The 2nd International Conference On Agricultural Science & Research

Date & Time: October 7, 2022 10:00 AM ~ 17:00 PM
Venue: Links to ZOOM rooms

Institute of Agricultural Science, Chungnam National University

Congratulatory Remarks

Good morning,

Ladies and gentleman,

Nice to meet you here. My name is Dae Sik Kim, Dean of College of Agriculture and Life Sciences. I am honored to be here and deliver my congratulatory remarks for the opening of 2nd International Conference on Agricultural Science & Research. I would like to express my deep appreciation to Prof. Ki-Teak Lee, the head of Institute of Agricultural Science, Chungnam National University, and the other member of Institute for their work in preparing for today's international symposium. On behalf of members of Chungnam National University, I would like to express my sincere welcome and appreciation to all the participants and speakers from home and abroad that we are honored to have here with us this morning.

As you all know, all of us around the world have been fighting COVID-19 for a long time, and now we are gradually recovering our daily lives and the economy. The world is paying more attention to health than ever before, and as a result, many changes are required in the agricultural industry. The increase in production cost and the shortage of manpower in rural areas are pointed out as obstacles to the growth and development of the agricultural industry. Our generation's use of natural resources and the environment have created serious problems such as global climate change for our future generation which should be solved. I think it is very meaningful to hold this conference at a time to prepare our young students and researchers a future and rebuild our environment.

This conference covers a wide range of research topics and issues in agriculture. I hope that this will lead to a active exchange of ideas and discussion involving important issues and they resulted in the formation of a number of new scientific collaborations. I hope that this conference gives you opportunities to share with each other the experiences that you have today. Once again I have the pleasure and honor of welcoming all of you to this international conference.

Thank you.

Dae Sik Kim,
Dean and Professor
College of Agriculture and Life Sciences
Chungnam National University

Welcome Address

I am pleased to welcome researchers who are contributing to the development of agriculture, animal, forestry, and food industry science.

We, the executive members of CNU Institute of Agricultural Science, are very pleased to be holding the 2nd International Conference in autumn, the season of blue skies and abundant harvest, and invite you to the academic festival.

Established in 1971, our Institute of Agricultural Science has contributed greatly to the development of agricultural life sciences in Korea over the past 50 years. The affiliated researchers have developed the science and technology necessary for the region and the country while continuously conducting leading research. We will also be interested in fostering core junior researchers from our school necessary for the development of advanced technologies.

The International Conference hosted by our institute aims to contribute to academic development through the exchange of new knowledge and information in various academic fields of the agricultural life industry. Today, 64 domestic and foreign research results will be introduced at this conference, and I hope that this event will serve as an 'academic forum' where we can discuss ways to develop the agricultural industry together.

Through this event, we hope that our institute will continue to serve as a hub for academic exchange and cooperation between excellent domestic and foreign institutions. We, the executive members of Institute of Agricultural Science, will do our best for the academic development of College of Agriculture and Life Sciences.

I wish you all good health and happiness

Ki-Teak Lee,
Director, Institute of Agricultural Science,
College of Agriculture and Life Sciences,
Chungnam National University

Conference Program

Schedule		Program	
2022-10-07(Fri)	10:00 ~ 10:20		Opening Ceremony
	10:30 ~ 12:00	Crop Science	Crop Science I
		Horticultural Science	Future of climate-smart horticultural science I
		Environment & Forest Resources	Present and future researches of carbon and nutrient cycling at diverse forest ecosystems I
		Applied Biology	Crop Protection I
		Animal Science	Livestock Production
		Agricultural & Rural Engineering	Advances in Agricultural & Rural Engineering I
		Food Science & Technology	Novel technologies to improve food quality and safety I
		Bio-Environmental Chemistry	Managing Climate Change and Sustainable Agriculture I
		Agricultural Economics	Research on International Agricultural Economy
	12:00 ~ 13:00		Lunch Break
	13:00 ~ 15:00	Horticultural Science	Future of climate-smart horticultural science II
		Environment & Forest Resources	Present and future researches of carbon and nutrient cycling at diverse forest ecosystems II
		Applied Biology	Crop Protection II
		Animal Science	Livestock breeding
		Dairy Science	Animal resources utilization I
		Agricultural & Rural Engineering	Advances in Agricultural & Rural Engineering II
		Food Science & Technology	Novel technologies to improve food quality and safety II
		Bio-Environmental Chemistry	Managing Climate Change and Sustainable Agriculture II
		Agricultural Economics	Research on Agricultural Economy
	15:00 ~ 15:30		Coffee Break
	15:30 ~ 17:00	Bio-Environmental Chemistry	Managing Climate Change and Sustainable Agriculture III
		Dairy Science	Animal resources utilization II
		Agricultural & Rural Engineering	Advances in Agricultural & Rural Engineering III
		Biosystems Machinery Engineering	The application of intelligent farming in Biosystems machinery engineering I

■ Zoom : https://us04web.zoom.us/j/76035365666?pwd=fuMghev0EbUddLa1yMDQIF096DN9WV.1(760 3536 5666/1007)

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Crop Science

Combining GWAS, Fine Mapping and Haplotype Analysis Reveals the Candidate Genes of Seed Awning in Rice

Ngoc Ha Luong[1], Sangshetty G. Balkunde[2], Kyu-Chan Shim[1], Cheryl Adeva[1], Hyun-Sook Lee[3], Hyun-Jung Kim[4], Sang-Nag Ahn[1*]

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Abstarct

Seed awning is an important domestication trait in rice. Therefore, considerable interest exists in discovering genes and genetic mechanisms contributing to awn reduction during domestication. 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*. These results indicate that the domestication process of awnless seeds was complicated because many genes are involved in awn formation in rice. This study will not only help future rice breeding and evolutionary studies, but will also accelerate study of other crops.

Key words: Quantitative trait loci, Rice, Awn development, Haplotype analysis, *O. minuta*.

Acknowledgement

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Horticultural Science

Influence of Various Nitrogen Concentrations in Nutrient Solution on Growth, Soil and Tissue Nutrient Contents, and Daughter Plant Occurrence in 'Seolhyang' Strawberry Propagation

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Abstract

This experiment was carried out to find the appropriate concentration of nitrogen (N) fertilizer for propagation of 'Seolhyang' strawberry. Seedlings were transplanted to plastic pots (length 64.3 cm × width 23.5 cm × height 17 cm) using commercial root medium (coco peat + peat moss + vermiculite + perlite, 52.5, 15, 2.5, 30 % respectively) on Autumn season. After that nutrient solutions containing different N levels (0, 5, 10, 15 and 20 mM N) with equal amount of all essential nutrients except N were applied. The seedlings were harvested and stored for 3 months at the temperature of 3°C. These were transplanted to the same medium on early April and the plants were uprooted to investigate the appearance of mother plants and occurrence of daughter plants at 90 days after transplanting. Data on tissue nutrient contents in dry matter of above-ground tissue, pH, EC and concentrations of micro and macro elements of root media were analyzed. Statistical differences in root medium pHs were not observed among the treatments and it was 5.61-6.05. The highest growth of mother plants in terms of numerical data of dry weight (17.2 g) in 'Sulhyang' strawberries was observed in 10 mM but the incidence of daughter plants in 15 mM N treatment. Where, the tissue N contents were 2.22% and 2.45% respectively regarding the dry weight of mother plants. Furthermore, the nutrient concentrations (mgL^{-1}) in root media were 20.7 NO_3, 30.5 PO_4, 0.26 K, 18.69 SO_4 in 10 mM N treatment and 20.3 NO_3, 29.1 PO_4, 0.26 mg, 18.72 SO_4 in 15 mM N treatment. Moreover, significant statistical difference in dry weight of mother plants was absent among the N treatments of 'Sulhyang' strawberry. Above results indicate that, the N concentration in fertilizer solution has to be controlled to 10 or 15 mM to enhance the growth of 'Sulhyang' mother plant and occurrence of daughter plants through vegetative propagation.

Key words: Mother plant growth · Daughter plant occurrence · N concentration · Soilless culture · Tissue contents

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Horticultural Science

Gene expression and cis-regulatory elements analyses identify the bimodal role of IDA-HAE/HSL module in tomato flower abscission

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Abstarct

Unwanted organ detachment such as flowers, leaves, and fruits from the main body of a plant (abscission) has significant effects on agricultural practice. Both timely and precise regulation of organ abscission from the plant is crucial as they influence the agricultural yield. Tomato (*Solanum lycopersicum*) has become a model system for research on organ abscission. Here, we characterized four tomato natural abscission variants named *jointless* (*j*), *functionally impaired jointless* (*fij*), *functionally impaired jointless* like (*fij*-like), and normal flower abscission joint (NJ), based on their cellular features within the flower abscission zones (AZ). Using eight *INFLORESCENCE DEFICIENT IN ABSCISSION* (*SlIDA*) genes and eight HAESA-like genes (*SlHSL2*) identified in genome sequence of tomato, we analyzed the pattern of gene expression during flower abscission. The AZ-specific expression for three tomato abscission polygalacturonases (*SlTAPGs*) in development of the flower AZ, and progression of abscission validated our natural abscission system. Compared to that of *j*, *fij*, and *fij*-like variants, AZ-specific expression for *SlIDA1*, *SlIDA3*, *SlIDA4*, *SlIDA5*, and *SlIDA6* in the NJ largely co-related and increased with abscission process. Of eight *SlHSL* genes examined, expression for *SlHSL2b* and *SlHSL2c* were found to be AZ-specific and increased as abscission progressed in the NJ variant. Unlike the result obtained from natural abscission system, in-silico analysis of transcriptional binding sites uncovered that *SlIDA* genes (*SlIDA1*, *SlIDA2*, *SlIDA7*, *SlIDA8*) are predominantly under the control of environmental stress, while most of *SlHSL* genes are affiliated with the broader context in developmental processes and stress responses. Our result presents the potential bimodal role of tomato IDA-HAE/HSL module associated with developmental and stress responses that affect flower abscission in tomato.

Key words: Tomato; flower abscission; stress; INFLORESENCE DEFICIENT IN ABSCISSION; HAESA; bimodal role

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Horticultural Science

Optimize the ratio of red, green, and blue light and preharvest UV-B irradiation to increase the growth and glucosinolate contents of Watercress (*Nasturtium officinale* R. Br)

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Abstract

Watercress (*Nasturtium officinale* R. Br) is a perennial aquatic plant belonging to the Brassicaceae family and rich in glucosinolates that act as a natural antioxidant in the human body with anticancer activity function and activity to reduce reactive oxygen species that attack DNA. The aim of this study was to find an optimal red, green, and blue light condition to increase growth and glucosinolate contents of watercress. In addition, the effect of pre-harvest UV-B irradiation on glucosinolate content was investigated. Watercress seeds were sown into soil and cultivated for two weeks. Two weeks after sowing, the seedlings were transplanted into a hydroponic system with six light combinations that were R10 (Red:Blue = 10:0), R9B1 (Red:Blue = 9:1), R8B2 (Red:Blue = 8:2), R7B3 (Red:Blue = 7:3), R6B4 (Red:Blue = 6:4), and R1B1G1 (control, Red:Blue:Green = 1:1:1) and grown for two weeks. Then, before harvesting, UV-B was irradiated with 1.55 $W \cdot m^{-2}$ at the canopy level for 0 - 24 hours. As a result of the light combination experiment, the R7B3 treatment represented the highest growth and quality of watercress. As a result of UV-B treatment before harvest, the total glucosinolate concentration of watercress was significantly increased at the initial 0.5 h of UV-B irradiation compared with control. Afterward, the total glucosinolate concentration indicated a tendency to decrease until 2 h. However, the total glucosinolate concentration increased again from 2 to 4 h and showed a tendency to reduce after 4 h. Finally, the total glucosinolate concentration was significantly decreased after 16 h compared with the control. Thus, these results indicated that about 30% of glucosinolate contents of watercress grown could be increased by UV-B irradiation for a short time before harvest.

Key words: Hydroponic, secondary metabolite, vertical farm

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Horticultural Science

Petunia stem elongation control by CRISPR/Cas9-derived GA responding gene editing

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Abstract

Petunia is not only an important bedding and balcony plant, but also a model plant for genetic breeding and molecular biology research. Since stem elongation is mainly related to a gibberellic acid (GA) response, plant growth regulators like GA inhibitors are commonly used to control plant height in the production of potted ornamentals and bedding plants. In the current model of GA signaling, GA binds to a soluble *GID1* (GIBBERELLIN-INSENSITIVE DWARF1) receptor, which in turn binds to the DELLA repressor protein. The bound DELLA protein is then targeted for degradation by the 26S proteasome, thus relieving DELLA-mediated repression of GA-dependent growth processes. Previously in our lab, three putative *GID1* genes (*PhGID1A*, *PhGID1B* and *PhGID1C*) were identified in petunia, encoding the GA receptor. We isolated three *GID1* homologous genes in the commercial petunia cultivar 'Madness Midnight'. The aim of this study was to obtain dwarf petunia by silencing three *GID1* genes in petunia using a genome editing tool based on the DNA-free CRISPR/Cas9 ribonucleoprotein (RNPs) or Agrobacterium-mediated transformation. First, we designed sgRNAs for three respective *GID1* genes, and two sgRNAs silencing two genes simultaneously. To determine the transfer efficiency, a transient GFP expression study was carried to optimize the concentration of PEG and incubation period. Then, RNPs were delivered into protoplasts to detect the editing efficiency of sgRNAs. Next, the recombinant plasmid containing sgRNAs and Cas9 was transformed into petunia leaves by Agrobacterium transformation. In summary, we knocked out *GID1* genes in petunia using CRISPR/Cas9-mediated methods and the following study is being conducted to verify the complex relationship between three *GID1* genes and the dwarf phenotype of petunia.

