters, the resources belonging to Cluster III showed the lowest seed width, height, area, and perimeter characteristics compared to other clusters. The wheat resources belonging to cluster IV had small seed width and low germination percent, but took longer to form heads and mature than resources in other clusters. These results will serve as the basis for further genetic diversity studies, and important agronomic characteristics will be used for improving wheat, including developing high-yielding and resistant varieties to biotic and abiotic stresses via breeding programs.

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PC-9

# Changes in β-glucan Content of Oats according to Cultivars, Grain Filling Stage, and germination Conditions

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**[Introduction]**
Consumption of oat-based food is rapidly increasing due to consumer preference for functional foods. β-glucan is a soluble fiber that lowers the blood lipid concentration, the occurrence of cardiovascular disease and reducing the severity of stress ulcers and allergic reactions. This study examined the β-glucan contents according cultivars, grain filling stage, germination conditions.

**[Materials and Methods]**
The oat 4 cultivars (Daeyang, DY; Choyang, CY; Jopung, JP; Highspeed) used in the experiment were grown in the Suwon test field in 2014, 2016, and 2018, and the β-glucan content was analyzed using the β-glucan kit (K-BGLU, Megazyme, Ireland).

**[Results and Discussion]**
Total β-Glucan contents ranged from 3.4 to 4.1g/100 g in oat flours. The DY (4.10 g/100 g, naked) and JP (4.09 g/100 g, hulled) showed high levels of β-Glucan contents. β-Glucan content by grain filling stage (25-40 days after heading stage) were 2.7 g/100 g on the 25 days and then peaked at 40 days (4.59 g/100 g). During storage period after harvesting, β-glucan content of DY did not change until 63 days of storage; However, that of CY and JP increase slightly. β-glucan content of the seeds according to the germination time in the water spray treatment device (at 21°C) was the highest at 4.41~4.78 g/100 g when germinated for 24 hours. When the germination continued under different temperature conditions, β-glucan content was highest at 15°C (sprouts, 2.41±0.12 g/100 g; roots, 1.40±0.05 g/100 g, and seeds 1.24±0.06 g/100 g). Findings of the study will provide useful information in extending the use of oats for fiber-based food.

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PC-10

# Evaluation of Metabolite Contents and Antioxidant Activities Korean landrace Sorghum Germplasms

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**[Abstract]**

In this study, 139 Korean landrace sorghum germplasms collected in 10 different Korean regions were analyzed for tannin, total phenolic contents(TPC), and antioxidant activities using three assays including ABTS, DPPH, and FRAP. The Korean landrace sorghums showed significant variations of metabolite contents and antioxidant activities by collection regions. Gyeonggi sorghum had the highest tannin and TPC contents with 273.73%, 7.395mgGAE/g, respectively. Therefore, three assays of antioxidant activities of Gyeonggi sorghum, which is highly related to tannin and TPC, were also significantly higher than others. However, Gyeongnam sorghums showed the lowest tannin and TPC with 148.34% and 3.482mgGAE/g, thus, three antioxidnat activities showed the lowest levels. Three accessions(IT322580, IT340261 and IT329053) had the highest tannin levels over 400%, but, two accessions (IT322613, IT270366) showed less than 1% of tannin content. Four accessions (IT270349, IT286448, IT331878, and IT251882) showed the highest level of TPC over 9mgGAE/g. In this study, antioxidant activities with three assays were strongly related to tannins and TPC, and TPC showed higher significance than tannin with all three antioxidant activities. The germplasms with the highest overall antioxidant activity were IT270349, IT340261, and IT286448, which had the highest levels of tannin and TPC. The principal component analysis presented that 2 sub-populations were divided. Gyeonggi and Gangwon Yeongseo sorghums, which had high metabolite contents and antioxidant activity levels, were mainly included in group 1. Gyeongnam and Jeonnam sorghums, which had low metabolite and antioxidant activity levels, were mainly included in group 2. This results could contribute to discover breeding metarials for the development of functional sorghum varieties.

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PC-11

# Monitoring of Wheat Stored Product Insects According to Simultaneous Storage with Rice, Barley and Wheat in Storage Warehouse

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**[Introduction]**
In Korea, the self-sufficiency rate of domestic wheat (*Triticum aestivum* L.) is less than 1%, and in 2021, more than 4 million tons of wheat were imported from abroad. However, it is very unstable to rely on wheat supplies from abroad solely, as can be seen such as the recent surge in wheat prices due to the Russia-Ukraine war. In Korea, it is aim to increase the self-sufficiency rate to 5% or more. In order to increase the self-sufficiency of wheat, it is necessary to conduct research on post-harvest management along with improving productivity. As the first step to reduce damage during storage, this study was conducted to monitor and identify stored product insects that emerge during the simultaneous storage of wheat and rice in grain storage warehouse.

**[Materials and Methods]**
In order to monitor wheat stored product insects in the warehouse according to simultaneous storage with rice, barley and wheat, pheromone traps (IMM trap, LGB trap, dome trap) were placed inside and outside of the warehouse in Buyeo-gun, Chungcheongnam-do, Republic of Korea. The automatic temperature and humidity measuring device also placed inside and outside of the warehouse to measure temperature and humidity affecting ecological and behavioral characteristics of insects. Moreover, probe trap and temperature and humidity measuring device were placed into ton-bag which filled with wheat grain to monitor stored product insects inside wheat ton-bag.

**[Results and Discussion]**
*Plodia interpunctella* and *sitophilus zeamais* which feed on rice was monitored in the early aspect. After that, *Sitotroga cerealella* and *Cryptolestes* spp. were observed. In winter, as the temperature decreases, the number of stored product insects observed decreases, and the insects reappeared from April of the following year. In following year, as a similar aspect, *P. interpunctella, S. zeamais,* and *Cryptolestes* spp. were observed. *Cryptolestes* spp. was emerged inside the ton-bag which filled with wheat grain. However, after rice ton-bags were stored in the warehouse, the number of *S. zeamais* which in the wheat ton-bag was increased. This result demonstrated that the wheat ton-bag could be cross-contaminated by simultaneous storage with other grains in storage process.

**[Acknowledgement]**
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PC-12

# Soil Storage Seed Bank Longevity Prediction by Seeding Period

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**[Introduction]**
Cultivation of LMO crops is increasing worldwide. LMO crops are cultivated and distributed overseas, which causes a problem of unintentional release. In Japan and Canada, unintentional release of genetically modified canola near grain transport ports and transport routes has been reported. As the number of imports of domestic LMO crops increases, the cases of unintentional release are occurring. There was a problem with the unintentional release of genetically modified canola in Korea. In addition, cases of unintentional release are increasing with the discovery of genetically modified corn near the Incheon Port. A management manual is needed to prevent unintentional release. Therefore, this a study was conducted to predict the longevity of unintentionally released seeds.

**[Materials and Methods]**
The seeds were planted in the soil in spring and fall in three different regions of Korea: northern (Namyangju), central (Cheongju), and southern (Jeju). Canola, alfalfa, cabbage, and cotton seeds were sampled at intervals of one month after soil storage at a depth of about 5-7 cm to predict the longevity of ungerminated seeds. For the sampled soil-stored ungerminated seeds, germination experiments were performed using the ISTA (International Seed Testing Association) manual. Germination conditions were tested in a chamber at 20 °C (light/dark, 16h/8h) for canola seed, and at 25 °C (light/dark, 16h/8h) for other seeds.

