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Study on the Metabolic Changes Occurring during Bud Dormancy in Japanese Pear under Mild Winter Conditions

(暖冬条件下でのニホンナシの芽の休眠における代謝変化に関する研究)

Abstract

Bud dormancy is essential for deciduous fruit trees to survive the harsh winters and to resume growth in the succeeding spring. Pear (*Pyrus* spp.) is an important deciduous fruit tree in the world, and Japanese pear (*Pyrus pyrifolia* Nakai) is one of the most important fruits produced in Japan. However, when these trees are grown in areas under mild winter conditions, problems related to dormancy release, such as absence and delay of bud burst and floral bud necrosis, occur that negatively affects fruit production. Furthermore, global warming has been affecting the process of dormancy release in deciduous fruit trees all over the world. The objective of this study was to elucidate the causes of these problems by investigating the metabolic changes on Japanese pear flower buds during endodormancy and ecodormancy under different thermal conditions in an attempt to simulate mild winter conditions and future global

warming scenarios. Moreover, we also investigated the metabolic profiles of Japanese pear buds during endodormancy at chilling requirement fulfillment and its release by CH_2N_2 and KNO_3 in order to clarify the mechanism of dormancy and to provide more detailed information to support endodormancy release by bud break agents in areas where chilling requirements are not fully satisfied. In chapter 2, the occasional thermal fluctuations during endodormancy phase were investigated and it was found that thermal fluctuation led to negative effects on bud burst and flowering and to the incidence of floral bud necrosis in Japanese pear. In chapter 3, the effects of thermal fluctuation during ecodormancy phase were investigated. It was found that floral bud necrosis increased during ecodormancy phase under thermal fluctuation and low soluble carbohydrates and water content were observed in these conditions. Thus, the dynamics and availability of soluble carbohydrates and water content were affected by thermal fluctuation and may contribute to the increase of both occurrence and severity of floral bud necrosis in Japanese pear during ecodormancy phase. In chapter 4, the metabolic profiles were investigated during flower bud endodormancy under different temperature treatments and it was found that several identified metabolites are involved during endodormancy of Japanese pear. Finally in chapter 5, the effects of CH_2N_2 and KNO_3 on endodormancy release were investigated, and it was found that CH_2N_2 gradually increased the bud burst and flowering percentages even in conditions where chilling was not accumulated. Several metabolites were identified during endodormancy release by CH_2N_2 in Japanese pear flower buds. In this work, a significant effect of KNO_3 in the release of endodormancy was not observed. However, it can be suggested that KNO_3

may provide nitrate for the production of amino acids during growth resumption and also it is possible that NO produced during the assimilation of nitrate may be involved in the dormancy release. In conclusion, thermal fluctuation during both endodormancy and ecodormancy of Japanese pear flower buds negatively affected bud dormancy release. The metabolic changes observed during dormancy under thermal fluctuations added important information in clarifying the mechanism of dormancy under mild winter conditions. The metabolic profiles during endodormancy release by CH_2N_2 and KNO_3 identified several metabolites involved during endodormancy release by these compounds. Furthermore, the results obtained in this work may contribute to the development of new cultivars of deciduous fruit species that can adapt to the lower chilling conditions in areas under warm winter and for future scenarios caused by climate change, as well as in the development of more effective cultivation strategies in areas with mild winter conditions.