Key words: Petunia, GA, *GID1*, CRISPR-Cas9, DNA-free gene editing, RNPs

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Horticultural Science

Development of a molecular breeding system and plant materials to facilitate breeding of peppers (*Capsicum annuum* L.) by applying cytoplasmic-genic male sterility (CGMS)

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Abstract

Cytoplasmic male sterility (CMS) that is caused by CMS-associated genes on mitochondrial genome is a maternally inherited inability to produce functional pollen. In many plant species, the actions of these genes were shown to be suppressed by specific nuclear genes, called as *Restorer-of-fertility*, shortly *Rf*. Cytoplasmic-genic male sterility (CGMS) system in which CMS and *Rf* are used together is very useful in commercial F_1 seed productions because they enable crosses between parental lines without laborious emasculation, high seed uniformity, and protection of varieties. However, there have been several limitations that hampered applications of it in pepper F_1 seed production. First, mitochondrial genome information to validate CMS candidate genes and classification of mitotypes were insufficient. Second, the molecular markers for *Rf* could not been applied to broad range of breeding lines. Finally, there were few breeding materials with stable CMS or *Rf* in sweet peppers due to widely-spread instability of fertility. Therefore, we performed molecular genetic studies to overcome these limitations. First, comparative analysis between a CMS and a normal pepper lines pinpointed CMS candidate genes and enabled development of markers for accurate mitotyping. Second, delimitation of genomic region that co-segregated with *Rf* and *Rfu* (unstable *Restorer-of-fertility*), respectively, enabled development of a broadly-applicable molecular breeding system for introduction of stable CMS and *Rf*. Finally, breeding of sweet pepper lines resulted in development of sweet pepper materials with stable CMS. The molecular breeding system and plant materials that we developed in present study will greatly facilitate breeding of peppers by applying CGMS.

Key words: Cytoplasmic-genic male sterility, pepper, mitochondria, *restorer-of-fertility*

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Horticultural Science

Effect of plastic house installation in pear orchard on reduction of frost damage and fruit quality

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Abstract

Recent climate change due to global warming is causing the increase in damage from low temperatures during flowering time in the domestic pear fruit industry. Among the low-temperature damage, frost damage caused by sudden low temperatures that occurs during the flowering period in April is the most problematic for pear trees. When frost damage occurs, the flower organs turn brown and the embryos are damaged, resulting in poor fruit set. In this study, a plastic house was installed in a pear orchard located in Nonsan-city, Chungcheongnam-do, and the effects on the incidence of late frost damage and the quality of fruit during the two consecutive years were investigated. As a result, the average temperature of the plastic house was 0.11 to 1.06°C higher than the control when the temperature of the orchard was 0°C and below. The rate of flower damage per flower cluster was 1.3 to 6.9% in the plastic house compared to 18.1 to 22.6% in the control group, showing a significant reduction. The number of fruits per flower cluster appeared higher in the plastic house than untreated control, indicating that the installation of a plastic house was effective in increasing yield. In the fruit shape index determined by length/diameter ratio, the plastic house grown fruits showed oblate shape (0.87) when compared with control (0.90). In addition, the fruit size and sugar content of the plastic house grown fruits showed better results than the control group. Consequently, this plastic house cultivation was expected to be used as a new horticultural practice that can contribute to the improvement of farm income in response to climate change in the future.

Key words: Frost damage, Fruit quality, Pear, Plastic house

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Environment & Forest Resources

Carbon and nutrient cycling by litterfall and fine roots in cool-temperate forest zones in Korea

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Abstract

Litter and fine roots are critical components of forest net primary productivity, representing a major pathway of nutrient and energy transfer to the mineral soil. The functional importance of aboveground litter and fine roots concentrates on the regulation of biomaterial circulation, conservation of soil and water, and maintenance of soil fertility, among various others. However, the spatiotemporal variation caused by confounding biophysical and environmental factors in the aboveground and the paucity of available information due to sampling limitations in the belowground hamper our understanding of litter and fine root properties, aboveground and belowground links, and their related inputs to forest biogeochemistry. This study is thus aimed at (1) quantifying litter production and associated elemental returns; (2) investigating above-and belowground relations via litter and fine root inputs; and (3) determining controls on litterfall production, fine root dynamics, and nutrient chemistry using both site-specific and consolidated datasets obtained from various research locales spanning the cool-temperate forest subzones in the northeast and warm-temperate forest subzones in the southern region of South Korea. Litterfall and fine root quantities are expected to be consistent with the range of reported values for temperate zones, as well as to have a significant relationship due to the congruence of limiting factors in the above- and belowground environments. At a regional scale, climatic factors particularly those related to temperature and precipitation are likely to affect litter and fine root properties, possibly due to the differentiated physiological response to meteorological shifts and changes in soil water and nutrient availability. The outcome of the study will contribute to the understanding of litter and fine root contributions to nutrient cycling in temperate forest ecosystems and to the improvement of above- and belowground representation in carbon budget and terrestrial simulation models.

Key words: Litterfall production, fine root dynamics, fine root mass, fine root production, nutrient cycling, terrestrial biogeochemistry, cool-temperate forest, warm-temperate forest

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Environment & Forest Resources

Effect of the understory vegetation and organic layer removal on the ecological characteristics of above- and underground of *Pinus rigida* plantation

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Abstract

In coniferous plantations, the over- and understory vegetations compete with each other for soil moisture and nutrients, and have complementary relationships about the nutrients supply and rapid changes of the environment, and so on. Understory vegetation removal can reduce competition for planted trees and other species. But the effects on conifer plantation ecosystems are poorly understood. This study was conducted to investigate the effect of the understory vegetation and organic layer removal on the ecological characteristics of the *Pinus rigida* plantation. The removal treatment was set in 2015, including control with 4 replications. In this research, the growth of planted trees (diameter at breast height, basal area, tree density), no. of bud sprout on the stem, the amount of the litterfall, the distributions of biomass and necromass of the fine roots (diameter $\leq$ 2 mm, 6 layers, 2 diameter groups) and soil physicochemical properties (4 layers) were investigated immediately after removal (2015), 5 years later (2020). After the understory vegetation removal, there were no significant differences in DBH, basal area, and tree density by year and treatment. No. of bud sprout on the stem were 2.9 (2015, P=0.019), 2.2 (2018, P=0.047), and 2.2 (2020, P=0.070) times higher in the removal than the control, respectively. The total annual litterfall was 27% higher in the control (679.1 g m^{-2}) than the remover (493.6 g m^{-2}). The total fine root biomass in the soil layer (0-30 cm) were 69.9 and 74.6 g m^{-2} in the control and remover, respectively. The total necromass were 39.3 and 40.3 g m^{-2}, respectively. Fine root biomass and necromass were located 57% and 45%, respectively, in the 0-10 cm layer. The fine root biomass did not show significant differences between treatments in all soil layers and diameter grades. But the necromass showed a significant higher in the remover (3.7 g m^{-2}) than control (2.0 g m^{-2}) in the 1-2 mm diameter (P=0.009). There were no significant differences in most of soil chemical properties, but total nitrogen and exchangeable calcium tended to decrease after removal. In this study, most of the understory vegetation and the organic layer did not have significant effects. However, it is necessary to analyze in detail the effects of removal on the various ecological characteristics (ex. microbial activities…) to increase understand of the coniferous plantation ecosystem.

Key words: Competition, Soil characteristics, Fine root, Litterfall, Forest ecosystem

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Environment & Forest Resources

Understanding patterns of above- and belowground phenology in pine and oak forests of Korea

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Abstract

Understanding patterns of plan phenology, which is one of the sensitive indicators representing plant response to climate change, is important to evaluate the function and productivity of ecosystems and establish countermeasures for conservation and adaptation of plant species. However, belowground phenology in forest ecosystems has not been fully investigated yet because of methodological limitations. Moreover, the timing of phenological events and abiotic factors affecting this timing have not been widely studied between above- and belowground ecosystems. In this study, we aimed to understand the response of plant phenology to changing climate by simultaneously investigating shoot and root phenology of *Pinus densiflora* (climate change vulnerable species) and accompanying species (*P. koraiensis*, *Quercus serrata*, *Quercus acutissima*) in Pocheon, Seoul, and Daejeon of Korea. We used a digital camera with a telephoto lens to periodically observe changes in aboveground shoot phenology. The root scanners were established in each site and then root images were monitored at 1-2 week intervals after soil stabilization. The birth-and-death process of fine roots and mycorrhizae was detected by analyzing scanned root images. Productivity rate of fine roots in pine forests was the highest in May for Pocheon and Seoul but two peaks of root productivity were observed in mid-June and the end of July for Daejeon. In oak forests, the peak of root productivity rate was found in May for Seoul and Daejeon while there was no distinct patterns of root productivity in Pocheon. The timing of mycorrhiza formation and disappearance was various among sites and stands. In Daejeon, the root disappearance rate was relatively high during the aboveground bud-burst period for both species. This study will contribute to understand the role and function of forest ecosystems in addressing global environmental challenges.

Key words: Climate change, shoot, fine root, *P. densiflora*, productivity

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Environment & Forest Resources

Aboveground Phenology of Vitex *Parviflora* J. on Dry Limestone Soil in Lobo, Batangas, Philippines

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Abstract

Vitex parviflora Juss. (Molave) has been recommended for reforestation projects and shelterbelts in the Philippines, but information on the phenology of the species is very limited. Thus, we investigated the phenology of *V. parviflora* mother trees which are naturally growing on dry limestone soil in Lobo, Batangas, Philippines to provide information on how to scale up the seedling production of the species for reforestation purposes. The stem diameter at breast height (DBH), total height (TH), and stem forking (SF) were measured. Trees with less than 25 cm DBH and 3 m height were not considered as potential mother trees. The leaf flushing, flowering, fruiting, and leaf shedding of *V. parviflora* were observed for two years (i.e., 2018 and 2019) and analyzed using circular statistics. The effects of environmental conditions (air temperature and precipitation) on the phenology of the species were also determined. The average TH and DBH were 6.81 m and 36.47 cm, respectively. The mother trees started to produce new leaves in mid-September until the end of rainy season and shed leaves during dry season from January until May in both observational periods. Thereafter, most of the mother trees flowered during rainy season (June to August) and the fruits started to develop gradually from July to September. Besides *in-situ* conservation implications, the findings of the present study may provide forest managers and seedling producers information on the best months to collect seeds in the study site for mass production of quality seedlings in the nursery for reforestation use.

Key words: leaf flush; limestone soil; Malvaceae; molave; reforestation; seedling production

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Environment & Forest Resources

Fine Root Dynamics and Fine Root Vertical Distribution at Different Ecosystems in South Korea

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Abstract

Fine roots contribute to the regulation of carbon and nutrient cycling in an ecosystem. Understanding about fine root dynamics and fine roots spatial distribution pattern at species level is essential for precise evaluation of productivity in whole ecosystems. Besides, previous studies on fine root dynamics and vertical distribution were usually conducted in woody ecosystems in subtropical and temperate regions but grassland and agricultural ecosystem. Therefore, in this study, we studied selected root traits in four different ecosystems including grassland, apple orchard, *Quercus acutissima* C. (QA), and *Pinus densiflora* Siebold & Zucc. (PD) plantations in Daejeon, Republic of Korea. Fine roots were characterized into two root diameter sizes (0-2 mm and 2-5 mm). Litterbag and intact core methods were used to examine decomposition rate and nutrient release of the two size class roots over one year period while fine root vertical distribution and seasonal dynamics of fine root mass were studied using sequential soil coring method. Root annual production and turnover rates were quantified using Decision Matrix approach. Expected results on fine root decomposition are fine roots (0-2 mm) decomposed more slowly than 2-5 mm roots of both tree species and differences in mass loss between size classes were smaller when using the intact core compared with litter bag. In addition, N release was much higher in the fine roots (0-2 mm). Thus far, results showed that overall root mass was highest in grassland, followed by QA and PD, lowest in apple orchard. Fine root mass 0-2 mm diameter and fine root mass 2-5 mm diameter differed significantly between four sites. In term of fine root vertical distribution, more than a half of fine root biomass and necromass in QA and PD were located in the soil layer from 0-15 cm and decreased with increasing depths, while in the apple orchard the biomass and necromass was not uniformly distributed from 0-30 cm. Root biomass and necromass dynamics in PD and QA revealed similar trend because of the similarity in soil characteristics while fine root biomass and necromass in apple orchard did not show clear vertical distribution. Our findings can improve the statement of investigating root dynamics should be based on root branching order, which might more adequately represent morphological traits, physiological functions and nutrient concentrations than root diameter classes. Moreover, study results also improve to model rooting depth profile in various ecosystems and ecological role played by fine roots in carbon cycling and storage.

Key words: fine root biomass, fine root necromass, fine root vertical distribution, annual production, turnover rate, sequential coring, grassland, apple orchard, pine stand, oak stand.