**[Results and Discussion]**
The results of longevity expectancy analysis of seeds are as follows. The average number of days required to reduce the longevity of soil stored canola by 0.1% was 57 days in spring soil storage and 774 days in fall soil storage. Alfalfa seeds were predicted to have an average of 34 days in spring and 37 days in fall. Also, it was showed that cabbage seeds would take an average of 57 days in spring and 572 days in fall. And cotton seeds were expected as 42 days in spring and 57 days in fall. It suggested that the longevity of the buried seeds in fall was longer than that of buried seeds in spring. These results suggest that ungerminated seeds remain dormant due to the low temperature in winter, and their vitality remains. Therefore, it indicates that the monitoring period is longer if the seeds are unintentionally released during sowing or harvesting in the fall than the unintentionally released seeds during sowing in spring. If the LMO seeds are unintentionally released, it is considered that continuous and in-depth monitoring and treatment for loss of vitality of the seeds should be carried out together.

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PC-13

# Characteristics of high β-glucan resources quality of Barley

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**[Abstract]**
β-glucan, a nonstarch polysaccharide, is one of the main functional component in the cell wall of barley. This study was quality characteristics to use a korean variety with a high β-glucan as an original material for developing functional food. The high β-glucan 'Jeonju528' and 'Betaone' were compared with 'Hyeyang', 'Dahyang', 'Hwanggeumchal' and 'Glacier AC38' total 6 varieties. Seed section dyed to classify of Waxy/non-waxy type, starch granule was tested and moisture, protein, amylose, and β-glucan of whole grains and pearl barleys were experiment. Whole grains were the average protein of 13.2% and were the average starch 50.1%. β-glucan of whole grains were 5.3~10.0%, and amylose were 3.0~23.4%. Pearl barleys were the average protein of 11.7% and were the average starch of 65.0%. β-glucan of pearl barleys were 6.5~12.3%, and amylose were 3.6~31.1%. As a results of the correlation analysis were recognized significance among varieties for protein, starch and β-glucan but there was no difference in other traits. It was concluded that amylose showed a positive correlation with starch and β-glucan showed a negative correlation with amylose.

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PC-14

# Comparison of Antioxidant and yield Properties of of Adzuki Bean (Vigna angularis L.) Cultivars Under Different Air Temperatures and Sunshine Hours

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**[Abstract]**
This study investigated the antioxidant and yield properties of eight adzuki bean (*Vigna angularis*) cultivars under different mean temperature and sunshine hours in 2020 and 2021. The mean temperature in 2020 compared to 2021, which was normal, were lower during the pod extension and grain filling period. In addition, due to frequent rainfall during the vegetative period in 2020, there were fewer hours of sunshine compared to 2021.
The Adzuki Bean yield in 2020 was about 13% lower than that in 2021 due to the decreased number of pods per plant and 100 seeds weight. The stability of yields was higher in 'Hongda' and 'Hongjin' than in 'Arari', which is the most cultivated in Korea. Also, the yields of these varieties were all higher than those of 'Arari' varieties for two years.
Compared to 2021, in 2020, when weather conditions were not favorable, both antioxidant components and activity were higher. The cultivar 'Hongda' was a higher antioxidant component and activity than others for two years. The results suggested that the antioxidant component and activity were good in 2020 with about 13% decrease in yield compared to a normal year in 2021 due to mean temperature and sunshine hours.

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PC-15

## 오대산 백리향과 골든레몬타임 백리향의 형태적 특성 및 정유 성분 비교

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**[초록]**
백리향은 꿀풀과에 속하는 다년생 식물로 세계적으로 약 100여 종이 자생하는 것으로 알려져 있다. 우리나라에서 자생하는 백리향은 외국 허브인 타임(Thymus vulgaris)과는 형태학적 및 유전학적으로 다르나 시중에서 백리향과 타임 구분 없이 유통되고 있다. 백리향은 가지가 많고 포복성으로 자라는 특성이 있어 지피용 식물로 유용하고 독특한 향기를 지니고 있어 식품 및 향장품용 향료자원으로 활용이 가능하다. 또한, 우울증이나 불면증 등과 같은 신경성 질환 예방에 효과적인 것으로 알려져 있다. 본 연구에서는 국내 자생 향료 식물의 발굴 및 산업화 소재 가능성 검토를 위하여 토종 허브인 백리향을 오대산에서 수집하여 증식한 후 외래종 타임과 특성을 비교하였다. 백리향과 골든레몬타임의 유전형태 조사는 국립수목원 백리향 조사 요령을 참고하여 각 20개체씩 조사하였다. 조사 항목은 식물의 높이, 엽신의 형태와 길이 및 너비, 화서 길이와 마디당 꽃 수, 꽃의 길이 등이었다. 오대산 백리향의 식물 높이는 평균 14.3 cm, 엽신 형태는 난형, 엽신 길이는 1.24 cm이었고 꽃의 길이는 0.92 cm, 꽃 수는 35개이었다. 골든레몬타임의 식물 높이는 평균 18.03 cm, 엽신 형태는 타원형, 엽신 길이는 1.06 cm이었고 꽃의 길이는 0.59 cm, 꽃 수는 146개이었다. 백리향과 골든레몬타임의 정유 추출수율은 각각 0.22, 0.08%이었으며 추출된 정유를 GC-TOF의 SPME장치를 사용하여 분석한 결과, thymol, Caryophyllene, linalool, camphor 등이 향기 성분으로 검출되었다.

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PC-16

## 자색옥수수 수술 제거에 따른 속대의 안토시아닌 함량 비교

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**[초록]**
자색옥수수 색소 1호와 색소 5호는 강원도농업기술원에서 육성한 옥수수 품종으로 색소 1호는 2014년에 품종 등록되었고 색소 5호는 2021년 품종 출원되었다. 색소 1호와 색소 5호는 알곡은 노란색, 포엽과 속대에 짙은 자색을 띄는 색소 옥수수이며 포엽과 속대에는 안토시아닌이 고함량으로 집적되는 특징이 있다. 색소 1호 및 5호 종실용 옥수수는 포엽과 속대의 안토시아닌 함량이 알곡보다 풍부하고 영양성분이 적어 유효성분을 활용하는데 효과적이며 건강기능성식품 소재로 활용 가능성이 높다. 현재 포엽과 속대 추출물은 식약처의 고시형 식품원료로 등재가 완료되었으며 간 보호 인체적용시험을 진행하고 있다. 추후, 식품원료 및 건강기능식품으로의 사용처 확대에 따른 원료의 효율적인 생산 및 관리를 위하여 농가를 대상으로 시범재배를 수행하고 있다. 본 연구에서는 자색옥수수 추출물의 품질관리를 위하여 원재료인 속대를 대상으로 제웅과 무제웅 재배 시 속대의 안토시아닌 함량을 비교하였다. 제웅한 옥수수의 속대는 알곡이 맺히지 않았으며 수확 후 건조하여 분석 시료로 사용하였다. 반면, 제웅하지 않은 옥수수의 속대는 수확 후 건조하여 알곡을 제거한 후 분석 시료로 사용하였다. 두 형태의 건조 속대의 안토시아닌 함량 비교를 위하여 UV와 HPLC를 사용하여 총안토시아닌 및 지표성분 cyanidin 3-o-glucoside(C3G)를 각각 분석하였다. 분석결과, 제웅한 속대의 총안토시아닌 및 C3G의 함량은 각각 2.45, 0.19 g/100g이었고 제웅하지 않은 속대의 함량은 0.87, 0.11 g/100g이었다. 이러한 분석결과는 향후 자색옥수수의 고품질 원료 관리를 위한 기초데이터로 활용할 예정이다.

