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Fruit Quality and Inflorescence Formation as Affected by Mechanical Injury Inflicted on Secondary Scaffolds in Satsuma Mandarin

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Summary

Effect of injury by drilling the secondary scaffolds of satsuma mandarin (*Citrus unshiu* Marc. cv. Okitsu) on soluble solids content (SSC) in fruit juice and inflorescence formation was examined. The SSC in the fruit of branches with 20 drill holes most greatly increased from 30 days after treatment, and thereafter was maintained about 0.5% higher than that in the fruit from branches with 0, 5 and 10 drill holes. There was no difference in SCC among the control, 5 and 10 hole treatment at harvest. The inflorescence formation, especially leafless types, on the secondary scaffolds in the following year was promoted in the 10 and 20 hole treatment but not in the 5 hole treatment. These results indicate that the mechanical injury on the secondary scaffolds inflicted by drilling induces localized water stress in the trees. The stress seems to exert the influence on the fruit quality and inflorescence formation only in the affected portions.

Introduction

Fruits with high SSC are highly favored and attract high prices from consumers. Drought stress during fruit development of stage II and III that was caused by mulching with polyethylene film [1] and micro-perforated vinyl sheets[9] or restricted root growth[8] increases sugar content in fruit. Therefore, cultivation under houses and with plastic mulch has increased in order to produce such high quality fruits. Sugar accumulation in the juice sacs is caused by the increase in translocation of photosynthates into fruit during drought stress[4,10]. It has also been observed that low moisture soils tend to increase the number of flowers in the following season[2].

Water stress has also been found to occur in trees attacked by trunk boring insects *e.g. Prionus insularis* Motschulsky or in response to physical injury. In such affected trees an increase in SSC of fruit is noticeable. Here we report the effect of drilling secondary scaffolds on the fruit quality and the formation of inflorescences of satsuma mandarin in the following year.

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Materials and Methods

Plant materials

Five trees of 20-year-old satsuma mandarin (*C. unshiu* Marc. cv. Okitsu) growing in the field at the Experimental Farm, Faculty of Agriculture, Ehime University (Hojo, Ehime Prefecture, Japan) were used. Ten fruit was sampled at 20-30 day intervals from treatment to harvest (middle November, 1999).

Drilling of secondary scaffold branches

Secondary scaffolds with a similar number of fruit were selected and tagged. On August 19, 1999, the secondary scaffolds were subjected to physical injury by drilling with a drill pin of 10 mm in diameter. In each tree, 5, 10 and 20 holes were drilled on separate branches and a fourth branch without drill holes was allocated as the control. After drilling, the secondary scaffold branches were fixed to other branches with a string to guard against the possibility of drilled branches being broken by wind. The diameter of trunk and primary scaffold in the treatment trees was 37±2.1 cm, 23.2±1.4 cm, respectively. The secondary scaffold branch diameter was 14.6 ±0.7 cm for the control, 16.3±0.7 for the 5 hole, 16.6±1.1 cm for the 10 hole, and 18.3± 1.0 cm for the 20 hole treatment. A schematic representation of hole placements on the secondary scaffold branches is shown in Fig.1.

SSC and acid analysis

Juice was obtained from pulp through cheesecloth by hand pressure. The juice was further filtered through a No.2 Toyo filter paper and stored at -20℃ until analysis. SSC was determined with a digital refractometer (PR-1 ; Atago, Tokyo, Japan). For the determination of titratable acidity, 1.0ml of juice sample was titrated using 0.1N NaOH with phenolphthalein as indicator and the results were converted to citrate concentrations.

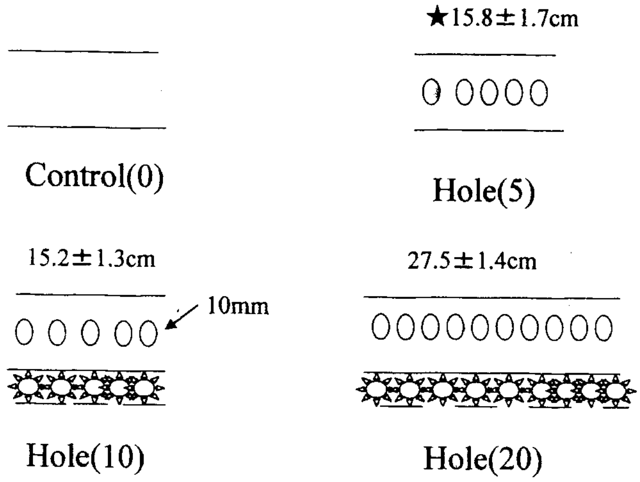

Fig. 1 Schematic diagram for hole treatment in the secondary scaffold branches with a drill of 10 mm in diameter. ★ The mean length ± SE of treated portions in the secondary scaffold branches.

Vegetative shoots and leafy and leafless inflorescences in the following year

The number of vegetative shoots and leafy and leafless inflorescences on the secondary scaffolds in the following year was counted on May 20, 2000.

Results and Discussion

Changes in SSC and acid content

SSC of the fruit in 20 hole treatment most greatly increased from 30 days after treatment, and thereafter was maintained about 0.5% higher than in fruit from 0, 5 and 10 hole treatments up to harvest (Fig. 2). However, there was no difference in SSC among the other treatments at harvest (Fig. 2). It is documented that water stress decreases leaf water potential, fruit size and weight[5]. Our results show that the relative increase in fruit diameter was lowest in the 20 hole treatment and that leaf water potential in 20 drill hole branches was lower by approximately -0.1 Mpa than the control (data not shown). There was no difference in acid content between treatments during the experiment (data not shown). The effect of water stress has been known to enhance sugar accumulation in satsuma mandarin fruit[4,6,9]. It has also been reported that sugar content in Hassaku fruit harvested from non-thinned tree was higher than in thinned trees[7]. It is highly likely that the crop load leads to water stress of the trees resulting in the increase in SSC. Our results suggest that the increase in SSC of fruit on the treated secondary scaffolds is possibly due to localized water stress as a result of the injury inflicted by drilling.