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Environment & Forest Resources

Effect of soil warming and litterfall manipulation on various leaf and fine root decomposition rate in forest ecosystem

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Abstract

In forest ecosystems, both root and leaf litter are main components for the nutrient cycle, carbon storage, soil organic matter, and other ecological functions. Further, climatic factors or atmospheric temperature have a significant impact on the rate of this litter's decomposition, among other factors. Global warming has been severe in recent years, and it is predicted that it will become more severe gradually at the end of this century. Despite their importance, there is still lack of knowledge on the decomposition rates of litter from different species in this changing global climate. This study advances our understanding of the warming effect on litter decomposition by highlighting the interaction effect of distinct species of leaf and fine root as well as organic litter manipulation. Therefore, the study objectives are (1) to reveal soil warming impacts on different species' leaf and fine root litter decomposition rates and (2) to examine organic litter change due to warming. We buried electric soil warming heating cables to the top of the soil surface and increased soil temperature by 4 °C above ambient temperature to measure various species litter decomposition and use litterfall manipulation to measure the organic litter changes. In addition, leaf and root litter bag methods will be used to determine both fine root and leaf decomposition. The expected results are that (1) litter decomposition will increase with increasing temperature, and leaf and fine root will become positively correlated, and (2) significant changes will occur in the organic litter. This study may add a significant contribution toward the understanding of predicting litter decomposition changes in the global biogeochemical cycle under a warmer climate, particularly in forest ecosystem function for sustainable forest management.

Key words: Soil warming, Organic litter decomposition, Fine root decomposition, Leaf decomposition, Forest ecosystem

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Environment & Forest Resources

Shorea sp. Waste Biochar for Increasing the Growth Rate of *Faltacaria moluccana*

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Abstract

Falcataria moluccana, one of Indonesia's mainstream forest product commodities, depends on its growth duration to increase productivity. The imperative factor affecting the growth rate of *F. moluccana* is the planting medium quality, where biochar, one of the pyrolysis products, is a soil-improving agent that can improve soil quality that is suspected can accelerate the growth of *F. moluccana*. This study aimed to determine the effect of biochar from meranti wood (Shorea spp.) waste pyrolysis at 400°C and 600°C with doses of 0 ton/ha, 25 ton/ha, and 50 ton/ha on the growth of *F. moluccana*. *F. moluccana* was planted within 2 m x 2 m in the field. The planting hole size was 100 cm x 60 cm x 60 cm; the biochar was placed with a thickness of 40 cm inside the planting hole and then covered with topsoil. This research used six months old *F. moluccana* seedlings planted in a field demonstration plot for 12 months. This research used the Split Plot experimental design with a Complete Random Design (CRD) 5 x 8. Data analysis used ANOVA) and was tested by Least Significance Different (LSD). The results showed that biochar with a dose of 25 tons/ha and pyrolysis temperature of 600°C significantly affected the growth increment of *F. moluccana* compared to other treatments and control. The effect of biochar could be seen since the 4th month of the plantation. Further research related to the dynamics of *F. moluccana* growth for a long time is needed because biochar's physical properties change underground over time.

Key words: *Falcataria moluccana*, *Shorea*, biochar, pyrolosis product

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Environment & Forest Resources

Fertilization responses of western hemlock and western redcedar in northern Vancouver Island

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Abstract

Forest fertilization is often implemented to improve seedling establishment, accelerate stand development for future wood supply, and enhance carbon sequestration. However, the inconsistent results of fertilization respsonses for western redcedar (*Thuja plicata* Donn ex D. Don) and western hemlock (*Tsuga heterophylla* (Raf.) Sarg.). A historical fertilization on northern Vancouver Island can provide a timely opportunity to address long-term responses of those species. The study site was revisited 30 years after establishment. Seedlings of western hemlock and western redcedar were planted at three densities (500, 1500, 2500 trees per ha) in two forest types (HA and CH sites) in 1988. Fertilization was applied at the time of planting, in 1993, and 2004. At age 30, both species showed strong growth responses to fertilization across the treatments. Increased mortality in the fertilized plots seemed due to increased competition with understory vegetation and crop trees in the plots with high planting density. Ingrowth volume differed by species and forest types. Among well-responded western hemlock trees, significantly higher sinuous rates were observed. The results imply that fertilization can increase productivity for both species but it may cause nutrient imbalance issues. Further research is required for a broader generalization of the fertilization responses.

Key words: mitigation; forest nutrient; speed wobble; wood quality; foliar nutrient analysis

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Environment & Forest Resources

The impact of combined drought, salinity and heat stress on plant growth and carbon distribution

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Abstract

Anthropogenically-driven surges in abiotic stress frequency and intensity are among the major drivers of global shift in plant environment. Impaired plant growth often stems from the confluence of various stressors whose individual effects are difficult to ascertain. However, the accelerating impacts of climate change necessitate the understanding of plant growth in response to various stress factors. The purpose of this study is to investigate changes in the plant growth and carbon distribution patterns following the introduction of drought, salinity, and heat stress in four representative species, i.e., *Metasequoia glyptostroboides*, *Cercidiphyllum japonicum*, *Hibiscus syriacus*, and *Zelkova serrata*. To distinguish individual and combined stress impacts, treatments will be applied using discrete [drought (D), salinity (S1, S2, S3), and heat (H1, H2)] and combinative approaches [drought and salinity (DS1, DS2, DS3), drought and heat (DH1, DH2)]. Height, root collar diameter, and biomass will be measured for plant growth, while carbon flow and distribution will be determined via stable isotope tracing. We hypothesize that combined stress will have a more negative effect on growth and carbon distribution than individual stress. This study will contribute to the understanding of plant response mechanisms and survival strategies under stress via carbon distribution.

Key words: plant stress, drought stress, salinity stress, heat stress, carbon distribution

Acknowledgement

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Environment & Forest Resources

Aboveground growth dynamics of Picea mariana in a boreal forest in Canada

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Abstract

Recent global climate change could cause boreal forests to become carbon sources instead of large carbon sinks. Therefore, a robust prediction of the carbon uptake capacity of such forests is necessary. Even though biomass production through tree growth represents the amount of carbon stored by forests, reconstructing annual leaf production in evergreen conifers is still challenging and the estimation of woody tissue production still requires numerous assumptions. Stem cambial growth at breast height and stem apical growth have been used as indicators of annual tree growth when investigating the climate response of the amount of carbon stored by trees. However, the interannual variation of stem cambial and apical growths do not necessarily proceed synchronously. The central motivation for this presentation is to clarify the fundamental rules for annual aboveground productions and their response to the climatic conditions of a boreal tree species, *Picea mariana*. Annual aboveground productions were examined separately for photosynthetic organ-leaf and non-photosynthetic organs-branch and stem. The growths of non-photosynthetic organs were further divided into apical and cambial growths. For photosynthetic organ, a new method was proposed to reconstruct the past yearly variation in leaf production using annual shoot length as an index. The estimated leaf production was compared with both annual stem cambial growth and the climate. For non-photosynthetic organs, interannual variations of apical and cambial growths on stem and branch were examined. Each aboveground production behaved responds differently to the internal and external factors, as a result of which each growth had their own interannual variation. Finally, I concluded that it leads to misunderstandings about the climate response of tree growth when only one part of the growth is used as an indicator of whole tree growth. The present thesis promotes understanding of the fundamental characteristics of annual aboveground productions and tree's response to the environmental conditions of a boreal conifer species, *Picea mariana*.

Key words: Aboveground biomass production, Boreal forests, Yearly variation

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Environment & Forest Resources

Production and decomposition of mycorrhizal hyphae in Japanese cypress plantations

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Abstract

Carbon (C) assimilation by forests is a significant counterweight to anthropogenic C emissions to the atmosphere. Understanding of the drivers of forest C cycling is, therefore, crucial for climate change projection and mitigation. Most forest trees live in symbiosis with mycorrhizal fungi: Mycorrhizal fungi use extraradical mycorrhizal hyphae (EMH) to acquire inorganic nutrients such as nitrogen and phosphorus from the soil and provide them to their plant hosts; in exchange, mycorrhizal fungi receive up to 20% of the plant-assimilated C in forests. Through this resource exchange, the production and decomposition processes of mycorrhizal fungi and, in particular, EMH become important drivers for forest C cycling. In recent decades, EMH production and decomposition has, hence, been studied at more than 150 forest sites. However, most of these sites were in cold-temperate forests where trees associated with ectomycorrhizal (ECM) fungi. In contrast, our understanding of EMH production and decomposition in warm-temperate forests, where arbuscular mycorrhizal (AM) fungi often dominate, is limited. In this presentation, the results of two studies in Japanese warm-temperate forests of hinoki cypress (*Chamaecyparis obtusa*), an AM tree species, are outlined. Firstly, evidence for the close coupling of EMH production to the C assimilation of hinoki cypress trees is shown. Secondly, evidence for a rapid decomposition of EMH in hinoki cypress forests, with an initial half-life of only 10 days, is shown. Presented results highlight EMH processes as important drivers of the C cycling in warm-temperate forests of AM trees and indicate the need for further study.

Key words: Arbuscular mycorrhizal fungi, extraradical hyphae, forest carbon cycle

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Applied Biology

Discovery and analysis of a quantitative trait locus associated with resistance to *Meloidogyne incognita* in *Glycine latifolia*

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Abstract

Perennial *Glycine* species are potentially valuable genetic resources that can improve disease resistance in soybean by hybridization or gene transfer techniques. From our initial screening of 18 accessions of 10 perennial *Glycine* species for resistance to *Meloidogyne incognita*, *G. latifolia* plant introduction (PI) 559300 had a higher level of resistance to *M. incognita* than the resistant soybean check cv. Forrest. Therefore, the goal of this research was to identify chromosomal regions associated with resistance to *M. incognita* in *G. latifolia* by phenotyping recombinant inbred lines derived from resistant (PI 559300) and susceptible (PI 559298) *G. latifolia* accessions and single nucleotide polymorphism markers generated through genotyping by sequencing. The analysis identified a single region from about 8.63 to 9.89 Mbp for *M. incognita* resistance on *G. latifolia* chromosome (Chr) 13 that explained 32.7% of the phenotypic variance. This region contains 74 putative genes based on soybean sequences used for annotation. Synteny analysis suggests that the region on Chr 13 is syntenic with a locus on *G. max* Chr 13 previously found associated with resistance to *M. arenaria*, *M. incognita*, *M. javanica* and other non-nematode pathogens that infect soybean. It appears that one or more genes on *G. latifolia* Chr 13 is responsible for resistance to *M. incognita* which could be useful to improve soybean resistance to *M. incognita*.

Key words: *Glycine latifolia*, *Meloidogyne incognita*, resistance

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Applied Biology

Characterization of Streptomycin Resistant *Erwinia pyrifoliae* Strain Isolated from Apple Orchard in Korea

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Abstract

Erwinia pyrifoliae was first reported in 1995 in Korea as a causal agent of black shoot blight in apples and pears. One of the main strategies to control *E. pyrifoliae* is spraying antibiotics such as streptomycin, and tetracycline during flowering period. In 2021, a streptomycin resistant strain *E. pyrifoliae* was isolated from apple orchard in Gwangju, Korea, and this strain has a point mutation in the internal region of the ribosomal *rpsL* gene at codon 43. In this study, we investigated biological characteristics of streptomycin resistant strain of *E. pyrifoliae* (EpSmR) including minimum inhibitory concentration (MIC) of varies antibiotics, growth rate and bacterial motilities. Based on MIC assay, EpSmR showed highly resistance to streptomycin and copper than the streptomycin sensitive strain *E. pyrifoliae* YKB12327, but not in kanamycin, gentamicin, validamycin, kasugamycin, and ampicillin. Interestingly, EpSmR showed significantly reduced growth rate in LB and AB minimal media, and bacterial motilities in swimming, swarming and twitching compared to the strain YKB12327. These results suggest that spontaneous point mutation at *rpsL* gene in *E. pyrifoliae* effect not only antibiotic resistance, but also changed biological function of the bacteria. This is the first report of biological characteristics in streptomycin resistant *E. pyrifoliae*.

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Applied Biology

The Chili pepper NAC transcription factor *CaNAC06* regulates the drought and salt tolerance of transgenic *Nicotiana benthamiana*

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Abstract

The increasing global temperature and the worst climate changes not only bring disastrous consequences such as rising sea water level and generating flooding, but also causes extended periods of drought and extreme soil salinity. These changes threaten the availability of our food. Genetically modified crop with resistance gene is one sure approach to boost the yield of the crop and increase resistance to various stresses. NAC (for NAM, ATAF1/2, and CUC2) proteins, which are plant-specific transcription factors (TFs) have been analyzed to play an important role in plant defense responses and in diversified developmental processes. In this study, we aim to identify the essential TF of *Capsicum annum* and characterize its roles. First, *Capsicum annum NAC06* (*CaNAC06*) was isolated from the leaves of chili pepper during a hypersensitive response to infection by the bacterial pathogen (*Xag*8ra). Second, the full-length cDNA fragment of *CaNAC06* gene (885bp, 294-amino acids) was cloned into the pCAMBIA2300-expression-vector, receiving (pCAMBIA2300-CaNAC06), and transformed into *Nicotiana benthamiana* under the control of CaMV 35S promoter by *Agrobacterium*-mediated transformation method. The transgenic plants overexpressing *CaNAC06* showed two different phenotypes; i) mild stunted phenotype (M) with mild leaf curling and reduction of the size of reproductive organs, ii) severely stunted phenotype (S) with severe leaf curling, immensely reduction of plant height, leaf size, flowers, and failure to bear fruits. In addition, we found that *CaNAC06* has transcription activator activity, which depends on its C-terminal region. As well, we also demonstrated that *CaNAC06* positively regulates abiotic stress tolerance by modifying the root architecture, maintaining higher leaf chlorophyll content, and upregulating the stress response-related genes, such as *NbLEA* and *NbDhn* under stressful conditions. Taken together, data obtained in this study provide strong evidence that *CaNAC06* gene is responsible for proper plant growth, and development, and has a crucial role in the activation of defense responses against abiotic stresses. Therefore, our finding provides information for further research of genetic analysis and may be a potential breeding target for developing stress-resistant crops.