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PC-17

# Anti-Inflammatory and Enzyme Inhibitory Activities of Polyphenols from Peanut (*Arachis hypogaea* L.) Hull

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**[Abstract]**

Peanut hull as by-product has been discarded during peanut processing. However, peanut hull contains plenty of polyphenols that shows various physiological activities. The objectives of this study were to investigate anti-inflammatory and enzyme inhibitory activities of polyphenols from 'Sinpalkwang' peanut (*Arachis hypogaea* L.) hull. Compounds were isolated from methanol extracts of peanut hull by preparative-high performance liquid chromatography after identifying and quantifying polyphenols using Ultra performance liquid chromatography (UPLC) and UPLC-Quadrupole time-of-flight-mass spectrometry profiling. The structures of compounds were elucidated by one-dimensional [$^{1}H$, $^{13}C$] nuclear magnetic resonance (NMR) and two-dimensional NMR (correlated spectroscopy, heteronuclear single quantum coherence and heteronuclear multiple bond correlation). Three compounds were identified as 5,7-dihydroxy-4H-chromen-4-one (peak 2), luteolin (peak 4) and eriodictyol (peak 5). Significant differences in inflammatory mediator such as nitric oxide (NO), interleukin-6 (IL-6) and interleukin-1β (IL-1β) in lipopolysaccharide stimulated Raw 264.7 macrophages and in enzyme (xanthine oxidase [XO] and α-glucosidase [AG]) inhibitory activities were observed between three compounds ($p < 0.05$). Peak 5 treated Raw 264.7 macrophages showed lower content of NO (16.4 uM), IL-6 (7.0 ng/mL), and IL-1β (60.6 pg/mL) than peak 2 (NO: 28.3 uM, IL-6: 11.3 ng/mL, IL-1β: 66.9 pg/mL) and peak 4 (NO: 24.7 uM, IL-6: 9.3 ng/mL, IL-1β: 62.6 pg/mL). Peak 5 showed higher XO inhibitory activity (84.7%) and higher AG inhibitory activity (52.4%) than peak 2 (XO inhibitory activity: 45.4%, AG inhibitory activity: 21.6%) and peak 4 (XO inhibitory activity: 37.9%, AG inhibitory activity: 37.5%) at concentration of 0.5mg/mL. This study suggests that peanut hull could be a potential source of anti-inflammatory and physiological materials while creating new use of discarded peanut hull as by-products concomitantly.

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PC-18

# Analysis on Antioxidant Activity and Agronomic Characteristics of Extract from Smilacis Chinae Radix

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**[Abstract]**
The *Smilacis chinae Radix* refers to the root of *Smilax chinae L* distributed in mountain and filed of Korea, and it is a vine shrub in the Lilaceae family, called Berchemia berchemiaefolia, and is referred to as *Smilacis chinae Radix* in it's a natural medicine name. Antibacterial, inflammatory, and antioxidant activity were studied in *Smilacis chinae Radix*. In this study, biological activities such as antioxidant (DPPH, ABTs, TPC), cytotoxicity, wrinkle improvement, and whitening improvement to increase the utilization value of *Smilacis chinae Radix* and identify the botanical value. Therefore, we tried to explore the applicability of *Smilacis chinae Radix* as a functional cosmetic material. *Smilacis chinae Radix* (SCR) was dried and extracted with ethanol. In order to measure the biological activity of the SCR, antioxidant activity, inhibition activities of collagenase, tyrosinase and cell viability were measured. The DPPH (1,1-diphenyl-2-picryl hydrazyl) radical scavenging activity in the extract with a concentration of 400μg/mL is 91.22% ± 0.41%%. ABTs (2,2'-azinobis-3-ethylbenzothiazoline-6-sulfonic acid) radical scavenging activity in the extract with a concentration of 400μg/mL is 99.60% ± 0.03%. Total polyphenol contents (TPC) are 0.203 ± 0.05 mg GAE/mg Ext when SCR was 1mg/mL. And the Cell viability for HaCaT derived human keratinocyte and Raw264.7, a mouse-derived macrophage was determined using the MTT assay. When cell was treated with 100μg/mL of SCR, HaCaT cell showed cell viability of 78.09 ± 0.1% and Raw264.7 cell showed cell viability of 91.88 ± 0.42%. From the above results, we have shown the possibility that the CSR have antioxidant ability, inhibition activity of collagenase and tyrosinase and cell safety ability which can be useful in a functional cosmetic material.

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PC-19

# Characteristics Changes of Floury-type Rice depending on Water Immersion and Heat Treatment Time

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**[Abstract]**
In the production of rice flour, wet milling is a method of milling rice after soaking it in water, and it takes a lot of time and cost from milling to drying. To overcome this problem, the floury type rice was developed for dry milling and it is known to have round starch granules, low content of damaged starch after milling, and a starch structure similar to wheat. Because of its unique properties different from normal rice, it is necessary to research on processing and characteristics of floury-type rice to expand its utility in the food industry. Therefore, this study aimed to prepare the pregelatinized floury type rice (Baromi2) by autoclave and investigate their physicochemical properties. As the heat treatment time increased, the brightness decreased from 83.8 to 76.8, however, both redness and yellowness increased from 0.57 to 4.5 and from 14.58 to 21.13, respectively. Despite of same treatment time, soaking in water (10 min) before autoclaving increased the solubility and swelling power of Baromi2 over 2 times. The peak viscosity of native Baromi2 was over 2000 RVU, on the other hand, there was a significantly decrease to less than 1000 RVU of pregelatinized Baromi2. Heat treatment without immersion caused partial gelatinization of starch, resulting that some starch granules maintaining their integrity. Whereas there were no starch granules in heat treatment with soaking in water due to complete gelatinization. This study would be helpful to the suggestion of using heat-treated floury-type rice as an intermediate material in the food industry in the future.

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PC-20

# Soybean Cultivation, Environmental Big Data Collection, Data-base Farmhouse Consulting

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**[Introduction]**

Information and communication technology, big data, and artificial intelligence are rapidly developing in the 4th Industrial Revolution, and in agriculture, smart farms are spreading through these technologies, helping to improve the quality of life and productivity in agriculture. In addition, productivity improvement models based on crop growth, environment, and management data necessary for stable operation of smart farms are being actively developed. In recent years, smart agriculture has spread to alleys, and by using alley crop growth and irrigation, soil environment, and meteorological data, precision material management, meteorological disaster early warning systems, integrated control systems, midpoint irrigation models, pest prediction digital traps, etc.

In Buljeong-myeon, Goesan-gun, Chungcheongbuk-do, an open-air smart complex of 53 ha is formed. In this study, data were collected from 9 soybean farms in the open-air smart complex to develop a productivity improvement model and conduct data-based field consulting.

