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学 位 論 文 要 旨
Dissertation Abstract

氏名： **Panawat SIKHANDAKASMITA**
Name

学位論文題目：
Title of Dissertation

Genetic improvement and protected cultivation of low-chill peach
(少低温要求性モモの遺伝的改良と施設栽培)

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The risk of insufficient chill accumulation in temperate fruit trees is increasing due to climate change. Under this situation, the demand for low-chill varieties would rise because they are well adapted to warm conditions. In addition, they can be grown in the protected agriculture for producing extreme early harvest season. Kagawa University initiated the breeding program for low-chill peaches in 2016. Hence, my research focused on genetic improvement for new lower chill peaches with early ripening that produces high fruit quality and expand the harvest season of the present peach cultivars. Moreover, we quantified optimal growth temperatures for each growing stage of a low-chill peach in forcing conditions to achieve an earlier harvest season at low costs.

1. Genetic improvement, embryo rescue, and seedling evaluation for new low-chill peach

‘KU-PP1’, ‘KU-PP2’, HFP1, and Flordaglo × Hikawa Hakuho were used as parents for new low-chill peach breeding program. However, the fruit development period of these parents is very short, where at fruit maturity the embryo does not reach full maturity; as a result, hybrid seeds have poor germination ability. Hence, *in vitro* embryo culture is needed to ensure germination, allowing the rescue of the immature embryo. Our study showed that the germination of the immature embryo was influenced by three factors: surface sterilization, culture technique with fruit age and culture conditions. Approximately 100 hybrid seedlings are generated each year for selection. Under natural conditions in Kagawa, we found that nineteen selected hybrids adapted and grew very well. The fruit of 8 in 19 seedlings are yellow-fleshed genotypes. We selected four hybrid peaches as the advanced selections. All these advanced selections

showed outstanding characteristics and will be evaluated actual chilling requirements by excised shoots technique under controlled conditions in winter 2021.

2. Optimization of growth temperature for growing ‘KU-PP2’, a low-chill peach in protected cultivation

2-1. Chilling accumulation and heating temperatures impact budburst and flowering of ‘KU-PP2’ peach trees.

In this study, we investigated the effects of chilling accumulation and heat requirement on breaking dormancy and flower development and the correlation between these factors over two consecutive seasons. ‘KU-PP2’ peach trees in containers were transferred to a phytotron after being exposed to different chilling periods (250, 500 and 750 h). The air temperature in phytotron varied at 15, 20 and 25°C. The results indicated that prolonged chilling exposure and higher forcing temperatures hastened bud burst and flowering, as well as increased the level and uniformity of bud break in the ‘KU-PP2’ peach cultivar. However, inadequate chilling exposure and excessive forcing temperatures negatively affected dormancy-breaking, flower development, anthesis, and fruit set in ‘KU-PP2’. Budburst and flowering were significantly retarded by insufficient chilling and forcing temperatures of 15–20°C used in this study.

2-2. Influence of growth temperatures on photosynthetic ability, fruit development, and fruit quality of ‘KU-PP2’ peach cultivar.

The aim of this study was to investigate the effects of temperature on peach fruit development and quality. Container-grown ‘KU-PP2’ peach trees grafted on low-chill peach rootstocks were cultivated under controlled conditions at different temperatures (20, 25, and 30°C). The high-temperature conditions enhanced fruit growth in S1 and S2 stages, hastened the harvesting period, and stimulated red coloration of the fruit peel; however, such conditions decreased leaf size and thickness, stomatal density, carbon assimilation rate. Moreover, high temperature retarded late fruit development (S3 stage) and negatively affected aspects of fruit quality (size, weight, and sweetness).

2-3. Flowering and fruit productivity of ‘KU-PP2’, a low-chill peach in heated and unheated plastic houses

Finally, we demonstrated the growing a low-chill peach in plastic houses with and without a heating system. The onset of forcing began in mid- and late January when the chilling hours reached 850 hours. The results indicated that heated conditions shortened the number of days from dormancy release to blooming and the length of the fruit development period, resulting in the blooming of flowers in late February, and fruit harvesting as early as mid-May, which were earlier than blooming and fruit harvest under natural conditions by 4 and 6 weeks, respectively. Similarly, the unheated conditions accelerated the time to blooming and harvest by up to 3 and 4 weeks, respectively compared with the open field conditions. The size and quality of fruit obtained under forcing conditions were slightly larger than those under natural conditions.