Key words: Chili pepper, NAC protein, stress tolerance, transgenic plants

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Applied Biology

Role of Plant Growth Promoting Rhizobacteria (PGPR) - *Microbacterium azadirachtae* CNUC13 in Amelioration of Plants Under Abiotic Stress

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Abstract

Accumulating evidence indicates that ecologically and environmental-friendly plant growth promoting rhizobacteria (PGPR) can enhance crop growth and reduce the negative impacts of salt and drought stress through regulation of some molecular, biochemical and physiological features. In the present study, *Microbacterium azadirachtae* strain CNUC13 was isolated from maize rhizosphere soil. This strain tolerated up to 1000 mM NaCl and 30% PEG 6000 and showed growth-promoting traits like phosphate solubilization, siderophore, and IAA production. The results showed that seed-priming with *M. azadirachtae* CNUC13 strain could protect maize from salt stress by regulating plant growth performance, photosynthetic capacity, lipid peroxidation, reactive oxygen species, and antioxidant enzyme levels. Furthermore, this study also investigated the effects of volatile organic compounds (VOCs) emitted by *M. azadirachtae* CNUC13 mediated enhancement on *Arabidopsis thaliana* seedlings' growth under osmotic (middle and severe) stress and inhibition of phytopathogens. Real-time quantitative PCR analysis investigated the positive correlation between plant performance and gene expression involved in the ABA-dependent pathway and ABA-independent pathway. In addition, bacterial VOCs profiles were obtained through solid-phase micro extraction and analyzed by gas chromatography coupled with mass spectrometry; dimethyl disulfide (DMDS), methyl thioacetate, and benzene acetic acid were identified to be produced by CNUC13. Meanwhile, results demonstrated that the VOCs of CNUC13 could inhibit plant pathogenic fungi, including *Colletotrichum scovillei*, *Fusarium oxysporum*, *Pythium graminicola*, *Phytophthora capsici*, and *Rhizoctonia solani*. This study confirmed the significant plant growth promotion and biocontrol potential of *M. azadirachtae* CNUC13 and should be characterized further for field application.

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Animal Science

Oxidative stress is relieved during in vitro maturation of porcine oocytes through the assistance of amniotic stem cells conditioned medium

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Abstract

Assisted reproductive technique (ART) is a biotechnology technology for reproduction and physiology of animals that contributes to efficient reproduction of industrial animals. In vitro maturation (IVM) is an early stage of ART, highly correlated with pre-transplantation embryonic development. In particular, oocytes produced *in vitro* are exposed to high oxygen concentrations outside, which increases reactive oxygen species (ROS). ROS and glutathione (GSH) are naturally produced during oxygen metabolism; ROS causes critical damage toward the cell, meanwhile GSH takes a role as an antioxidant resisting oxidative stress. Excessive ROS during IVM can cause lipid peroxidation and DNA fragmentation, which can affect RNA transcription and protein synthesis. To support oocytes from *in vitro* defects, adding conditioned medium (CM) to the culture medium is an effective approach. CM contains various factors secreted by the cells during culture. Depending on which cells were cultured, the CM tends to possess the similar properties as its cells. Amniotic fluid is well known to provide essential nutrients during embryogenesis as a protective solution for fetal growth, and amniotic fluid stem cells (AFSC) have proved to stimulate tissue regeneration, reduce tissue damage, and inhibit cell apoptosis through the paracrine effects. However, the effects on oocytes and cumulus cells (CCs) during IVM remains unknown. The aim of this study was to investigate the antioxidant effect of equine AFSC-CM retrieved from early passages (3, 5, 7) on nuclear maturation, ROS, and GSH level of oocytes during porcine IVM. Moreover, the effect of AFSC-CM toward embryo development competence, total cell number of blastocysts (BLs), real time-qPCR with cumulus cells and BLs of antioxidant genes (SIRT1, SIRT6) was evaluated, and antioxidant enzyme activity; superoxide dismutase (SOD), catalase (CAT) within the CM was observed. Despite no difference in oocyte nuclear maturation, the ROS level in CM groups were significantly lower than the control group by 0.3 times, and the GSH value of CM-P7 was 1.82 times higher than the control group ($p<0.001$). SIRT1 and SIRT6 in CC were up-regulated in the CM groups than control ($p<0.05$). SIRT1 in CM-P7 BLs showed higher expression levels than control and CM-P3 ($p<0.05$). ROS was lower in CM-P7 BLs compared to control and CM-P3 ($p<0.05$). SOD and CAT showed higher activity in pre-medium of CM groups than control, only CM-P7 maintained high activity till 2nd-medium ($p<0.05$). In conclusion, this study demonstrated that CM-P7 of AFSCs supports the expression of antioxidant-related genes enhanced oocyte quality, improving embryonic development.

Key words: Antioxidant, Conditioned medium, Stem cell, Oocyte maturation, Embryo Development

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Animal Science

Dietary probiotics on growth performance and immune responses of weaned pigs

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Abstract

Dietary probiotics has been well studied that it could be alternatives to antibiotics because of their ability to reduce diarrhea and improve the growth performance of weaned pigs. This study was conducted to investigate effects of dietary probiotics on growth performance, nutrient digestibility, intestinal morphology, and immune response of weaned pigs. A total of 40 weaned pigs (7.01 ± 0.86 kg body weight [BW]; 28 d old) were randomly assigned to two treatments (4 pigs/ pen; 5 replicates/treatment) in a randomized complete block design (block = BW and sex). The dietary treatment was either a typical nursery diet based on corn and soybean meal (CON) or CON supplemented with 0.01% probiotics containing a mixture of *Bacillus subtilis* and *Bacillus licheniformis* (PRO). Fecal samples were collected daily by rectal palpation for the last 3 days after a 4-day adaptation. Blood, ileal digesta, and intestinal tissue samples were collected from one pig in each pen at the respective time points. During overall experimental period, pigs fed PRO had higher ($p < 0.05$) average daily gain than those fed CON, but no differences were found on feed efficiency and intestinal morphology between CON and PRO. Pigs fed PRO had higher ($p < 0.10$) crude protein of apparent total tract digestibility than those fed CON. The PRO increased ($p < 0.10$) the serum transforming growth factor-β1 on d 7 and 14 and tumor necrosis factor-α on d 7 compared with the CON. In conclusion, dietary probiotics improved growth rate and modulated immune system of weaned pigs.

Key words: Growth performance, immune response, probiotics, weaned pigs

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Animal Science

Comparison of the growth performance of White Pekin ducks under different bedding materials from hatch to day 42

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Abstract

The main objective of this study was to investigate whether the different commercially available bedding materials including i) coco peat, ii) rice husks, or iii) sawdust could affect the growth performance of ducks over 42 days. 288 one-day-old White-Pekin ducklings (60.48 ± 0.16 g) were randomly allocated into floor pens with one of the three bedding materials. A total of 24 pens with 12 ducklings per cage and 8 replicate pens per treatment were used. Birds were fed a starter diet from day 1-21 and a grower diet from day 22-42. Body weights (BW) and feed consumption were measured weekly. Upon using the collected BW and feed consumption data, the average daily feed intake (ADFI), average daily gain (ADG), and feed conversion ratios (FCR) were calculated. Obtained data were analyzed for statistical significance at $P < 0.05$. Higher body weights ($P < 0.05$) were noticed with rice husks at day 42 only. Improved daily gains ($P< 0.05$) were noticed for birds raised with rice husks over the entire period (day 1-42). Concerning the ADFI, improvements ($P< 0.05$) were similarly noted with rice husks for the starter, grower, and entire period. For the FCR, lower values ($P< 0.05$) that signify improved feed efficiency were noted with the bedding material as rice husks at d 35 ($P= 0.036$), grower period ($P= 0.008$), and the entire period ($P= 0.009$). Our results suggest the existence of a relationship between the type of bedding material provided and the growth performance of ducks.

Key words: Bedding, coco peat, growth performance, rice husks, sawdust.

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Animal Science

Roles of different molds on dry-aged beef as a potential starter: Effect on their proteolytic activity, physicochemical and sensory quality, and functionality

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Abstract

The objective of this study to investigate the effect of different molds on dry-aged beef as a potential starter. *Penicillium candidum* (PC) and *Penicillium nalgiovense* (PN) were used as major strains. A total of 120 beef sirloins were inoculated with PC, PN, and their mixture (1:1, PCPN) and non-inoculated samples were used as control. Then, all samples were dry-aged for 21 days and analyzed for their molds growth, proteolytic activity, physicochemical and sensory quality, and functionality at 7 days interval. As a result, each mold in PC-, PN-, and PCPN-inoculated samples remained at high population during whole dry aging period, showing their growth capacity at refrigerated condition. Different molds have different impact on physicochemical and sensory quality, and functionality possibly due to their different proteolytic activity. PC and PN increased aroma volatiles and flavor compounds [free amino acids (especially Ala, Pro, and Asp) and nucleotides], respectively. However, when PC and PN were used together as mixture, it induced different changes in quality and functionality of dry-aged beef from the PC- and PN-inoculated samples. Taken together, application of molds can be effective for dry-aged beef and each mold may have different roles during aging period. Starter of dry-aged beef should be selected carefully, considering consumers' need. Also, their combination can have other advantageous effect on dry-aged beef, therefore, optimal ratio of PC and PN should be investigated before its usage as a starter.

Key words: beef, dry-aging, starter, quality

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Animal Science

Development of nutrigenomics based precision management model for Hanwoo steers; Genomic selection for marbling and feeding different dietary energy levels.

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Abstract

Hanwoo (Korean native cattle) has been genetically improved to produced high marbled beef over the past few decades. Focusing high marble deposition, Hanwoo feedlot system uses high-energy diet over the prolonged fattening period. However, due to the individual genetic variation, around 40% of them are graded into inferior quality grades(QG), despite they utilized the same resources. Therefore, focusing to develop a nutrigenomic based precision management model, this study was to evaluate the response to the divergent selection on genetic merit for marbling score(MS), under different dietary TDN (total digestible nutrient) levels. Total of 112 calves were genotyped and initially grouped for estimated breeding value (high and low) for marbling score(MS-EBV). Subsequently, managed under two levels of feed TDN% (basal diet, + 3%TDN increase) following 2X2 factorial arrangement. As the direct response to the selection was significant, the results confirmed the importance of initial genetic grouping of Hanwoo steers for MS-EBV. However, dietary TDN level did not show an effect ($P > 0.05$) on the MS. The present results showed no correlation response ($P > 0.05$) on the carcass traits; Backfat thickness (BFT), Eye Muscle Area (EMA) and Carcass Weight (CWT) indicating especially that the selection based on MS-EBV can be used to enhance the MS without undesirable effect on BFT. Further, no genetic-by-nutrition interaction ($P > 0.05$) for all the carcass traits were also observed. However, MS-EBV significantly lower the meat quality traits; shear force, cooking loss and protein content. Dietary TDN level show a positive association ($P < 0.05$) with meat colour CIE a* and CIE b*. The Low- and High-MS-EBV steers were almost similar in the fatty acid profile. However, dietary TDN level showed an effect ($P < 0.05$) on SFA C14:0 and C18:0, MUFA C16:1n-7 and PUFA C18:2n-6 and C18:3n-3. In addition, there was no significant effect of either genetic merit or nutrition on growth performances. Ultimate turnover of the Hanwoo feedlot operation is primarily determined by the QGs. The present model shows that the initial grouping for MS-EBV increased the proportion of carcasses graded for higher QGs (QG1 ++ and QG1 +) by approximately 20%. Moreover, there appear to be a potential to increase the proportion of QG 1 ++ animals among the high-genetic group by further increasing the dietary energy content. Overall, this nutrigenomic based precision management strategy suggests the importance of adopting an MS based initial genetic grouping system for Hanwoo steers with a subsequent divergent management based on dietary energy levels.

Key words: Genetic merit for marbling, feed energy level, Response to the selection, Meat quality, Hanwoo

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Dairy Science

Starter culture of Mongolian traditional fermented milk products and their application for Probiotic development

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Abstract

The tradition of making fermented milk products and their starters , which is inherited to this day through the Mongolian family - herdsmen's for many centuries, is one of the most unique and rich resources of lactic acid bacteria. We are 357 bacterial strains isolated from 22 "Airag" and 29 "Tarag" in Mongolia, were identified phylogenetically based on rDNA and functional genes sequences. The microbial composition in fermented horse milk "Airag" was more diverse than that of "Tarag"(one of kind similar yogurt).We confirmed that Airag and Tarag had unique LAB compositions, that is, *L. helveticus*, *L. kefiranofaciens* were the predominant in Airag, whereas *L. delbrueckii subsp*. *bulgaricus*, *L. helveticus* and *S. thermophilus* were the predominant in Tarag. These findings suggested strongly that the differences among the animal species from which the milk was sourced, were the most important factors influencing the diversity of microbial composition.