**[Materials and Methods]**

For agricultural big data collection, growth and soil environment data were collected by visiting soybean cultivation sites at 10-day intervals. For growth data, 30 weeks per farm were investigated for plant height, long length, light tare, number of main stem nodes, and number of branch nodes, and post-harvest investigations were conducted on light weight, tuberous weight, number of pods, protein content, fat content.

**[Results and Discussion]**

Based on the collected data, on-site consulting was conducted once every two weeks for each farm. By comparing and analyzing growth data for each farm, the current crop status was informed, and changes in soil temperature, moisture, and EC were identified to provide consulting tailored to farm household conditions, such as farm environmental management methods and decision-making favorable to farm management.

The results of the soybean growth survey in the Noji Smart Complex in Goesan showed that the average daytime plant height was 114cm, the length was 67.4cm, and there were three branches. It can be seen that the average number of main gorges was 39, and the number of branching gorges was 23. The soil environment averaged 20-23.8°C during the day and 19.9-23.1°C at night, and the soil moisture was 15.3-33.9%.

The collection and analysis of big data on soybeans will be the basis for not only developing a production improvement model, but also building an infrastructure that can manage and guide scientific farming, such as precision water management and operation of an integrated control system.

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PC-21

# Correlation Analysis between Azuki Bean Quality Characteristics and Sediment Yield

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**[Abstract]**

Azuki bean is the important bean crop in Korea, and is traditionally used as a filling material for red bean porridge, rice cakes, and bread, as well as for sediment. So far, the National Insititute of Crop Science has developed azuki bean varieties for various uses, such as for sediment, tea, and azuki bean sprouts. Among azuki bean elite lines, 25 strains were used to analyze the correlation between red bean quality characteristics and sediment yield. The crude protein of red beans was 25.0~28.9%, ash content was 3.8~5.3%, and fat was 0.4~1.0%. As for the appearance quality characteristics of azuki bean, one hundred seed weight was 11.1~19.5 g, the length of seed was 6.45~8.49 mm, the width seed was 4.84~6.45 mm, and the withd/lenght ratio was 0.72~0.89. When the azuki bean were boiled, the thickness of the seed coat was 0.14~0.27 mm and the length ratio of seed was 0.65~0.76 mm, showing that the length of seed was slightly larger than the width. The yield of azuki bean sediment was 239~284% for whole red bean paste, and 144~203% for fine azuki bean paste. As a result of analyzing the correlation between the quality characteristics of azuki beans, such as protein, husk and seed weight, and the yield of azuki bean sediment, the yield of whole azuki bean sediment showed a negative correlation with the seed coat thickness and the length ratio of the original grain at -0.62 and −0.45, respectively. The yield of fine sediment showed a negative correlation with the length ratio of whole azuki beans at −0.49, and a positive correlation with that of white beans at 0.41. However, protein and ash content did not show any correlation with sediment yield. In view of the above results, it is thought that it would be better to have a high seed weight or a low width/length ratio of seed to develope azuki bean cultivar for sediment.

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PC-22

# Nutritional Analysis of Purple Corn Husk Extract

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**[Abstract]**
Seakso 5, a maize hybrid, was applied for variety in 2021 by Gangwon Agricultural Research and Extension Services in Korea. This variety was bred to produce a purple extract of corn husk. It shows purple color in the husk and cob and contains abundant anthocyanins. In this study, to obtain basic data on purple corn 'Seakso 5' husk extract (PCHE), a husk extract was prepared and the contents of vitamins, amino acids and fatty acids were analyzed. The Seakso 5 husks were extracted with 30% alcohol and concentrated, after adding dextrin to the concentrate, it was spray-dried to prepare an extract. The PCHE were analyzed for vitamins, amino acids, and fatty acids by referring to the Food Code. As a result, three types of vitamins were detected, and their contents were vitamin $B_1$ 0.14 mg/100g, vitamin $B_2$ 2.30 mg/100g, and vitamin C 11.32 mg/100g. A total of 15 amino acids were detected in the PCHE, including aspartic acid and glutamic acid, and the content of aspartic acid was the highest at 3.02 mg/g. Simultaneous analysis of fatty acids Among 37 types, saturated fatty acids were palmitic acid (C16:0), stearic acid (C18:0), monounsaturated fatty acids were oleic acid (C18:1(n-9)), polyunsaturated fatty acids were linoleic acid(C18:2(n-6)c) and α-Linolenic Acid (C18:3(n-3)) were detected. Among the detected fatty acids, the content of palmitic acid was the highest at 40.75 mg/100g. In the future, These analysis results will be used as reference data for temporary food ingredient applications by the Ministry of Food and Drug Safety.

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PC-23

# Genetic Characteristics and Anthocyanin Content of Basil(*Ocimum basilicum* L.)

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**[Abstract]**
Basil(*Ocimum basilicum* L.) is an annual herb that grows wild in hot and humid regions such as tropical Asia and Africa. This study was carried out for resource discovery, propagation, and DB construction of aromatic plants. In order to evaluate the genetic characteristics, 28 kinds of basil seeds were supplied from the Center for Genetic Resources. For basil characteristics, planting date, plant height, growth shape, leaf length, leaf shape, petiole color, petiole, stem color, flower color, after harvest, full length including roots, flower length, stem thickness and biological weight were measured. For anthocyanin analysis, only basil with purple color was selected, anthocyanins were extracted with 60% ethanol containing 1% citric acid, a standard quantitative curve was prepared with cyanidin-3-glucoside, and absorbance was measured at 525 nm. Basil planting started around June 16, and the flowering period lasted for a total of 18 days from July 19 to August 5. On August 6, when flowering was completed, morphological characteristics including flower color were measured at the site by an object. The measured basil plant length was 26.6-59.6 cm, leaf length 2.0-7.9 cm, leaf width 0.7-5.2 cm, and petiole 1.3-3.9 cm. The growth pattern of basil was generally straight, medium in shape. The color of the leaves was observed evenly by mixed green, purple, purple and green, and the recesses in the shape of the leaf were also conspicuously observed. A total of three basil flower colors were observed: white, light pink(149P 10P/84), and purple(37V 2.5RP 4/12). During the second growth survey after harvest, the total length including the basil roots is 26.7-52.0 cm, the flower length is 8.2-29.3cm, the stem thickness is 7.1-15.9mm, the number of stem nodes is 3-12 nodes, and the total weight of the basil was measured to be about 218-1540 g. There are a total of 16 types of basil expressed in purple, and the anthocyanin content was measured to be 73.74 ~ 380.72 mg/100g.

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PC-24

# Genetic Characteristics of Dill(*Anethum graveolens* L.)

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**[Abstract]**
Dill(*Anethum graveolens* L.) is a buttercup family, and flowers, leaves, stems, and seeds are all mainly used as spices. This study was carried out to discover and propagate genetic resources for the development of plant-derived medicinal fragrance materials, and to establish a database. In order to investigate the genetic characteristics of dill and to extract natural essential oils, 50 resources were parceled out the genetic resource center, sown, germinated, and then formally cultivated in the test research field. After sowing and propagation of 50 dill resources, the characteristics of each individual such as plant height, the diameter of polychasium during flowering, and the number of small inflorescences were investigated. The flowering period of dill was around May 31 to June 17, and about 10% of the proliferating population flowered around May 31. The plant length of dill was 32~141cm, and the length of petiole was 1~16cm, showing an average of 5cm. The color of the stem and leaf color was referred to the RHS Color chart, and the colors were classified as 44S, 19V, and 75DI. Uses as many resources as possible with 35 resources equivalent to 19V. Inflorescences are lateral and opposite, polychasium inflorescences are somewhat flat at the upper part and have a diameter of 4.5~20cm, and divergent inflorescences are irradiated with 5~86 multiple flowers. The number of pedicels is 16~74, and the length of the pedicel is 1-18cm spread sideways or the length is different from each other.