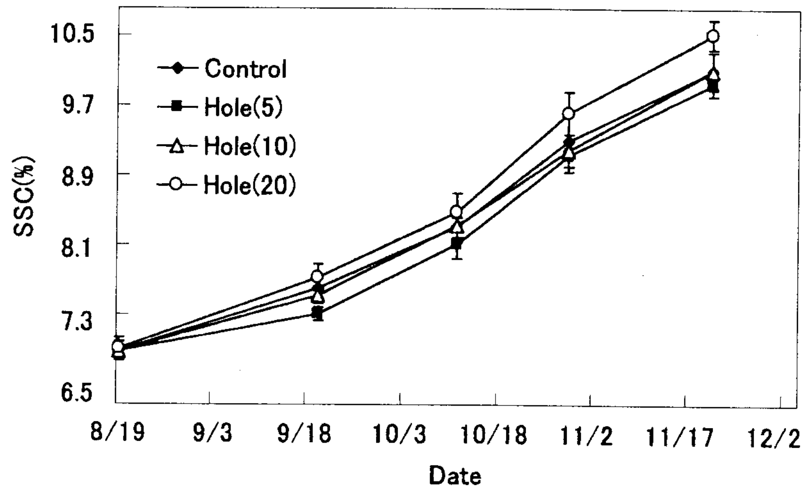

Fig. 2 Changes in soluble solids content (SSC) in fruit bearing on the secondary scaffold branches with different hole numbers. Vertical bars indicate means ± SE in ten fruit for each determination.

Formation of vegetative shoots and inflorescences

The percentage of vegetative shoots produced was not differed between the control and hole treatment branches (Fig. 3). However, the inflorescence formation tended to be promoted in the 10 and 20 hole treatments compared with the control and 5 hole treatments. Our results suggest that the 10 and 20 hole treatment were most affected by water stress because they had the highest

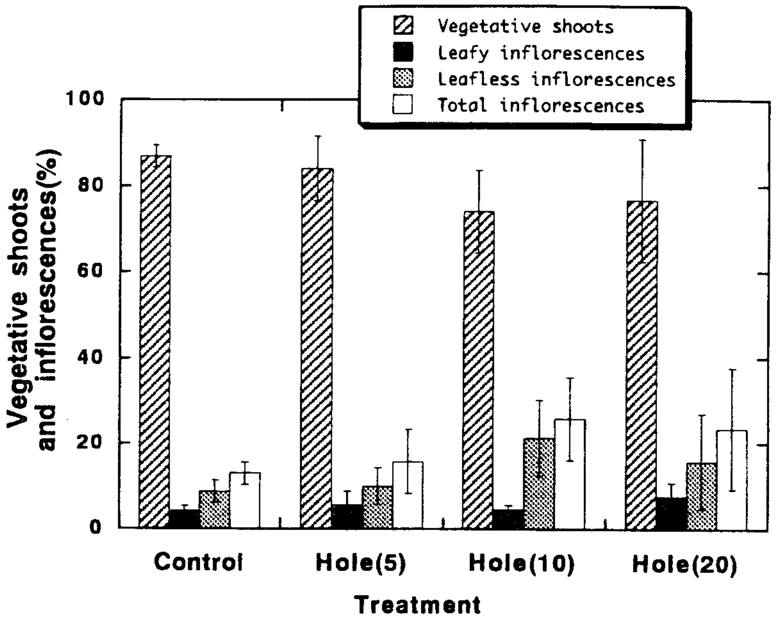

Fig. 3 Vegetative shoot and inflorescence formation in the following season on the secondary scaffold branches with different hole numbers. Vertical bars indicate means ± SE.

percentage of leafless inflorescences. Inoue[2] reported that soil drought caused an increase in flower production in satsuma mandarin. Also, girdled trees had more flowers per sprouting node than did non-girdled ones[3]. Our results suggest that inflicting physical injury on bearing shoots has effects similar to soil drought and girdling.

Therefore, inflicting physical injury on bearing branches can increase SSC and flower production. These effects could be due to localized water stress in the treated branches. Further work is necessary to develop less damaging physical or chemical treatments that could be applied on bearing branches to induce water stress. If such a method is to become available, it could be used in place of mulching as a method of improving fruit quality.

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亜主枝にあける穴の数の違いがウンシュウミカンの果実品質と花芽形成に及ぼす影響

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摘　　　要

亜主枝にあけた穴の数の違いがウンシュウミカンの果実の糖度及び翌年の発育枝形成及び着花に及ぼす効果を調べた。糖度は穴20個処理区が、処理一ヵ月後から対照区、5個区、10個処理区より高くなり、その後収穫期までほぼ0.5％高く推移した。対照区、5個および10個処理区の間には差がなかった。酸含量には処理区間で差がなかった。翌年の発育枝数は処理間で差がなく、花数は10個及び20個処理区で対照区に比べて多い傾向であった。また、処理区では直花が有葉花より多くなった。以上の結果より、亜主枝に穴をあけることは樹体に部分的な水分ストレスをひき起こして果実の糖度が上昇させ、翌年の花数を増加させることが明らかとなった。また、このストレスの効果の及ぶ範囲は処理された亜主枝に限定されるように思われた。

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