The obtained information on microbial compositions from our research study of Airag and Tarag are fundamental aspects for the selection of effective strains for probiotic products with distinctive features of Mongolia and compling their collection. With the aim of most effective strains suitable for probiotics, we have isolated more than hundred primary cultures from traditional fermented dairy products. As a result of the study, we have received registered and patented a number of the best effective strains suitable for use in the probiotics and developed probiotic production technologies. Thanks to the successful development of patented technologies, " Monbiotic" Startup Co., Ltd was organized at the IVM of MULS, where the production of Lactos containing probiotic strains *L.helveticus LBMA 44c* and L.*bulgaricus subsp LBMA 65b* and Lactobacterin CTX containing strains *L.plantarum LBO78* and *L.reuteri LBO50* has already started.

Key words: lactic acid bacteria, DNA , fermented milk products

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Dairy Science

Comparison of buffering capacities of breast milk with those of infant formulas and bovine skim milk

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Abstarct

Maximum buffering capacity of bovine skim milk occurring at ~5.2 is known to be due to presence of calcium phosphate inside casein micelles. Comparative studies on buffering capacity were made between breast milk and proprietary infant formulas. Breast milk was taken on the stage of lactation in days 15, 90, 120, and 240. It was found that the maximum peak of buffering capacity in breast milk took place at 6.1~6.4, which was different from that of bovine skim milk. This indicates that the form of calcium phosphate in bovine milk was not the same as one in breast milk. Buffering capacities (area formed by forward and back titration) decreased in the order of 90>120>240>15 days. In order to look at similarity of infant formulas to human milk, buffering capacities of three brands of formulas were measured and compared. Although buffering peaks occurred at pH from 4.7 to 5.2, none of them was close to that of human milk. The manufacturers of infant formula should be aware of these different buffering peaks, and do something to match these peaks.

Key words: Buffering capacity, Breast milk, Infant formular

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Dairy Science

Current status of animal byproduct utilization in Indonesia

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Abstract

Indonesia is the world's largest archipelagic state and the 14th-largest country by area, at 1,904,569 square kilometers (735,358 square miles). With over 275 million people, Indonesia is the world's fourth-most populous country and the most populous Muslim-majority country. The livestock sub-sector contributes to the national economy and can absorb labor significantly so that it can be relied on in efforts to improve the national economy. In addition, the availability of livestock products will directly improve the nutritional status of the community, especially for the fulfillment of calories and animal protein. However, livestock activities produce waste, which is the source of air, water, dan land pollution, if they are not well treated and managed. Several technologies are applied to treat livestock waste to convert it into a more add value product and save the environment. This presentation aims to show the current situation of livestock waste, byproducts in Indonesia, and the technologies applied to manage it. Furthermore, several studies conducted before handling the animal byproduct are also presented, such as utilizing eggshell waste from the hatchery industry and local animal byproducts for other sectors.

Key words: Indonesia, livestock, by product, eggshell, bioconversion

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Dairy Science

Influence of dairy manure as inoculum source on solid-state anaerobic digestion of swine manure

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Abstract

Inoculation is the widely used method to improve the efficiency of solid-state anaerobic digestion (SSAD) with a high organic load. This study was conducted to prove the potential of dairy manure as an inoculum source for SSAD of swine manure. Also, an appropriate inoculum-to-substrate (I/S) ratio was determined to improve methane yield and reduce the hydraulic retention time of SSAD. We carried out 171 days of anaerobic digestion for five different I/S ratios (3, 1, 0.33 on a volatile solid basis, dairy manure alone, and swine manure alone) of manure, using lab-scale batch reactors in mesophilic conditions. As a result, solid state swine manure inoculated with dairy manure can be digested without inhibition caused by ammonia and volatile fatty acids accumulation. The highest methane yield potential (acquired through the Gompertz model) was observed in I/S ratios 1 and 0.33, as 133 and 145 mL CH_4 g^{-1}-VS, respectively, rather than swine manure alone. The lag phase of swine manure alone was longer in 42 to 45 days than other treatments which contained dairy manure, it directly related to tardy start-up. These results reveal that dairy manure can be used as an inoculum source for SSAD of swine manure. The proper I/S ratios to lead to successful SSAD of swine manure were 1 and 0.33.

Key words: Solid-state anaerobic digestion, Inoculation, Swine manure, Dairy manure

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Dairy Science

Odor reduction effect of rice husk biochar addition on the bedded pack dairy barn

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Abstract

With the accelerated growth of the livestock production industry, as well as environmental and health issues, odors have been a public concern. Odor reduction strategies that can be directly applied to the source of odor have been preferred for cattle barns with open or partially enclosed housing. Among the various odor mitigation technologies, the addition of biochar is not only effective in reducing odor emission but also can support controlling bedding moisture content and alleviating nutrient loss in the form of leachate and gas.

This study evaluated the odor abatement effect of adding rice husk biochar to the bedded pack of the dairy barn for 21 days using 14L reactors. Rice husk biochar was only mixed with dairy manure (2.7kg) and sawdust (0.25 kg) mixture at different ratios (Treatment-1: 5% of total solid, Treatment-2: 10% of total solid) at the start of the experiment. 0.4kg of dairy manure was added twice in total every seven days.

In treatments-1 and 2, NH_3 emissions were reduced by 27% and 43%, respectively, compared with control ($p<0.05$). Methyl mercaptan (CH_4S, MM) and dimethyl sulfide (C_2H_6S, DMS) respectively accounted for 2.1-16.3% and 81.7-96.9% of the analyzed total sulfur compound. Only total DMS emission showed a 53% reduction rate with treatment-1 and a 75% reduction rate with treatment-2 ($p<0.05$). In the case of odor unit and odor intensity measured by sensorial methods, treatment-2 had 30-51% of odor unit mitigation effects by 7 days (before 1st additional manure addition) and 21-48% of odor intensity mitigation effects by 7 days (after the 1st additional manure addition). Treatment-1 exhibited only 20% of odor intensity reduction 30 minutes after the commencement of experiment.

Key words: Rice husk biochar, Bedded pack dairy barn, Odor mitigation

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Dairy Science

Evaluation of enteric methane emission from growing and finishing pigs

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Abstract

Among greenhouse gases, methane is known to be a major factor in climate change. Most of the methane emitted from the livestock industry occurs during intestinal fermentation. 7.4% of domestic intestinal methane emissions are emitted from the intestinal fermentation process of pigs. Since the enteric methane emission factor for domestic swine operation has not been developed, the IPCC Tier 1 approach default methane enteric fermentation factor, 1.5 kg CH_4 $yr^{-1} \cdot head^{-1}$, is used. Therefore, this study was conducted to develop domestic enteric fermentation methane emission factor of pigs according to the growing stage. This experiment was carried out on growing pigs up to 2-4 months old and finishing pigs up to 4-6 months old using the respiration chamber designed and manufactured to determine the enteric methane emission. The ventilation rate was maintained at 304.7±0.90L per minute, and methane concentration was measured using a real-time monitoring system. The recovery rate of the enteric methane emission evaluation chamber used in this study was 101.7±0.90%. This experiment was conducted on 18 growing pigs and 12 finishing pigs for each growing stage using three respiration chambers. The pigs were given free access to water and fed ad libitum throughout the entire experiment period. As a result of the study, the methane emission rate was 0.86±0.19 g/head/day for grownig pigs and 3.7±0.50g/head/day for finishing pigs. The enteric methane emission rate of finishing pigs was about four times higher as that of growing pigs ($p<0.05$). According to 1 kg of body weight, the daily methane emission per head is 13.1±2.45mg of growing pigs, while the finishing pigs was 35.7±13.02mg, which was 2.7 times higher than growing pigs ($p<0.05$).

Key words: Pig, Enteric fermentation, Respiration chamber, Methane

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Agricultural & Rural Engineering

Integrated Tool to Assess Climate Change Impacts on Extreme Rainfalls

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Abstract

In recent years, it has been recognized that society has become more vulnerable to extreme weather and climate events. Continuing population growth, land use changes, and industrial development will further increase vulnerability by creating more potential for catastrophic impacts from climate extremes. In view of these important issues, many studies have been carried out to investigate the variation in extreme climatic events. Of particular interest for water management are the investigations of precipitation change that have revealed some empirical evidence of the increase trends in precipitation extremes over many regions of the world. Hence, it is essential to know whether the past extremes could be well extrapolated into the future under changing climate conditions. General Circulation Models (GCMs) have been commonly used to investigate climate change impacts on hydrological regime. However, outputs from these modes are not suitable due to too coarse resolution in space and in time. Many downscaling methods have been hence proposed to describe the linkage between GCM predictors to regional/local weather properties. Of particular importance for the estimation of extreme rainfalls for small urban watersheds are those downscaling procedures dealing with the linkage of the large-scale climate variability to the historical observations of the sub-daily rainfall extremes at a local site. Hence, in this study a decision support tool for statistical downscaling of extreme rainfall processes (SDExtreme) was developed to assess the climate change impact on the extreme rainfalls at a given location. The feasibility and accuracy of SDExtreme were assessed using rainfall data available from the selected rain gauge stations in Ontario provinces (Canada), and climate simulations under three different climate change scenarios provided by the Canadian Earth System Model (CanESM2) and the Canadian Regional Climate Model (CanRCM4).

Key words: extreme rainfall, climate change, climate change adaptation, floods

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Agricultural & Rural Engineering

Understanding the ANN algorithm for the improved hydrological modeling and forecasting

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Abstract

Artificial neural networks (ANNs) were tested extensively in hydrologic modeling in the 1990s, once the mathematical concept of the network training, back-propagation algorithm, was established in 1986. In the review paper of the Journal of Hydrologic Engineering (ASCE) published in 2000, various applications in hydrologic fields were introduced with the core concepts of ANN and back-propagation algorithm.

However, the performance of ANN model was not sufficient at that time due to the limited computing power, lack of digital data, and insufficient understanding on the neural network algorithm. By the time ANN received its first attention in the 1990s, digital data and observation data were not sufficient to train the network properly. At the same time, computing power was insufficient to train the network in various forms of structures. Furthermore, there was a lack of understanding regarding the training process. However, these problems have been solved one by one with improved training techniques, such as ADAM, Xavier Initializer, and ReLU. Over the last several decades, we also have accumulated a large amount of observation data in digital format, and computing power has been upgraded drastically. Owing to GPU and deep-learning packages, such as Keras and TensorFlow, even beginners can easily utilize high-tech neural network algorithms.

In this presentation, a brief history of ANN will be introduced including the limitations of the algorithm as well as the ways that we breakthrough to improve the performance of the algorithm. Several application examples will be introduced, such as dam inflow modeling considering snowmelt, hourly based river stage forecasting, short-term rainfall forecasting and spatial downscaling of precipitation data. Important considering points including limitations and advantages will be discussed.

Key words: Artificial Neural Networks; Hydrological Modeling; Hydrological Forecasting; Input Variables

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Agricultural & Rural Engineering

Comparative self-sensing performance of cement-based and asphalt-based concretes containing carbon nanomaterials

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Abstract

Recently, research and development is underway on conductive concretes containing carbon nanomaterials. The self-sensing performance of these conductive concretes can be utilized for various purposes, including damage detection of road pavement, vehicle speed detection, and overloaded vehicle weight detection, without the need for additional sensor installation, thus providing excellent economic and maintenance efficiency. In this study, self-sensing performance of two different types of pavement materials, such as cement-based concrete and asphalt-based concrete, were evaluated and compared by assessing the stress-resistivity relationship under a cyclic load. Two different types of carbon nanomaterials, i.e., carbon fiber (CF) and multi-walled carbon nanotube (MWCNT), were incorporated into the concretes at 1% to provide conductivity of the pavement materials. The test results show that both types of concretes exhibited sufficient self-sensing capacity when they contained 1% of carbon nanomaterials. The cement based-concrete showed similar self-sensing performance regardless of the types of carbon nanomaterials, whereas the asphalt-based concrete having MWCNT showed improved self-sensing capacity than that containing CF.

Key words: self-sensing, cement-based concrete, asphalt-based concrete, carbon nanomaterial

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Agricultural & Rural Engineering

Effects of UHPFRC layer thickness on flexural performance of conventional concrete-UHPFRC composite beams

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Abstract

Previous research has demonstrated the benefits of using Ultra-High-Performance Fiber-Reinforced Concrete (UHPFRC) on the structural members, such as beams and columns, to ensure significantly high strength, toughness, and durability. However, application of UHPFRC is very limited due to significantly high unit cost of the material itself. The use of a thin UHPFRC layer together with conventional concrete is a promising and effective method because it takes advantage of the structural benefits of UHPFRC while minimizing the use of expensive materials. Therefore, this study aimed to evaluate the strengthening effect of conventional reinforced concrete (RC) beam with UHPFRC under flexure. The strengthening thickness of UHPFRC layer, such as 30 and 70mm, was mainly considered as the test variable. The effects of steel fiber types and volume fractions of UHPFRC on the strengthening efficiency of the RC beams were also evaluated. The results showed that the higher flexural stiffness and load carrying capacity of RC beam can be obtained when it was strengthened with 70-mm layer of UHPFRC at the fiber volume fraction of 1.5%. The thicker UHPFRC layer was effective to increase the flexural strength of RC beam, but ineffective in terms of the ductility.