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PC-25

# Evaluation of Genetic Characteristics and Essential oil Composition of Coriander(*Coriandrum sativum* L.)

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**[Abstract]**
Coriander(*Coriandrum sativum L.*) belongs to the family Umbelliferae/Apiaceae. It is cultivated as a spice and medicinal herb around the world, including its leaves and seeds. Coriander leaves have soft and fragrant, so they can be used in cuisines such as China, Mexico, and, Southeast Asia. Coriander leaves contain a high amount of vitamin C, carotene, and multiple polyphenols. Coriander essential oils and extracts have various chemical components and are known to have antioxidant, antibacterial, and antifungal activities. This study was carried out for resource discovery, propagation, and DB construction of aromatic plants. In order to evaluate the genetic characteristics, 30 kinds of Coriander seeds were supplied from the Center for Genetic Resources. The evaluation of characteristics of the basal part leaf number, leaf shape, and plant height was investigated. Also, Essential oils extract from various parts of plants including the leaves, flowers, and steam isolated by simultaneous distillation extraction(SDE) apparatus. In the results, heights showed growing to 70 cm over and basal part leaf number 0 to7. The leaves are variable, they are measured according to leaves incisions, and most of the included incision. The qualitative analysis of EOs was performed using gas chromatography-mass spectrometry. EOs had various chemical compositions. Major compounds were trans-2-Decenal, linalool, decanal, 2-Dodecenal, 13-Tetradecanal, 2-Undecenal.

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PC-26

# What is an Appropriate Promotion Strategy for Korean Wheat Consumption? - Find Out in the Sensory Evaluation of Rice Meal Versus Rice Containing Wheat Meal by Age Groups-

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**[Abstract]**
Wheat was brought to solve food scarcity with aid from the United States caused by the Korean War. The Korean government launched a campaign to encourage mixed rice and wheat meals due to shortage of rice production in the 1960s, Wheat consumption began in earnest. However, it is difficult to rebuild the domestic wheat production base devastated by the Korean War with the technology at the time. Thus, wheat was mainly consumed from imported in the past. Since then, as wheat consumption has increased due to westernization and diversification of dietary life, wheat became the second staple grain in Korea. In this situation, the government enacted the Wheat Industry Promotion Act to create a basis for sustainable production and consumption of wheat in Korea. This study sought to improve the self-sufficiency of domestic wheat by examining the possibility of using "Ariheuk", a variety of new Korean wheat, as a rice supplement in the same context as the government's policy. Wheat has been used as a raw material for the processed food, such as noodles and bread. However, we approached it by using whole wheat as a nutritional grain. Participants were recruited from the agri-food consumer panel conducted by Rural Development Administration. We set a final sample of 525 consumer panels based on the age of census household heads. The experiment was conducted in such a way that participants cooked and ate 100% rice meal and rice containing 20% whole wheat meal. Participants completed the sensory evaluation questionnaire with online. For this experiment, all participants were given same whole wheat product. The sensory evaluation questionnaire consisted of color, glossiness, stickiness, aroma, chewing, sweetness, nuttiness, chewiness, softness, bursting, flavor, texture and swallowability. The sensory evaluation results were analyzed by giving −3 points to +3 points. The former points were given to the response that 100% rice meal is very superior to the response that rice containing 20% whole wheat meal. The latter points were given vice versa. Zero point was given to the response that they are similar each other. As a result, rice with 20% whole wheat meal was better than 100% rice meal in terms of color, aroma, chewiness, bursting and flavor. In case of sweetness and glossiness, there didn't exist significantly different. On the other hands, 100% rice meal was better in terms of softness and swallowability. As a result of ANOVA by age groups, from 30s or younger to 60s or more, there was significant difference among the groups in terms of color, chewiness and bursting. As a result of post-hoc analysis with Duncan's multiple range test ($p < 0.05$), 50s were evaluated to be significantly superior in color, chewiness and bursting compared to other age groups. In conclusion, it is appropriate to use whole wheat as a supplement to rice in order to improve the self-sufficiency of domestic wheat. As a strategy to promote domestic wheat consumption, in case of Ariheuk, it is necessary to provide an experience through whole wheat tasting and to establish a marketing strategy segmented by age groups.

**Keywords :** Ariheuk, Consumer Panel Survey (RDA), Sensitivity evaluation, Promotion of Korean Wheat Consumption

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PC-27

# Effect of Harvesting Time on Hay and Haylage Feed Value and Quality of Triticale (X *Triticosecale* Wittmack)

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**[Abstract]**
Hay and haylage as forage are increasing in preference for cattle feed. Triticale (X *Triticosecale* Wittmack) is growing up as a forage crop due to its high production and feed value in South Korea. It is difficult to determine the harvesting stage of triticale for producing hay or haylage with the highest forage value and quality because feed and nutritional value by growth stages of triticale were not known in South Korea yet. In this study, we analyzed forage values, pH, and contents of organic acid, to confirm feed value and quality by growth stages of triticale. The triticale 'Joseong' was sown in the spring of 2022. The sample was prepared in 5 stages: seedling stage, booting stage, heading stage, 10 days after heading, and 20 days after heading. The triticale was dried under 10% and to about 50% moisture for hay and haylage respectively, and then both triticales were fermented anaerobically at room temperature for 40 days. The pH value in all hay and haylage became lower as the triticale was grown up, although the pH value of all triticale hays and haylages ranged between 7.05~5.68. The content of lactic acid in all triticale hays was almost meaningless. The contents in the haylage of the seedling stage were the highest (2.39%) among the haylages, even though those of 20 days after the heading stage (1.67%) were the lowest, which showed a similar tendency with pH value. Conclusionally, the results implied that the feed value and quality of triticale haylage were affected by harvesting time but not hay.

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PC-28

# Pattern of 'Concanavalin A' Synthesis during Development of Jack Bean (*Canavalia ensiformis*) Pods

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**[Abstract]**
Jack bean [*Canavalia ensiformis* (L.)], belonging to the Leguminosae family has been frequently used in edible and medicinal plants in Asian countries. Jack beans are high in protein which is approximately 30%. Concanavalin A (Con A) is a major protein of Jack bean and belongs to the family of legume lectins. It has inhibitory effect on hepatocellular carcinoma by inducing autophagy. However, Con A negatively affects nutrient utilization by other mechanisms. It binds to the glycoproteins and glycolipids of the digestive tract mucosa, inhibits the activity of the enzymes of the brush border of the enterocytes. In order to use Jack bean young seedpods, they are restricted to 'young pods (soft, pre-swelling)' according to the 'Food Code' (Ministry of Food and Drug Safety). Therefore, in this study, we investigated the quantitative change of Con A across developmental stages of Jack bean pods. Biological samples consisted of Jack bean pods and seeds in 7 stages of development. The expression pattern of Con A mRNA was monitored by quantitative reverse transcription PCR (RT-qPCR). Expression of Con A proteins was analyzed by western blotting. The expression of Con A mRNA and protein in the seeds tended to increase gradually as the seeds expanded. However, in pods, they were much less than in seeds. As the expression of Con A mRNA and protein increases as the pods thicken, it is predicted that Con A synthesis increases when the thickness growth of the pod begins after the length growth of the pod is completed. Since the expression of Con A in the pods and seeds in very low when the pods are about 2 cm, therefore 2 cm pods seem appropriate when using 'young pods'. It is also necessary to study other proteins in Jack bean, such as Urease and Canavalin. These studies will serve as the basis for processing Jack bean.

