

Fruit Productivity of Strawberry ‘Sulhyang’ as Affected by Propagation Method and Cultivation System

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propagules for the next propagation generations. After producing three runner plants from each propagule for about 40 days, the initial propagules whose crown diameter became ca. 12 mm are shipped out or stored in a cold storage room to be used as mother plants or transplants. We verified that 3,497 runner plants were annually produced from 9 initial propagules in 3.6 m² cultivation area of S-PFAL using fluorescent lamps, which is about 110-140 times greater than that by conventional propagation methods. Simulation results showed that the annual cumulative number of runner plants produced could be increased to 19,103 and 36,345 if the cultivation area were 18 and 36 m², respectively, under the optimum lighting spectrum with mint-white and blue LEDs. Trials of the S-PFAL using the novel propagation method were satisfactory, and so scaling up is currently being reviewed for propagating mainly elite transplants in the Korean national propagation program.

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채소3

Invited-O-1

Current Situations of Korean Asparagus Industry, Asparagus Physiology and Functional Compounds

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The farmer ratio (%) of Korea has reduced from 46.7% in 1970 to 4.7% in 2017 and the ratio (%) of over 65-year-old increased from 4.9% to 35%. Farming labor problems in the farming land area are getting worse so many foreigners from East Asia have been hired to work in the farming land. Horticultural crop production is around 30% among agricultural production \$48 billion and vegetable crop production is around 25% among agricultural production \$48 billion. Production crops over \$940 million are strawberry (\$1.3 billion), chili pepper (\$1.1 billion) and tomato (\$0.7 billion). Production area of major vegetable crops is leafy and root vegetables (62,283 ha), fruit vegetables (49,000 ha) and condiment vegetables (96,00 ha) in 2018. The exporting major vegetables are paprika, kimchi, seeds, and strawberry and the imported vegetables are pepper, kimchi, seeds, and tomato. 50% of kimchi used in restaurants in Korea imported from China. Nowadays western vegetables like onion, paprika, tomato, pumpkin, melon, and asparagus have been increasing but oriental vegetables like Chinese cabbages, radish, carrots, and garlic is vice versa. Recently the consumption of asparagus has been increasing ever since asparagus crops introduced in 2010 with personal income increasing. Korea GNP is over \$31,000 so that we expected that demanding western styles vegetable crops like asparagus is increasing. Asparagus is a perennial plant and the young spears are eaten as a vegetable. Asparagus plants have a clear annual cycle like bud break in spring, fern growth and accumulation of carbohydrates in storage roots during the summer and autumn to be

harvested from spring to autumn for many years at one place. Functional substances of asparagus are rutin, caffeic acid, kaempferol-3-o-rutinoside, and vitamins. Asparagus can be used in various kinds like foods, drugs, cosmetics, cattle feeding, and plantations. Production of asparagus spears is affected by environmental conditions such as soil moisture, temperature, gas environment, and rhizome age. The growing area of asparagus (around 150 ha) in Korea is very small compared with China (100,000 ha) and Japan (6,500 ha) but the growing area will be increased rapidly up to 500 ha. Therefore Korean agricultural division decided to prepare for these trends so that research and development projects and consulting teams have been organized to prepare for asparagus. The market patterns of asparagus can be divided into four systems like an auction, local markets, exporting and internet markets. We began to export some fresh asparagus to Japan. Also, much of asparagus is imported from Thailand, Peru, Mexico, and Australia all the year round. Several counties like Yonggu has started successfully to invest R and D projects to boost asparagus production and help farmers increase farming income by designing special production area. To have more international competitiveness, asparagus research and development technology for production, processing, storage, functional substances, disease pests, and smart farming should be developed. The production and consumption of asparagus in Korea will be continued to be increased so that the asparagus industry window looks bright in the future.

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채소4

O-1

Fruit Productivity of Strawberry 'Sulhyang' as Affected by Propagation Method and Cultivation System

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This study was conducted to investigate effect of cultivation method and propagation method of strawberry runners on plant growth and fruit productivity of strawberry (*Fragaria × ananassa*) 'Sulhyang'. Daughter plants propagated by either sticking cut-off runner plants (termed as 'cutting propagation') or by pinning at the node of runners (termed as 'pin propagation') were planted in two cultivation systems. The propagation was made by a commercial grower, and the cultivation was made in a hydroponic grower's and a soil grower's greenhouses in Sugok-myeon, Jinju, Korea from Sep. 12, 2018. Fruit harvest was started on Dec. 20, 2018, and conducted at every 3-4 days until the end of harvesting season in both growers. Growth parameters measured during crop cultivation, such as crown diameter, leaf chlorophyll (SPAD) level, leaf thickness, length of longest leaf petiole, skin color index (Hue angle and chroma index) of harvested fruits, and average