Key words: RC beam, strengthening effect, UHPFRC, layer thickness

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Agricultural & Rural Engineering

Pollution accident analysis using 1D hydraulic model (K-River)

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Abstract

With the establishment of the Basic Plan for the Promotion of the Heavy and Chemical Industry in the 1970s, the number of domestic industrial complexes has been continuously increasing. Accordingly, the discharge of various industrial wastewater is increasing, and water pollution accidents are occurring frequently. In the Nakdong River, there have been 30 tons of phenol leak at the Gumi Industrial Complex in 1991, an organic solvent contamination accident in 1994, and a phenol leak at the Gimcheon Industrial Complex in 2008. There were 14 of these cases and 13 cases of fire wastewater leakage. The main causes were accidents caused by improper storage of oil, damage to old facilities, inexperienced facility operation, and negligence in management, such as factory fires. Such water pollution accidents can adversely affect the ecosystem or human health in the short and long term. For this reason, the water pollution accident model is an important tool in responding to water pollution accidents. Water pollution accident analysis should be able to be executed accurately and quickly. However, the current EFDC (Environmental Fluid Dynamic Code) water quality model and HSPF (Hydrological Simulation Program-Fortran) watershed model, which are used to respond to water pollution accidents, require a lot of simulation execution time because the program structure is complex. Therefore, it is necessary to develop a model that can accurately simulate water pollution accidents within a short period of time. Therefore, in this study, among the 1-D river hydraulic analysis models, the K-River and K-DRUM linkage model will be introduced that is suitable for the purpose of river hydraulic and water quality analysis.

Key words: Water pollution accident, Water quality model, Simulation, 1-D river hydraulic analysis model

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Agricultural & Rural Engineering

Analysis of factors influencing the construction of a check dam to reduce damage caused by debris flow

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Abstract

The check dam is one of the most effective countermeasures to reduce the damage caused by debris flows. While several previous studies have tried to find the priority factor of check dam construction, there are still limitations in terms of quantitive analysis for figuring out the factor of check dam influencing debris flow damages. This study analyzed the most influential factor to assess the best location for the mitigation effect through numerical simulations, which are on the Raemian apartment at Mt. Umyeon in Seoul and Gallam-ri in Gangwon-do, the Republic of Korea, in 2011 and 2019, respectively. The simulation results were quantitatively analyzed by Spearman's rank correlation method. As a result, it was found that the storage capacity of the check dam is the most reasonable factor in the construction of the check dam. The check dam constructed at the point which could store more debris revealed the best performance in mitigation effect.

Key words: Debris flow; Check dam; Mitigation effect; Numerical model; Landslides

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Agricultural & Rural Engineering

Comparative analysis of ONE parameter hydrological model on domestic watershed

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Abstract

Agricultural reservoirs supply water for various purposes in various aspects such as irrigation water, maintenance water, and rural living water. In order to efficiently operate these agricultural reservoirs, it is essential to estimate the supply and inflow, and water management should be done rationally based on these data. However, in the case of agricultural reservoirs, the measurement of supply and inflow is relatively incomplete compared to multipurpose dams, and to efficiently and rationally manage water, it is necessary to analyze the inflow-supply in agricultural reservoirs through water budget analysis. Therefore, in this study, the water balance of the reservoir was analyzed using the ONE model, which is a rainfall-runoff analysis model. The ONE model is designed for single-unit runoff calculation, and the model has one parameter, so it is advantageous for calibration and unmeasured watershed analysis, which is pointed out as a limitation of the tank model. In this study, the ONE model and the Tank model were used for 15 watersheds upstream of dams to compare and analyze the performance of the two models and evaluate their applicability. The simulation results showed that R^2 and NSE of the ONE model were higher than the Tank model. This shows that the application of the ONE model is suitable for estimating the inflow of unmeasured watersheds.

Key words: ONE model; water budget analysis; rainfall-runoff analysis model; agricultural reservoirs

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Agricultural & Rural Engineering

Basic study of unmanned flood early warning system using CCTV

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Abstract

Recently, the number of cases of damage caused by changing climate has increased, and the damage of flooding is particularly noticeable. Many policies have been established and implemented in cities to reduce flood damage, but rural areas do not have much importance for flood damage. However, rural flooding is very important because it is directly related to crop damage. In rural areas, direct observation is difficult, so it is realized that observation using CCTV that does not require manpower is necessary. Therefore, the purpose of this study is to establish an unmanned alarm system that continuously observes and measures drainage channels. Using CCTV, the water level of the irrigation canal is measured and the dangerous level is learned to recognize the current state of the water level. And at the same time, it continuously monitors human access around the irrigation canal. A black box model called YOLO was used to determine the level and person, and real-time CCTV images were used. The water level is classified into safety, alert, and danger, so that if the water level enters the alert area, it can be prepared by contacting the irrigation water management facility without permission, and if the water level enters the danger area, an alarm can be raised to prevent accidents. In addition to reading the current level, it is expected that if the water level predicted and predicted changes in the future in combination with rainfall prediction falls within the risk category, it will create time to prepare for flooding through pre-alerts. This study is still in progress, and I would like to introduce the progress at this point and the future direction.

Key words: Image tracking; water-level; CCTV; YOLO

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Agricultural & Rural Engineering

Sewer Pipe Water Level Prediction using Machine Learning Algorithm

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Abstract

In recent years, due to climate change, sudden heavy rainfall has caused frequent backflow due to insufficient capacity of the existing sewage system, which is responsible for draining rainwater. Urban floods cause damages such as human loss and property damage, and it is necessary to set up solutions. As countermeasures, structural measures to expand the capacity of sewage pipes and non-structural measures to notify local residents in advance and evacuate can be taken. Structural methods are relatively time-consuming, so they cannot be effective immediately, and non-structural measures must be taken first, which is what this study is about. Deep learning-based LSTM, which showed high prediction accuracy in several studies, was used to predict the water level in sewage pipes to prepare for sewage backflow. This study was conducted using information from the Gangdong side of the sewer pipe water level data of 25 points published by Seoul Metropolitan Government, where there are few missing data and large fluctuations in water level due to rainfall. To increase the accuracy, include rainfall data that affects the water level, and since it is relatively easy to predict the water level if the rainfall amount is known in advance, the rainfall amount was entered in advance and after that, the accuracy of the three cases was compared. As a result, running with rain forecasts is more accurate than running without rain data, and for all predictions, short-term predictions were very accurate. By using this to anticipate and prepare for the backflow of sewers, it is believed that the scale of damage caused by floods can be reduced, and it is judged that the accuracy can be further improved by adding factors that affect the water level in addition to rainfall.

Key words: LSTM; Sewer backflow; water level prediction

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Biosystems Machinery Engineering

Design and development of a corn picker for small-scale farming in Bangladesh

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Abstract

Maize picking is one of the most critical issues in maize cultivation, which has not been mechanized in Bangladesh. Manual harvesting of maize is more time-consuming, requires more labor, and increases production costs compared to the mechanical maize harvesting process. The picking rollers and picking boards are the major components of a maize harvester that determine the picking performance of the harvester. Therefore, this research aimed to design and fabricate picking rollers and picking boards of a proposed corn picker and perform lab-based tests to determine the picking efficiency of a single-row corn picker prototype for small-scale farming in Bangladesh. The major components of the proposed maize picker, such as picking rollers, roller heads, and picking boards, were designed and fabricated in a local workshop. Lab-based performance tests of these major components were conducted on a test bench to determine the picking performance. Two types of inwardly rotating reversed picking rollers (Type-1 with a picking board, and Type-2 without a picking board with an extra pulling section) were used in the roller picking mechanism of the proposed maize picker. During the lab-scale tests on a test bench with BRRI maize-6 plants, a picking percentage of 90%, 96%, and 98% was observed at 300, 400, and 500 rpm, respectively, for the Type-1 roller, where the picking board clearance was 21 mm and the picking board edge angle was 14º. The picking efficiency of the Type-2 roller was observed to be 0 %, 20 %, and 100 % at roller speeds of 400, 500, and 650 rpm, respectively, with a roller clearance of 23 mm. Some maize ears were found blocked between the picking board and clearance due to the physical characteristics of the maize ears. For both rollers, the blocking percentage of ears was observed more during low roller speeds and decreased to almost zero for the higher roller speeds. Based on the performance tests of these two types of rollers, higher picking efficiency and lower grain damage were observed for the Type-1 roller compared to the Type-2. This research would facilitate the development of a corn picker prototype for small-scale farming in Bangladesh considering our agro-climatic conditions and cultivation practices.

Key words: Agricultural mechanization, maize, picking roller, maize picker, small-scale farming

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Biosystems Machinery Engineering

Analysis of the supercooling condition in an oscillating magnetic field using the electromagnet

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Abstract

Agricultural products have a short shelf life. If not consumed immediately, it must be preserved safely. Basically, food is always refrigerated, but refrigeration cannot preserve produce long. Cryopreservation can preserve food at sub-zero temperatures, inhibiting the activity of microorganisms. Freezing can dramatically extend shelf life compared to refrigeration. However, freezing can cause quality changes due to ice crystallization and osmotic pressure inside the products. Customers are unwilling to low-quality vegetables and fruits, leading to economic loss. Supercooling technology can cool a material below its freezing temperature without a phase change process. Agricultural products can be stably stored for a long time using the supercooling method that can control the ice crystallizing. In this study, the optimal oscillating magnetic field (OMF) was investigated to supercool the water in a refrigeration system for primarily study. The electromagnet fabricated with enameled copper was installed in the chest freezer. 20 test tubes containing water of 10 mL in each tube were placed in the middle of the electromagnet and the inside temperature of freezer was -10°C. The electromagnet could create the OMF by supplying pulsed electric field through a power system based on IGBT. The supercooling probability of the sample was tested depending on the strength of the OMF. The samples could be successfully supercooled at low OMF. The supercooled sample remained in the liquid phase upon weak impact.

Key words: food preservation , supercooling, electromagnet, oscillating magnetic field

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Biosystems Machinery Engineering

Acceleration Lifetime Analysis of the Hydraulic Pump of a 78 kW Agricultural Tractor

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Abstract

This study was emphasized on the development of the reliability test method for the hydraulic pump of a tractor during major agricultural operations at various driving and PTO gear stages. The hydraulic pressure measurement system was installed on the tractor. The measured hydraulic pressure and engine rotational speed were converted to the equivalent pressure and engine speed for each agricultural operation using a mathematical formula. Also, the overall equivalent pressure and overall engine speed were calculated to determine the acceleration lifetime. The average equivalent pressure and engine speed for plow tillage were calculated at around 54.41 bar and 1,548.37 rpm, respectively, whereas the average equivalent pressure and engine speed for rotary tillage were almost 57.02 bar and 2,074.73 rpm, accordingly. In the case of baler and wrapping operations, the average equivalent pressure and engine speed were approximately 112.23 bar and 2,203.01 rpm, and 118.58 bar and 913.76 rpm, respectively. The overall hydraulic pressure of the pump and the engine rotational speed were found around 100.70 bar and 1,512.93 rpm, respectively. The acceleration factor was calculated using the overall pressure and engine speed accounting for 336. In summary, the developed reliability test method was evaluated by RS-B-0063, which is the existing reliability evaluation standard for agricultural hydraulic gear pumps. The evaluation results proved that the developed reliability test method for the hydraulic pump of a tractor satisfied the standard criteria. Therefore, it could be said that the developed reliability test method could be applicable to the hydraulic pump of the tractor during agricultural field operations

Key words: Tractor, hydraulic pump, tillage, acceleration lifetime

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Biosystems Machinery Engineering

Cucumber seedlings nutrient deficiency detection with image extracted plant features in controlled environments

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Abstract

Early detection and control of nutrient stress of vegetable seedlings is important to produce high-yield and high-quality cucumbers, especially under controlled environment. Nowadays, image-based stress identification of plants at canopy level showed exceptional performance, resulting in high yields and economy. Our main objective of this research was to identify stress of cucumber seedlings, with image based plant features extraction, prior to visual stress detection by human eyes. Cucumber seedlings were grown for four weeks, treated with three different levels of electrical conductivity (EC) 0.0, 3.0, 6.0 dS/m, respectively, where a constant temperature (25oC), humidity (60%), CO_2 (1000 ppm), fluorescent light intensity of 150 µmol/m^2s^1, and photoperiod (18/6 day/night hrs) were maintained. Images of cucumber seedlings from the plant factory were captured using an automated image capturing devices. The region of interest or the plant canopy areas were extracted from the original images using an image segmentation process. The white foreground extracted from the black background represented the top projected canopy area (TPCA) as morphological features and homogeneity, energy, entropy, and contrast as textural features were also obtained. A statistical analysis that was based on dual-segmented regression analysis was performed to identify the presence of early stress. The change point and regression lines were recorded for each of the image analysis parameters. With the confidence interval of 97.5% and the coefficient of determination (R^2) of 98%, day 4.7 was predicted the change point for TCPA, homogeneity, energy, and entropy. The suggested approach detected the nutrient stress on cucumber plant about a 1 day earlier than the visual identification.