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PC-29

## 저장기간에 따른 지방산 조성이 다른 콩가루의 품질 변이

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**[초록]**
식생활이 풍요로워진 우리나라는 국민의 포화지방산 섭취량이 빠르게 증가하고 있는데 섭취량을 줄일 필요성이 있다. 최근 우리나라의 콩가루,두유 시장규모는 건강과 국산 열풍으로 2016년부터 연평균 13%씩 성장 중이며 국산콩 사용량이 두부 다음으로 많다. 콩은 풍부한 단백질과 더불어 건강에 좋은 불포화 지방산함량이 높다. 하지만 높은 불포화지방산 함량은 저장성을 떨어뜨리는 역할을 한다. 본 연구에서는 불포화지방산 함량이 상이한 3가지 콩을 3종류의 포장재에 밀봉 포장하여 상온과 저온에서 3개월간 저장실험을 하였다. 저장안정성 평가는 유지를 추출하여 산가측정을 하고 가스크로마토그래피(GC)를 이용하여 지방산함량 변화를 확인하였다. 산가는 저장기간에 따라서 매달 산가가 유의적으로 증가하는 경향을 보였으며, 저장온도에 따라 초기, 상온, 저온 모두 각각 유의적인 차이를 보였다. 콩 종류에 따라서도 유의적인 차이를 보였는데 포장재에 따라서는 차이를 보이지 않았다. 저장기간에 따라 콩가루의 지방산 변화는 대찬콩은 저온에서 올레산이 감소하는 경향을 보였고, 호심콩은 상온, 저온 처리구 모두에서 올레산과 리놀레닉산이 감소하는 경향을 보였으며, 49-3-1-8 콩은 상온, 저온 처리구 모두에서 올레산, 리놀레산, 리놀레닉산이 감소하는 경향을 보였지만 호심 상온처리구에서 리놀레닉산이 감소한 것을 제외하고는 유의미한 결과값을 얻지 못하였다. 저장 3개월차에 산가는 상온, 저온 처리구 모두에서 호심콩가루가 가장 낮게 나왔는데 이것은 이중결합이 하나라 비교적 안정성이 높은 올레산함량(~80%) 때문으로 보인다. 반면에 49-3-1-8 콩은 이중결합 3개로 가장 산화 되기 쉬운 리놀렌산 함량이 비교적 많아 가장 산가가 높게 나왔다. 결과적으로 올레인산 함량이 높은 호심 콩가루가 가장 저장안정성이 좋을 것으로 보인다.

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PC-30

# Comparison of the Quality Characteristics of the Rice yield Trial Lines in the Central Plain Region for Four Years

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**[Abstract]**

In order to developing high-quality rice varieties and processing varieties, systematic and stable evaluation of physicochemical properties is required for breeding lines. In this study, we compared the quality characteristics evaluation results of rice breeding lines for cooked rice, special rice, and whole crop silage rice adapted to central plain region (Suwon) in order to use as basic data for future rice variety development.

Brown rice length/width ratio, head rice ratio, protein content, amylose content, alkali digestion value(ADV) and Toyo value were analyzed to evaluate the quality characteristics of yield trial lines cultivated in Suwon for four years (2017-2020).

Brown rice length/width ratio, head rice ratio, protein content, ADV and Toyo values showed significant differences by year, but there was no significant difference in amylose content ($p<0.05$), which showed little environmental variation. The head rice ratio and Toyo value showed an increasing trend, while the protein content showed a decreasing trend. However, the protein content was the highest in 2020, which is thought to be owing to little sunlight hours due to heavy rainfall in 2020. The protein content of whole crop silage rice was 8.1%, which was significantly higher than that of other lines ($p<0.05$). Toyo value of medium-maturing and early-maturing lines were 67.6 and 73.7%, respectively, and the Toyo value of medium-maturing lines was higher than that of the early-maturing lines ($p<0.05$).

In correlation analysis among the quality characteristics of the rice lines for cooked rice, significant positive correlations were detected between Toyo value and head rice ratio, amylose content, ADV, and a negative correlation was observed between Toyo value and protein content ($p<0.05$).

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PC-31

# Comparison of Agricultural Characteristics and Seed Quality for Suitable Natto Varieties

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**[Abstract]**
Natto is a soybean fermented food from Japan, which is made from steamed soybean, *Bacillus natto* and water. Demand of Natto has increased recently because it does not have smell compared to *Cheonggukjang*, which is Korean traditional fermented food. Currently, Pungsannamulkong is the most commonly used in Korea for Natto. Four candidate varieties of soybeans were investigated and compared in terms of Agronomic Traits, quality characteristics, hard seed rate, and water absorption rate in order to determine more suitable Korean soybean variety than pungsannamulkong. 'Haewon' had higher yield than other three varieties in Goesan-gun and Jinan-gun. The infected seed rate which affects soybean processing is higher in pungsannamulkong. 'Haewon' showed low 100 seed weight with 8.6 g in Goesan-gun and 9.5 g in Jinan-gun, which was the smallest of four soybean varieties. The water absorption rate was higher in 'Haewon' than in pungsannamulkong which is desirable characteristics for Natto process. The hard seed rate of pungsannamulkong was 6 ~7%, which is considered to be unsuitable to Natto process. The yield of Natto was significantly different for each variety. 'Haewon' showed the highest amino nitrogen content with 575.0 mg%. These results suggested that 'Haewon' can be considered as suitable candidates for yield and quality of Natto compared to pungsannamulkong.

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PC-32

# Antioxidant Effect of Fractional Extracts from *Gastrodia elata Blume*

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**[Introduction]**

Recently, plant and plant-derived products are treated a part of the healthcare system by applying the bioactive phytochemicals. This study was investigated to evaluate the DPPH, ABTS radical scavenging rate and nitrite scavenging activity from *Gastrodia elata Blume* fractional extracts. Antioxidant activity substances in food play an important role as a health-protecting factor. This study was focused to evaluate of antioxidant activity of *Gastrodia elata Blume* in the different fractional extracts solvent for biological search on plant-based antioxidant agents.

**[Materials and Methods]**

The rhizome of *Gastrodia elata Blume* were freeze-dried, and then ground to a fine powder. Each sample powder was stored at -20°C for experiments. The concentrated extract was partitioned between hexane and water. The aqueous layer further fractionated with methyl chloride, ethyl acetate and butyl alcohol. Four solvent fractions (hexane, methyl chloride, ethyl acetate and butyl alcohol) were collected and concentrated using vacuum rotary evaporator. The spectrophotometric analysis of DPPH and ABTS scavenging activity of *Gastrodia elata Blume* was determined according to the method described previously (Brand-Williams *et al,* 1995; Re *et al.,* 1999). The nitrite scavenging activity was determined according to a method using Griess reagent.