weight, height, diameter and firmness of the fruits, contents of total soluble solids and titratable acidity of the fruits showed not significantly differences between the propagation method. Total yield was the significantly lowest in pin propagated plants grown in the soil cultivation system. Average fruit weight and nonmarketable fruit ratio were not significantly different between two propagation methods, while they were greater in the soil than hydroponic cultivation system. Generally, the cutting propagation method is more efficient than the pin propagation method in saving manpower during propagation of strawberries. It is concluded that cutting propagation was better than pin propagation, and hydroponic cultivation was better than soil cultivation in fruit productivity of strawberry 'Sulhyang'. (This research was supported by the Korea Institute of Planning and Evaluation for Technology in Food, Agriculture, Forestry and Fisheries (Project No. 315004-5). Dong Il Kang, Jiangtao Hu, Yali Li, and Eun Hye Jeong were supported by a scholarship from the BK21 Plus Program, Ministry of Education, Republic of Korea.)

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채소5

O-1

Optimization of Photoperiod, Temperature, and PGRs for Formation of Runners and Flower Buds in Strawberry 'Sulhyang' and 'Maehyang'

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Strawberry (*Fragaria × ananassa*) stands as an interesting model for studying asexual and sexual reproduction in polycarpic perennial plants. Strawberry plants produce both inflorescences and stolons (also called runners), which are lateral stems growing at the soil surface and producing new clonal plants. This study was conducted to investigate the best combination of photoperiod, temperature, gibberellin (GA₃), and 6-benzyladenine (6-BA) in inducing runners and flower buds in propagated runner plants of strawberry 'Sulhyang' and 'Maehyang'. An L₉(3)⁴ orthogonal test of photoperiod (8, 12, or 16 h), temperature (23/17, 25/15, or 27/13°C for day/night), GA₃ (0, 50, or 100 mg·L⁻¹), and 6-BA (0, 50, or 100 mg·L⁻¹) was conducted in the growth chambers. Data were collected at one month after the treatment initiation, and after another 5 weeks the plants were moved from the growth chambers to the glasshouse. The results showed photoperiod was the most influential factor for the formation of runners and the long day condition obviously promoted runner formation, and 50 mg·L⁻¹ 6-BA also significantly increased the number of runners. On the other hand, flower initiation was promoted by lower night temperatures and a 12 h photoperiod. Although GA₃ did not promote runner or flower formation in both cultivars, 100 mg·L⁻¹ GA₃ increased length and width of the leaf, plant height, and petiole length in both cultivars. Overall, the expected optimal combination for runner formation in both cultivars was 16 h

photoperiod combined with 25/15°C day/night temperatures and 50 mg·L⁻¹ 6-BA, and this treatment was not only the best combination for runner formation in the growth chambers, but also produced more daughter plants, shorter internodes and heavier runners after the plants were moved to the glasshouse. For the flower initiation, the best combination was 12 h photoperiod combined with 27/13°C day/night temperatures and 100 mg·L⁻¹ 6-BA in both cultivars. (This study was carried out with support from the Korea Institute of Planning and Evaluation for Technology in Food, Agriculture, Forestry and Fisheries (Project No. 118078-2). Yali Li, Jiangtao Hu, Hao Wei, and Dong Il Kang were supported by a scholarship from the BK21 Plus Program, the Ministry of Education, Republic of Korea.)

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채소6

O-1

Effects of Short-term Exposure to High or Low Temperature on Flowering in 'Maehyang' and 'Seolhyang' Strawberries

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It was reported that the occurrence of a sudden heat event decreased the production of strawberry during the flowering and fruiting. Several studies have also shown that the response to sudden temperature changes varies according to flower developmental stages. To understand the effects of short-term exposure to high (daytime) or low (nighttime) temperatures on flowering pattern in 'Maehyang' and 'Seolhyang', we observed primary, secondary, tertiary and quaternary flowers from their first to third inflorescences. Flowers were classified into five developmental stages: when flower petals appear (stage 1), when pistils and stamens become visible (stage 2), when ca. 50% of petals open (stage 3), when all the petals fully open (stage 4), and when anthers dehisce (stage 5). The plants grown in a greenhouse were transferred to each growth chamber kept at 35°C during photoperiod (9 h·d⁻¹) or 2°C dark period (15 h·d⁻¹) in three days. Acceleration of flowering by short-term exposure to high temperature was observed, while flowering was delayed by short-term exposure to low temperature in both 'Maehyang' and 'Seolhyang' from stage 1 to stage 5. These results indicate that extreme changes in temperatures during cultivation season, even though it was for a few days, can negatively affect the flowering and other reproductive processes for winter growing strawberries.

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채소7

O-1

Temporal Relationship between Glucosinolates Content and Expression of Major Genes Involved in Aliphatic Glucosinolate Biosynthesis from the