Key words: Smart Agriculture, Seedling Growth Stress, Cucumber, Nutrient Stress, Real-time Seedling Stress Monitoring

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Biosystems Machinery Engineering

Analysis of temperature and humidity variability for different positions of the suspension type dehumidifier inside smart Greenhouses

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Abstract

Temperature and humidity control inside greenhouses is essential for optimum plant growth and physiological disorders and diseases managements. The temperature and humidity response and variability depend extensively on the performance of the heater and dehumidifier. The objective of this research was to analyze of temperature and humidity data for different positions of the suspension type dehumidifier inside smart Greenhouses. The dehumidifier consisted of a 0.65 kW compressor, a 0.12 kW fan and 2.9 – 3.5 kW heating coil. We compared the performance of dehumidifier among the different installation layouts like one at the center, two at the center (facing opposite directions from the center to the sides), one at either of the sides, two at both of the sides (facing to the center). To evaluate the functional ability of the dehumidifier, 27 temperature and humidity sensors were placed at three layers (top, middle, and bottom) and in three sections for monitoring the environmental status inside the greenhouse. Two additional sensors were placed in front of the dehumidifier and outside of the greenhouse. A server-based data acquisition (DAQ) system was used to collect the data of temperature and humidity inside the greenhouse and transfer data wirelessly to the server for storage besides this control the dehumidifier remotely. The humidity response results showed that the time required for 90% to 70% dehumidification were 30 minutes. Temperature fluctuates 5 degree after 20 minutes in upper layer and 33 minutes in bottom layer. The spatial and variability results indicated that the changes in humidity at, two at the center (facing opposite directions from the center to the sides) were higher than those in the other setup of dehumidifier in greenhouse. The outcomes of this research will be helpful for the development of low-power, small-sized dehumidifying systems and its setup position in greenhouse for cultivation.

Key words: Dehumidifier, sensor, server-based data acquisition, temperature response, humidity response

Acknowledgement

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Biosystems Machinery Engineering

Deep Learning Based Plant-Organs Segmentation and Phenotypic Traits Extraction Using LiDAR 3D Point Cloud Data of Sorghum Plant

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Abstract

High-throughput phenotyping of sorghum at each plant and organ level is vital in molecular plant breeding to increase crop yield. Light detection and ranging (LiDAR) enable the identification and selection of genes and offers new ways to characterize the three-dimensional (3D) plant architecture. However, we need to develop robust algorithms for extracting the 3D phenotypic traits of sorghum plants using LiDAR 3D point cloud data. The segmentation of individual plant organs in field LiDAR data remains a challenge for accurate 3D sorghum plant phenotyping in field conditions. Plant phenotyping automated by computer vision-based techniques have become essential for agricultural research to enable high throughput experiments. In contrast to using hand-crafted traits, deep learning techniques offer the advantage of learning traits from raw input data and modeling both the within-class and between-class changes of the traits at the same time. This study utilized 3D point cloud-based deep learning segmentation models for the specific objective of segmentation of sorghum plant organs. It then measured the sorghum plant phenotypic traits such as plant height and stem diameter using LiDAR data. Annotated 3D Lidar point clouds data of sorghum have been used for training and testing the deep learning networks. The study samples were grown under controlled conditions at various developmental stages. The results have been validated through the manually collected phenotypic traits of sorghum plants. The obtained results showed that the major obstacles for extracting organ-level plant phenotypic traits associated with organ segmentation were overcome using 3D deep learning segmentation models, which may aid research on precision agriculture.

Key words: LiDAR technique, Deep learning, Segmentation, Plant phenotyping, 3D point cloud, Sorghum.

Acknowledgement

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Food Science & Technology

Whole-Genome Sequencing of *Listeria monocytogenes* from the first foodborne outbreak strain in South Korea

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Abstract

Listeria monocytogenes is a foodborne pathogen causing human listeriosis with sporadic cases, outbreaks, and recalls. Listeriosis has been reported only by hospitalized patients until the first foodborne outbreak by *L. monocytogenes* in Korea in 2018. In this study, the outbreak strain of *L. monocytogenes* was characterized using whole genome sequencing (WGS) and compared with publicly available genome sequences from *L. monocytogenes*. The serotype, multilocus sequence typing (MLST) and antibiotic resistance were compared with L. monocytogenes isolated from food in Korea. WGS was analyzed by hybrid genome assembly combining Illumina and nanopore sequencing technology. The outbreak strain is sequence type (ST) 224, clonal complex 224, and sublineage (SL) 6178. Five antibiotic resistance genes, 64 virulence genes, and pathogenicity island LIPI-1 and LIPI-3 were identified. The sequence comparison of WGS shows the potential epidemiologic association locally and internationally. This study contributes to characterizing *L. monocytogenes* as the first case of a foodborne outbreak in Korea.

Key words: *Listeria monocytogenes*, foodborne outbreak, WGS, MLST

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Food Science & Technology

Enzymatic production and industrial applications of high purity maltodextrins

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Abstract

Maltodextrins are important ingredients for the food, cosmetics, and pharmaceutical industries. However, the production of high purity of these maltodextrins is still challenging and expensive for industrial application. This is due to the promiscuity effect of cyclodextrin hydrolyzing ernzymes (CDases) on linear maltodextrins. *Pyrococcus furiosus thermostable* amylase (PFTA) was found to produce up to 97% purity maltodextrin in continuous reaction. To achieve higher purity, the crystal structure of PFTA was studied, potential amino acid candidates for point mutation were targeted and various mutants of PFTA were developed. Among them, the double mutant K152N_R95K revealed a slight increase in the relative activity on cyclodextrins (α-CD 119.2 ±23.6%, β-CD 94.6 ±13.0%, γ-CD 100.8 ±9.6%). For over 24 h reaction time, the mutant PFTA could still produce about 90% purity maltohexaose, 88% purity maltoheptaose, and 90.6% purity maltooctaose from high concentrated α-CD, β-CD, and γ-CD respectively.

Key words: High purity maltodextrin, PFTA, cyclodextrins

Food Science & Technology

Supercooling as an innovative food preservation technology

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Abstract

Freezing has been recognized as the most popular process for the long-term storage of perishable foods; however, inevitable damages associated with ice crystal formation can cause undesirable quality losses during storage. Supercooling is the process of lowering the temperature of food below its freezing point without ice crystal formation. As a food preservation technology, supercooling has great potential to maintain the quality attributes of foods since the damage caused by ice crystal formation can be completely avoided. In this study, microcontroller-based supercooling units were designed and fabricated to achieve a stable supercooled state by applying a combination treatment of pulsed electric fields (PEF) and oscillating magnetic fields (OMF). The combined PEF and OMF ensured maintaining the supercooled state of perishable food items such as beef, tuna, and fresh-cut pineapples at below -4°C for up to 14 days by synergistically inhibiting ice nucleation. The quality assessment factors such as texture, microstructure, color, and weight loss indicated that the supercooling preservation successfully extended the shelf-life of foods while maintaining their original quality.

Key words: Supercooling, freezing, electromagnetic fields, food preservation

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Food Science & Technology

Physicochemical properties and *in vitro* digestibility (pH-stat) analysis of dietary fats and oils

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Abstract

Triacylglycerols consist of a glycerol backbone and three fatty acid chains. Dietary fats and oils comprise a mixture of triglycerides with differing fatty acids. The chemical, physical, and nutritional properties of triacylglycerol depend on the profile of the fatty acids that make up it. Therefore, in order to understand the physicochemical and nutritional characteristics of oils and fats, it is necessary to identify the fatty acid profile (total fatty acid composition, positional distribution of fatty acid) and triacylglycerol composition. The fatty acid composition of triacylglycerol is analyzed by gas chromatography by converting fatty acids into volatile fatty acid methyl esters through acid or alkali-catalyzed methylation. Intact triacylglycerol species are typically analyzed using reverse-phase high-performance liquid chromatography. Furthermore, physical properties such as melting point/freezing point and crystalline form can be determined through differential scanning calorimetry and X-ray diffraction. *In vitro* digestion model simplifies the digestion process of oils and fats occurring in the small intestine by emulating the environment of the human small intestine through chemical composition and pH control of the digestive juice. Lipase hydrolyzes triacylglycerols and measures the amount of free fatty acids released to determine digestibility. The amount of free fatty acids released can be confirmed by the amount of NaOH consumed to neutralize them. The composition and positional distribution of fatty acids constituting triacylglycerol also affect the digestibility of fats and oils. For example, Stearic acid is one of the long-chain saturated fatty acids with 18 carbon backbones. When the digestibility of oils and fats with high stearic acid content was compared with soybean oil through in vitro digestion model, the digestibility of oils and fats with high stearic acid content was significantly lower than that of soybean oil (control). In addition, it was confirmed that the higher the content of stearic acid, the lower the digestibility.

Key words: Lipid analysis, pH-stat digestion model, hydrolysis, long-chain saturated fatty acids, stearic acid

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Food Science & Technology

Analysis of the microbiota and antibiotic resistance of *Klebsiella pneumoniae* isolated from Kale

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Abstract

Kale (*Brassica oleracea L.*) is a popular vegetable worldwide and has been associated with food poisoning. To understand regional features of microbial communities and microbiota was analyzed. The dominant genera were *Exiguobacterium* (39.89%), *Bacillus* (15.22%), *Enterobacter* (10.69%), *Pantoea* (10.31%), *Acinetobacter* (5.09%), and *Klebsiella* (3.99%) in August kale. The pathogenic species such as *B. cereus* (1.67%), *P. agglomerans* (30%), *A. lwoffii* (5%), and *K. pneumoniae* (33.33%) were detected and quantified. 13 *K. pneumoniae*-isolates were identified. The existence of antimicrobial resistance genes (ARG) were detected using PCR. Successful transmissions of the ARGs were demonstrated in some trans-conjugants. In addition, we observed the influence of storage conditions on the shift in kale microbiota. When stored at 30℃ after washing, the abundance of *Klebsiella* was the highest (8.50 to 59.95%). This study can be used to better understand the kale microbiota and antibiotic resistance and to provide insights into the managing process of raw vegetables.

Bio-Environmental Chemistry

Color-based Prediction for Statistically Estimating Soil Carbon Content Using Soil Color

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Abstract

Soil carbon (C) is crucial factor to mitigate climate change and reduce greenhouse gases in atmosphere. However, the current technologies for estimating carbon content in the soil demand many resources (e.g., labor, time, cost and equipment). To guess the soil carbon content, predictive model for carbon content in the soil was derived from soil color and multiple linear regression method in this study. The soil collected from Chungcheongnam-do and Chungcheongbuk-do was classified into upland, paddy and orchard. The each soil was photographed to obtain color parameters (e.g., RGB value, lightness, chroma and hue). In addition, soil moisture content and bulk density were investigated for use as an independent parameter. Pearson's correlation analysis was performed using color parameters and soil properties, and parameters showing high correlation coefficient were removed. Furthermore, the variance inflation factor (VIF) analysis was assessed to confirm the multicollinearity between independent parameters and soil carbon content. The result of Pearson's correlation analysis was revealed that soil moisture content had a high positive correlation efficient with soil carbon content. Contrariwise, the color parameters showed negative correlation and chroma indicated blueness or yellowness had a high negative positive coefficient. The performance of predictive models was verified using adjusted coefficient of determination (Adj. R^2), root mean square error (RMSE) and mean absolute percentage error (MAPE). When each verification method was substituted to determine the performance of predictive models, the predictive model for orchard soil had a highest reliability (Adj. $R^2 = 0.77$) in comparison with the prediction formula of upland (Adj. $R^2 = 0.65$) and paddy soil (Adj. $R^2 = 0.76$). In addition, the orchard soil prediction model had a lowest RMSE and MAPE. However, the results of RMSE and MAPE analysis showed a statistically significant difference. In future study, we will perform the supplementation of the predictive model for upland soil.

Key words: Multiple linear regression, Prediction, Soil carbon content, Soil color

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Bio-Environmental Chemistry

The Combined Use of Organic and Inorganic Nitrogen Fertilizers on Reducing NH3 and Greenhouse Gas Emissions in a Maize Field

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Abstract

Nitrogen (N) has been considered an essential element in agricultural ecosystem. However, inappropriate use of N fertilizers can lead to increase ammonia (NH_3) and greenhouse gases (GHGs) emissions in agricultural environments. Combination of organic and inorganic fertilizations can enhance nutrient holding capacity and crop productivity, resulting in decreasing potential N losses during crop cultivation periods. In this study, NH_3 and GHGs emissions, greenhouse gas intensity (GHGI), soil properties, and crop yield were investigated under the different N management strategies with equivalent N rate including NPK (urea), compost (compost), NPK+compost (urea and compost) except control (no fertilizer). Our results showed that total NH_3 volatilizations were significantly increased with all fertilizations as compared to the control. The combination of both organic and inorganic fertilizers effectively mitigated NH_3 emissions during the cultivation although equivalent N was added in all treatments except the control. Inorganic fertilizations significantly increased nitrous oxide (N_2O) emission as compared to the control. NPK+compost and compost treatments effectively decreased N_2O emissions by ca. 50% as compared to the NPK. Carbon dioxide (CO_2) and methane (CH_4) emissions were not mainly influenced or negligible in this study. Overall soil quality was improved particularly in the compost and NPK+compost, mainly enhancing extractable ammoniacal nitrogen (NH_4^+-N) and cation exchangeable capacity (CEC). The GHGI, a sustainable index, was lowest in NPK+compost, which suggest a promising N fertilization regime. In conclusion, the combined use of inorganic and organic fertilizers could be considered a sustainable way to mitigate potential N losses, to enhance crop yield, and to improve soil quality in a maize field.

