学位論文の要旨

Abstract of Thesis

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学位論文題目 Title of Thesis（学位論文題目が英語の場合は和訳を付記）

Developmental process and factors affecting fasciation of strawberry floral organs

イチゴ花芽の帯化とその発生要因

学位論文の要旨 Abstract of Thesis

Fasciation of strawberry floral organs is a physiological disorder first reported by Darrow and Borthwick in 1954. Large-fruiting cultivars including famous modern cultivars, such as ‘Fairfax’ and ‘Howard 17’, often develop enlarged and flattened peduncle and receptacle, and sometimes develop coxcomb-shaped or curled primary fruit and witches’-broom-like appearance of inflorescence in severely affected plants. However, there is a lack of detailed study about the fasciation development in strawberry. Therefore, the present study aims to (1) precisely observe the developmental process of fasciation, (2) examine the factors affecting fasciation, and (3) demonstrate the implication of floral transition by determining the expression of *TERMINAL FLOWER 1 (TFL1*), a crucial floral repressor gene.

The fasciation incidence in the primary fruit and inflorescence and developmental process of shoot apical meristem (SAM) were evaluated in a susceptible cultivar ‘Ai-Berry’ and compared with a non-susceptible cultivars ‘Nyoho’ and ‘Sagahonoka’. Classification of severity was established for evaluating fasciation in fruit and inflorescence and applied for later experiments. When large nursery plants were grown under nutrient rich conditions, SAMs of ‘Nyoho’ and ‘Sagahonoka’ developed normal inflorescences and a few fasciated flowers. The size of vegetative SAM of ‘Ai-Berry’ was larger compared to ‘Nyoho’, then longitudinal diameter of ‘Ai-Berry’ SAM increased during floral induction, from September 11 to September 30, and oval-shaped SAM was formed as the initial symptom of fasciation. Such oval or elongated SAMs often differentiated two or more leaf primordia simultaneously and developed into divided multiple vegetative SAMs before floral transition or linearly-fasciated SAMs during floral transition. Normal non-fasciated round SAM differentiated into an inflorescence meristem (IM) then divided twice or more and differentiated into two or more secondary IMs and a floral meristem (FM) of primary flower. But the linearly fasciated SAMs of ‘Ai-Berry’ which differentiated multiple leaf primordia at the same time divided into several parts and each part differentiated into individual IM which were often still flattened. Each IM divided into several small secondary IMs and one or more flattened FM(s) and then developed into a cluster. Such a malformed inflorescence consisted of multiple clusters or fused clusters. The flattened FMs developed into flattened receptacles and finally into wedge-, fan- or coxcomb-shaped primary fruits.

‘Ai-Berry’ plants propagated with larger pots developed thicker crown and larger SAM. The fasciation incidence in fruit and inflorescence was more frequent and severe in larger pot grown plants compared to smaller pot plants. Larger pot grown plants developed linearly fasciated SAM just after planting. Although the smaller pot grown plants developed round normal shaped SAM until mid-October, a considerable part of these plants developed fasciated fruits and

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inflorescences.

It is well known that floral transition of short-day strawberries is suppressed by long-day, high temperature, and also rich nitrogen nutrition. Thus, a nutrient starvation from late August is often applied for old large nursery plants to induce early floral transition. In an early and less susceptible cultivar ‘Kaorino’, fasciation of floral organs has been rarely observed in the nutrient starved plants before transplanting, but the frequency and severity of fasciation increased by continuous nutrient supply before transplanting. That most of the nutrient starved plants flowered earlier indicated that the starvation induced early floral transition. The continuously supplied plants could be divided into two groups, plants flowered little bit earlier than starved plants (20-40%) and those flowered around one weeks later. The former may have terminated floral transition before transplanting or plant establishment and the latter absorbed excessive nitrogen and floral transition may have suppressed.

Nutrient starved ‘Ai-Berry’, ‘Benihoppe’, and ‘Toyonoka’ were transplanted on 13, 20, and 23 September, 2018 and ‘Tochiotome’ and ‘Fukuoka S6’ were transplanted on 10, 20, and 30 September, 2019, to fertilized annual hills. The incidence of fasciation was severe in all of cultivars transplanted earlier, and slight especially in ‘Toyonoka’ and ‘Tochiotome’ transplanted on 27 or 30 September. When nutrient supply was adequately controlled for the pot grown plants, visible floral transition, doming of SAM into IM, has been observed around 20 September in these two cultivars and some days later in the rest three cultivars. The plants transplanted before 20 September established quickly and absorbed nitrogen. Floral transition of nitrogen rich plant was delayed and processed slowly under critical daylength and temperature. Thus, the time of transplanting also may have affected the fasciation through nitrogen absorption.

‘Kaorino’ plants were grown with two different sized pots and tray, 30 % Enshi-nutrient solution was supplied three times a week until 30 August, and they were transplanted on annual hills on 10 September. There was no significant difference in fasciation incidence among the plants grown with different root-zone volume. In each plot, 60-80% of plants flowered within October, but the rest plants flowered after 20 November. Fasciation incidence of late flowering plants was severe compared to early flowering plants. Intermittent low-temperature storage (ILTS) was applied for nutrient starved nursery plants of ‘Ai-Berry’ grown in trays and pots, and they were transplanted with non-treated plants. The treatment effectively accelerated the flower induction and flowering in 40% of the treated plants, and all of these plants developed normal inflorescences and well-shaped primary fruit. However, all remaining plants that did not respond to the treatment and non-treated plants, developed fasciated inflorescences and/or primary fruit. In ‘Ai-Berry’, *FaTFL1*, the key floral repressor gene in seasonal flowering *F.×ananassa*, was downregulated after 16 September and then the fasciation symptoms were observed in the SAM. These results indicate that the fluctuating temperature combined with critical day-length in September may be a major factor of strawberry fasciation.

In conclusion, fasciation of floral organs may be triggered and develop during floral transition by temperature fluctuation around boundary values between floral inhibition to induction. Such insufficient floral inductive stimulus for vigorously growing plants may cause the half-finished or slowly processed floral transition. Consequently, the development of deformed IMs and FMs in SAMs may finally result in severe fasciation of the inflorescence and receptacle.