**[Results and Discussions]**

The extract of *Gastrodia elata Blume* had the highest DPPH activity in ethyl acetate partition layer and while water partition layer showed the lowest DPPH activity. That is, the activity of DPPH showed a significantly higher activity in ethyl acetate partition layer compared with the other fraction at concentration ranging from 0.5 $mg \cdot mL^{-1}$ to 10 $mg \cdot mL^{-1}$. The extract of ethyl acetate partition layer showed the highest ABTS activity, and while water partition layer showed a relatively low activity at all tested concentrations. The ABTS radical scavenging activity was progressively increased in a dose-dependent manner. The nitrite scavenging activity from different fractional extracts of *Gastrodia elata Blume* were affected by pH. The water extract was significantly less effective than was hexane, methylene chloride, ethyl acetate, and butyl alcohol extracts. At a pH of 1.2, the scavenging effect of all of the extracts tested observed higher than that of the other two pH ranges(pH 4.2 and pH 6.0). These analyses indicate that there is a linear relationship between DPPH and ABTS radical scavenging activity.

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# *In Vitro* Anti-inflammatory Effect of Fractional Extracts from *Gastrodia elata Blume*

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**[Introduction]**

*Gastrodia elata Blume* is a traditional herbal plant, which belongs to the Orchidaceae family. The rhizomes of *Gastrodia elata Blume* have been used in traditional medicine for the treatment of headaches, dizziness, vertigo and convulsive illnesses, such as epilepsy and tetanus, and it has been used clinically as a complex prescription rather than as a single herb. Medicinal plants including *Gastrodia elata Blume* are good sources of anti-inflammatory agents. Many infectious diseases have been known to be treated with herbal extracts. The evaluation of anti-inflammatory property of the *Gastrodia elata Blume* rhizome is of great interest and importance.

**[Materials and Methods]**

The rhizome of *Gastrodia elata Blume* were freeze-dried, and then ground to a fine powder. Each sample powder was stored at -20°C for experiments. The concentrated extract was partitioned between hexane and water. The aqueous layer further fractionated with methyl chloride, ethyl acetate and butyl alcohol. Four solvent fractions (hexane, methyl chloride, ethyl acetate and butyl alcohol) were collected and concentrated using vacuum rotary evaporator. Anti-inflammatory activities were evaluated on the several inflammation-related factors such as nitric oxide (NO) and the release of proteinflammatory cytokine [tumor necrosis factor-alpha (TNF-α), Interleukin-6 (IL-6) and Interleukin-1 beta (IL-1β)] in lipopolysaccharide (LPS)-treated RAW 264.7 cells.

**[Results and Discussions]**

The all fraction extracts of *Gastrodia elata Blume* significantly inhibited LPS induced NO production in mouse macrophage cells, RAW.264.7, at 50, 100 and 200 $\mu g \cdot mL^{-1}$ concentrations. This study suggests immunosuppressive potential of *Gastrodia elata Blume* extract, and in particular, these effects are differences depending on the extraction solvent. After pretreatment with *Gastrodia elata Blume* extract, the cell supernatants were measured by ELISA after 24 hours of stimulation with LPS. The treatment results of *Gastrodia elata Blume* extract by different fractional solvent showed that the anti-inflammatory activity was most excellent in ethyl acetate fraction as a whole. The present study demonstrate improved anti-inflammatory response in a LPS-stimulated macrophage model upon treatment with extract of *Gastrodia elata Blume* via reduction of IL-6, TNF-α and IL-1β production, or reduction of expression of NO. These results indicate that *Gastrodia elata Blume* fractional extracts tested here may have potential anti-inflammatory activity, however, numerous and in-depth studies should be carried out for this purpose.

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# Antidiabetic Activities and Anti-oxidants of Seed and Whole Plant of Tartary Buckwheat 'Hwangguem-Miso'

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**[Introduction]**
Buckwheat (*Fagopyrum* spp.) is an annual herbaceous crop, and is known as a health food. The seed and whole plant of buckwheat were evaluated for its antidiabetic potential on normal and streptozotocin (STZ)-induced diabetic rats.

**[Materials and Methods]**
For the experiments, the diabetic animal models in STZ-induced diabetic rats were divided into 4 groups: normal mice group, streptozotocin-induced diabetic mice group (STZ), mice group fed seeds of common buckwheat or tartary buckwheat, and mice group fed whole plant of common buckwheat or tartary buckwheat. In the chronic model, the aqueous extract was administered to normal and STZ-induced diabetic rats at the doses of 100 mg/kg body weight per day for 4 weeks. The fasting blood glucose levels, oral glucose level, serum insulin level and biochemical data such as homeostasis model assessment of insulin resistance (HOMA-IR) were evaluated and compared with that of the known anti-diabetic mice group.

**[Results and Discussion]**
Rutin content of tartary buckwheat 'Hawngguem-Miso' was 44-48 times higher than that of common buckwheat, and the flavonoid and polyphenol contents were also 2.5-4.8 times higher than those of common buckwheat. The mice group fed tartary buckwheat group showed significant decrease in blood glucose, serum glucose and HOMA-IR when compared with the STZ group. Thus the seed and whole plant of tartary buckwheat had beneficial effects in reducing the elevated blood glucose level and insulin tolerance of STZ-induced diabetic rats. The results suggest that high rutin content and antioxidant activity in tartary buckwheat are closely related with the anti-diabetes effect. The cultivar 'Hawngguem-Miso' have anti-diabetic effects that attenuate blood glucose in the animal model of type II diabetes and might be useful as a functional diet for human diabetic diseases.

**[Acknowledgement]**
This study was supported by joint research project from Rural Development Administration, Republic of Korea (Project number PJ01606803)

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PC-35

# Effect of Cold Plasma on Total Polyphenol Content and Anti-Inflammatory Activities of Peanut (*Arachis hypogaea* L.) Hull

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**[Abstract]**

In recent studies, cold plasma has been used to induce exudation of polyphenols and flavonoids from food materials, leading to enhancement of functional properties. And it is known that polyphenols interact with inflammation related metabolism. The objectives of this study were to investigate the effects of cold plasma treatments on the increase of total phenolic content (TPC), total flavonoid content (TFC), and anti-inflammatory activities of 'Sinpalkwang' peanut (*Arachis hypogaea* L.) hull. Plasma treatments were carried out using a dielectric barrier discharge gas exchange system at different radicals and temperatures ($O_3$-25°C, $O_3$-150°C, $NO_x$-150°C). Significant differences in TPC, TFC, and inflammatory mediator such as nitric oxide (NO) and tumor necrosis factor α (TNF-α) in lipopolysaccharide stimulated Raw 264.7 macrophages were observed between treated and non-treated peanut hull samples ($p < 0.001$). Cold plasma treated samples showed higher content (TPC: 2.87-2.93 mg/g sample, TFC: 0.96-0.98 mg/g sample) than non-treated sample (TPC: 2.47 mg/g sample, TFC: 0.78 mg/g sample). Cold plasma treated samples showed lower content of NO (3.3-5.0 uM) and TNF-α (141.4-162.2 ng/mL) than non-treated sample (NO: 11.1 uM, TNF-α: 210.2 ng/mL). This study suggests that cold plasma has potential to improve functionalities of food materials and that cold plasma treated peanut hull can be used as immune enhancing materials.