Key words: Amendment, Combined incorporation, Compost, Corn, Gas flux, Organic matter

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Bio-Environmental Chemistry

DNA extraction method from a seed without damage to its germination in maize (*Zea mays* L.)

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Abstract

In order to preserve excellent genetic resources and exploit them to breed better cultivars for food production, various studies on maize are underway. These studies are accompanying with genotyping and phenotyping at the same time. DNA extraction is essential processes for genotyping and genetic studies. Extracting DNA from young leaves in seedling stage is advantageous because it will cause less damage to remaining plant which can be further used for phenotypic analysis. Seed DNA extraction is even more advantageous in terms of saving time, space, and labor for germination. However, since seeds are mostly damaged during DNA extraction, the plant phenotype of the seed cannot be observed. Therefore, here we present seed DNA extraction method which does not cause damage to the seed germination. DNA was extracted by CTAB method or commercial DNA extraction kit from the seed fragment and quantity and quality of the DNA was analyzed. Seed germination was tested for proportional seed cut in 0, 10, 30, and 50% of the upper part seed by weight. When DNA was extracted from the upper seed fragments, high-quality and enough amount of DNA was obtained. Germination rate was not reduced in the range of 10-30% of seed cut by weight. This direct DNA extraction method from the seed fragment can be an efficient way for the samples needed to be selected by genotypes before performing phenotyping, and this method can be further applied to other smaller seeds.

Key words: Maize seeds, DNA extraction, germination

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Bio-Environmental Chemistry

Degradation of veterinary antibiotics during manure composting

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Abstract

Livestock manure-based compost is a good soil amendment to supply nutrients to crops and enhance soil quality. However, it also can be a major source for the spread of veterinary antibiotics (VAs) in agricultural environments. This study investigated the fate of VAs during aerobic composting. Swine manure was collected from the local farm and analysis was conducted to identify the residual of VAs. Three VAs including chlortetracycline, tylosin, and sulfamethazine were detected in swine manure. This raw material was mixed with the three different amendments (sawdust, rice hull, and rice hull biochar) respectively, and composted for four weeks. During the first three days, the temperature increased and reached a thermophilic stage (>54°C) in all composts. The final compost showed that a C/N ratio was decreased under 30, and the solvita maturity index indicates the completion of maturity. The analysis of VAs concentrations during composting showed that detected VAs decreased as the composting process progressed. In the end of composting, chlortetracycline, tylosin and sulfamethazine were degraded by 66.1%, 89.8%, and 74.6%, respectively compared to initial VAs concentration. The degradation of VAs was significantly high during the first and second weeks, suggesting that the VAs was decomposed during the thermophilic stage. These results indicated that increased temperature could be the major factor for degradation of VAs during the composting.

Key words: Agricultural environment, LC-MS/MS, Tetracycline, Sulfonamide, Macrolide

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Bio-Environmental Chemistry

Developing Enabling Technologies for Plant Transformation and Gene Editing

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Abstract

CRISPR-Cas technology demonstrated a great potential for developing new crop varieties with improved traits, but the low capacity of plant transformation hinders its wide applications. My lab has been developing innovative and enabling technologies to enhance plant transformation and gene editing efficiencies. We recently developed a rapid *Agrobacterium*-mediated transformation method for maize inbred B104 using a ternary helper plasmid and immature embryos. This improved method substantially reduced the time to produce rooted transgenic plants from 165 days to 51 days. In addition, we developed an efficient genome editing tool for *Agrobacterium* functional genomics and strain engineering. Using a transposon-encoded Type 1-F CRISPR-Cas system called "INTEGRATE", we demonstrated efficient single and multiplex gene knockouts via targeted DNA integration and generated 'disarmed' *Agrobacterium* strains by precisely deleting the natural T-DNAs from the tumor inducing plasmids. These enabling technologies will contribute to expanding the plant transformation capacity.

Key words: maize, agrobacterium, inbred B104, CRISPR-Cas

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Bio-Environmental Chemistry

Meta-analysis on transcriptomic view of plant heterosis

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Abstract

Heterosis, superior phenotypes in F1 hybrid compared to parents, is commonly observed in large number of biological species. Even with the high impact on evolution in biology and on seed production in agriculture, the underlying mechanism is largely unknown. With the help of next generation sequencing technology, transcriptomic view of the F1 hybrids and its parents have been studied. Different aspects on heterosis have been proposed with those transcriptomic studies. Here we analyzed published transcriptome data on plant heterosis, and tried to draw common transcriptomic changes with the genes which have effects on heterosis. We also tested the hypothesis that shift on secondary to primary metabolism have impact on heterosis

Key words: hybrid vigor, meta-DEG, RNA-seq, metabolic shift

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Bio-Environmental Chemistry

Monitoring of Pollutants Related to the TMDL in the Agricultural Environment Adjacent to Confined Animal Feeding Operation

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Abstract

Wastewater released from confined animal feeding operations (CAFOs) can be one of the main source for the water pollution in the river and total nitrogen (TN) and total organic carbon (TOC) are used as indicators of water pollution. The main purpose of this research was to monitoring TN and TOC in the environment adjacent to intensive livestock facilities. The sample was collected from 29 different locations including cattle manure (12), sewage and wastewater effluent (8), agricultural soil (6), and forest soil (3). Total of 11 properties were analyzed including total nitrogen (TN), total phosphorus (TP), nitrate nitrogen (NO_3-N), ammonium nitrogen (NH_4-N), cation (Na^+, Ca^{2+}, K^+), anion (Cl^-, SO_4^-, PO_4^-), and total organic carbon (TOC). The solid sample was analyzed after extracting target compounds mixing with distilled water at 1:10 (w/v). The mean concentration and (range) of the analysis were following. Industrial complex effluent: TN 17.4(15.7-22.5) mg L^{-1}, NO_3-N 0.95(0.87-0.99) mg L^{-1}, NH_4-N 0.77(0.04-1.09) mg L^{-1}, TOC 5.72(5.00-6.43) mg L^{-1} , sewage effluent from individual house: TN 23.3(16.8-33.3) mg L^{-1}, NO_3-N 5.36(0.89-15.2) mg L^{-1}, NH_4-N 1.45(0.60-2.55) mg L^{-1}, TOC 9.14(5.96-11.1) mg L^{-1} , treatment effluent from cattle farm: TN 140.7(97.7-160.3) mg L^{-1}, NO_3-N 93.1(7.10-151.7) mg L^{-1}, NH_4-N 1.67(0.11-5.08) mg L^{-1}, TOC 107.8(40.7-207.9) mg L^{-1}, liquid compost : TN 1299.5(445-2147) mg L^{-1}, NO_3-N 371.2(0.9-1322) mg L^{-1}, NH_4-N 69.7(2.5-151) mg L^{-1}, TOC 2074(531-4524) mg L^{-1}, cattle manure (cow, swine, poultry) : TN 969.9(340.1-1507.8) mg L^{-1}, NO_3-N 587.6(186.7-988.5) mg L^{-1}, NH_4-N 22.8(5.27-57.8) mg L^{-1}, TOC 10155(7680-12630) mg L^{-1}. Much higher concentration of nitrogen and organic carbon contents were found in livestock pollutant source (individual treatment, cattle manure, liquid compost) compared to industrial complex and village sewage effluent. We confirmed that TN and TOC can be used as indictor of the water pollution and also suggest that more indicators should be necessary to enhance the track or manage the water pollutants in agricultural environment.

Key words: Total Nitrogen, Total Maximum Daily Load, Pollutant Source Tracking, Nitrate nitrogen, Total organic carbon

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Bio-Environmental Chemistry

Effect of No-till and Green Manuring on Long-term Carbon Storage in Arable Soil

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Abstract

Green manuring (GM) and no-till (NT) are known as the practical soil managements to increase soil carbon sequestration. Stable soil organic carbon (SOC) content could be an important factor affecting long- and short-term carbon sequestration. However, the effect of GM and tillage practice on long- and short-term SOC stability in arable soil has not been clearly determined, so far. The objectives of this study was to determine the effect of tillage practice and GM on long- and short-term carbon stability in arable soil by evaluating net eco-system carbon budget (NECB) and aggregate size distribution. This study was conducted in upland soil supporting for maize with GM including fallow (F) and hairy vetch (HV) under different tillage practices including NT and conventional till (CT) for 3 years from 2018 through 2020. Hairy vetch (HV) was cultivated and maize were cultivated as green manure and subsequent crop during winter season (November-April) and summer season (May-October) for 3 years, respectively. Green manuring significantly affected NECB, but tillage practice did not. The value of NECB was highest with HV under CT, because the amount of carbon input to the soil was greatest. Tillage practice significantly affected aggregate size distribution, but GM did not. Small macro-aggregate (SM) increased with CT and decreased with NT whereas, large macro-aggregate (LM) and micro-aggregate (MI) decreased with CT and increased with NT. The ratio of fine intra particulate carbon (IPC) to coarse IPC in SM was higher with NT than CT. The SOC concentrations in all aggregate size were higher with HV than F. However, there was no significant difference of SOC concentration in all aggregate size between CT and NT. Even if the SOC concentration in all aggregate size was greater with HV than F, the high SOC concentrations in MI and s+c sizes benefits for long-term carbon sequestration. Therefore, we suggest that HV under CT may be optimum agricultural practice for short-term carbon sequestration in upland soil, whereas HV under NT for long-term carbon sequestration.

Key words: Soil carbon sequestration, Agricultural practice, Soil aggregation, Ratio of fine IPC/ coarse IPC

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Agricultural Economics

The price relationship between the U.S. soybean oil, biodiesel, and diesel

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Abstract

Soybean oil is the main feedstock for biomass-based diesel production, accounting for 48% of U.S. biodiesel production in 2021, and the share of soybean oil consumed as a biodiesel feedstock in U.S. soybean oil production increased eight-fold from 2010 to 2021. We employ a vector error correction model (VECM) and a vector autoregressive model (VAR) to test for a long-run relationship between soybean oil, biodiesel, and diesel prices, and, if detected, estimate the size of the interactions utilizing monthly data from 2007 to 2022. Results relate to the following questions. (1) Are soybean oil, biodiesel, and diesel prices cointegrated? (2) Is there a granger causal relationship between these prices? (3) What is the impact of individual price shocks on other endogenous variables? (4) How much does a future uncertainty of individual prices due to future shocks influence other price changes through the system? Answers to these questions matter to firms and people that operate in these markets and the policies that target them.

Key words: Soybean oil, Biodiesel, Diesel, Long-run relationship, Vector error correction, Vector autoregressive

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Agricultural Economics

Impacts of the Korean Wave on Agricultural Food Export in Korea

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Abstract

Our study analyzed the impact of the Korean Wave on agricultural food export in Korea using the single-country gravity model. The empirical model is applied to the trade data from 2005 to 2019 for 176 countries. We used distance, GDP, population, agricultural land area variables. We also added the Korean Wave as a proxy variable by collecting Korean content service exports, which reflects the recent shift of media platforms such as music, dramas, and movies from actual products to music streaming sites and online video service OTT. We separated the data into country groups (Asia, Middle East, Europe, Americas, Africa, and Oceania). The Poisson Pseudo Maximum Likelihood (PPML) was used to solve the problem of endogenous and zero-trade data. The results are as follows. First, Korean content exports were positively correlated with agricultural exports in the Middle East, Europe, the Americas, and Africa, especially Europe. Second, Korean content exports were positively correlated with processed food exports in all regions except America. Third, distance from trading partners is negatively correlated with exports in most countries, and its size varies by region and dependent variable. Fourth, the GDP of the trading partner country was significantly estimated in a positive relation, and agricultural exports increased as the economic size of the partner country increased. Our study implies that the Korean Wave has a significant effect on agricultural food exports. We expect that the Korean Wave will positively affect Korea's agricultural food exports and will be used as a fundamental study to prepare measures to increase agricultural exports through analysis by country.

Key words: food export, Korean wave, gravity model, export determinants

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Agricultural Economics

Measuring the Impact of TRQ on the Onion and Garlic Markets Using an Equilibrium Displacement Model

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Abstract

This study analyzes the impact of Tariff Rate Quota (TRQ) on the onions and garlic markets in Korea with a production substitution relationship. We use the Equilibrium Displacement Model (EDM) and set three scenarios: (1) Introduction of Onion TRQ, (2) Introduction of Garlic TRQ, and (3) Introduction of Onion and Garlic TRQ. As the result of analyses, scenario 2 (introduction of Garlic TRQ) had a greater impact on alternative markets than scenario 1 (introduction of Onion TRQ), and scenario 3 (introduction of onion and garlic TRQ) had a greater change on supply, demand and price than scenarios 1 and 2. This suggests that the introduction of TRQ in garlic should be concerned more carefully than onions, and the simultaneous introduction of TRQ in agricultural products with a production substitution relationship can stabilize prices but increase the volatility of supply and demand. This study is the practical research using the current announced TRQ plan and applies the EDM which is easy to change and expand the target market. Discussions on the results of this study can provide political guidelines and implications for establishing a TRQ plan.

Key words: Onion, Garlic, Production Substitution, Tariff Rate Quota (TRQ), Equilibrium Displacement Model (EDM)

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