**[Acknowledgement]**

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PC-36

# A Study on Development of Main Producing Areas for Industrialization of complex and of fusion in Field

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**[Abstract]**
This research aims to developing new commercialization project of convergence agricultural industrial model. First, we established an inventory for the planning of convergence agricultural industrial model categorize the relevant factors identified, and then suggested three models which are the business profit model for convergence agriculture industrialization, the resource recycling complex and agricultural tourism model, and the smart agricultural model. Second, in order to investigate the feasibility of each industrial model, we investigated the willingness to participate in the project according to the pilot models such as related organizations and management agencies, and proposed the result of business feasibility analysis. Finally, we suggested the establishment of a demonstration complex through the systemization of element technologies at two models. The related systems and technologies was reviewed as a new commercialization plan through the modeling of convergence agricultural industrial types in main crop production complex presented, and set up mid- to long-term development direction. The results of this study can be applied to the design of convergence agricultural industrial model in main crop production complex.

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# Antioxidant activities of germinated Ginseng(*Panax ginseng* C.A. Meyer) Seed

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**[Abstract]**
Ginseng has been traditionally used in Asia including Korea, for health care and to treat verities of different diseases such as immune disease, liver disease, and cancer. The current study was aim to unveal the most efficient method such heating, prethanol-A and ultrasound, for cured extraction of ginseng with higher antioxidant activity. The current results shows a significant improvement in the inhibition of $H_2O_2$ by the ultrasound method than the HT and Pre-A method. Thus this inhibition in free redical is possible through the increase in the antioxidant activity. Therefore in this study the CAT, APX and phenolic and flavonoid content was increased in ginseng seed and germinated ginseng sprouts by the US method, while the POD, SOD and GSH activity was increased in HT method. This suggest that the different extraction method in different stage of ginseng growth show a different biochemical and metabolites activation. Thereby the Ultrasound and Heat extraction was a feasible alternative method for extracting interested ingredients from biological materials.

**[Materials and Methods]**
1. Sprout growing and sample preparation
   A 100 grams of dehisced intact seeds, were washed 3 times with tap water. The container containing seeds or sprouts were sprinkled with tap water using a spray for 2 min every day. The sprouts were grown at 4-5°C in a refrigerator for 14 days. The sprouts were kept into deep freeze (-70°C) before subjected to freeze-drying. 100 grams of intact seeds were also freeze-dried.
2. Preparation of sample extracts
   For hot water extractions, the ginseng powder (30g) was dissolved in 300mL distilled water and heated for 3h at 80°C in a water bath. For prethanol-A (ethanol) extractions, the powder (30g) was mixed with 300mL of 70% (v/v) prethanol-A (ethanol) and heated for 3h at 60°C in a water bath. For ultrasound-assisted extractions, the powder (30g) and the predetermined volume of extracting solvent were put in an Erlenmayer flask (500mL): the ratio of powder and solvent was 1:10g/mL. The sonication were performed in 40 min using an ultrasonic cleaning bath (BRANSONIC, 8510E-DTH, Mexico; in ternal dimensions: 47×29×15 cm) operating at 44KHz frequency.
3. Determination of $H_2O_2$, total polyphenol(TP) and total flavonoid content
   Hydrogen peroxide ($H_2O_2$) content was estimated using the method of Velikova, V. *et al*, Total phenolic content (TPC) and total flavonoid content (TFC) were quantified using the method of Liang *et al*.
4. Determination of catalase, SOD(superoxide dismutase), and APX(ascorbate peroxidase) activity
   The catalase activity was measured using the method of Halo, B. A. *et al*.
   Superoxide dismutase activity was estimated using the method of Giannopolitis, C. N. *et al*. The ascorate peroxidase (APX) activity was estimated using the method of Khan, A. L. *et al*.
5. Quantification of Reduced glutathione
   The raduction in GSH content was estinated using the method of Ellman, M. A.
6. Statistical analysis
   All the data are presented as a mean±standard error (SE). Analysis of variance test was conducted using PROC GLM in SAS 9.4 (SAS Institute Inc., Cary, NC, USA). The significant differences among treatment means were identified by Student's t-test at 0.05 probability level.

**[Results and Discussion]**
In this study, we carried out to investigate the inhibition of $H_2O_2$ and antioxidant activity of ginseng seed and germinated ginseng spruts through heat extraction, Pre-A extraction and ultrasound extraction. Compared with the heat and Pre-A extraction methods, the US treatment provided high extraction efficiency. Moreover, the US treatment contained more total polyphenol and flavonoid content, higher SOD, POD, CAT and GSH activity, along with significant inhibition of H2O2 radical activity compared with heat and Pre-A extraction methods. When choosing an extraction method, one should consider both extraction efficiency and the maximum antioxidant activity. Ultrasound extraction was a feasible alternative method for extracting interested ingredients from biological materials.

**[Acknowledgement]**
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PC-38

# Identification of the Variants for Carotenogenesis Genes in Hexaploid Sweetpotato

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**[Introduction]**
Sweetpotato (Ipomoea batatas [L.] Lam) has a high heterozygous hexaploid genome (2n = 6x = 90). According to recent studies, the three diploid subgenomes exhibited a high degree of similarity or were partially homologous. As a major source of carotenoids, the investigation of variants related to the responsive genes is still elusive. Furthermore, obtaining a haplotype-resolved assembly is still a challenge due to the genome complexity. The present study was designed to (i) generate draft assembly (ii) identify carotenogenesis genes and; (iii) their variants structure at nucleotide level.

**[Materials and Methods]**
The assembly was generated by hifiasm from trimmed Pacbio hifi reads of sweetpotato cv. Jinyulmi. The assembly quality was checked with BUSCO. Afterward, Exonerate and Augustus were employed for homology-based carotenogenesis genic regions detection. To find out potential carotenoid co-linear genes, we performed an ALL vs ALL alignment with NUCmer. Besides, a reads-mapping approach was implemented to dive into variants detection by using Minimap2. In the next step, we extracted reads mapped on the region including the target gene by Samtools view. And then, We chose clean variants(number of reads about per variant > 6) for haplotyping by the command line we made.

**[Results and Discussion]**
As a result, a genome assembly (99.3% BUSCO) was produced with an N50 of 828,807 bp. The homology-based annotation revealed the presence of carotenogenesis genes including PSY, GGPS, et al. This analysis of some carotenogenesis genes shows variants of homoeologous copies. The preliminary results from this study pave the way for the genetic determinant of color in sweetpotato. Additional variants including diverse accessions will be performed to accurately characterized the genetic basis of color variation in sweetpotato.

**[Acknowledgement]**
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# 2022 Annual Meeting and Fall International Conference of the Korean Society of Crop Science


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2022 한국작물학회 정기총회 및 추계 국제 학술대회

# Innovative Direction of Crop Science Research for Food Security

## 식량안보강화를 위한 작물학연구 혁신방향

The Korean Society of Crop Science
한 국 작 물 학 회