Note
Effects of Uniconazole-P on Abscission and Endogenous ABA, IAA, and GA-like Substances Levels of Satsuma Mandarin Fruitlets

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Uniconazole-P, a gibberellin (GA) biosynthesis inhibitor, did not affect growth of mandarin fruitlets definitely but stimulated abscission markedly. Endogenous abscisic acid concentration in fruitlets treated with uniconazole-P was about 4-fold higher compared with the control. Endogenous indole-3-acetic acid and total GAs levels also changed. The relationships between these changes in endogenous hormone levels and fruit abscission were discussed.

Key words: abscisic acid; gibberellin; citrus; indole-3-acetic acid; fruit-drop

Abscission of citrus fruits has been studied to allow mechanical harvesting by a control of this process in the abscission zone. 11 Addicott stated that abscission is controlled directly by phytohormones. 21 Abscissic acid (ABA) was originally discovered as an abscission-promoting hormone and the promoting effect of exogenously applied ABA on abscission has been documented in several plants. 21 On the other hand, auxins, which include indole-3-acetic acid (IAA) delay abscission, generally. 31 On the basis of relationship between endogenous phytohormone contents and abscission pattern, Takahashi et al. suggested that a sudden decrease of auxin content from the maximum peak as well as the appearance of the ABA peak might be important in abscission of citrus fruitlets. 31 Gibberellin (GA) is not considered a primary hormone in the control of fruit abscission when applied to trees of various species in the field. 11 However, the exact roles of endogenous hormones on abscission of citrus fruits are not known.

The alteration of the level of endogenous hormones by inhibitors of phytohormone biosynthesis is a useful approach for making clear the roles of endogenous hormones. Uniconazole-P, a triazole-type growth retardant, acts as an inhibitor of GA biosynthesis. 41 This work describes the effects of uniconazole-P on the levels of endogenous phytohormones in fruitlets and discusses possible relationships between changes in endogenous hormone levels and fruit abscission.

Experiments were done using three 21-year-old trees of Satsuma mandarin (Citrus unshiu Marc. cv. Hayashi) grafted on trifoliate orange (Poncirus trifoliata Raf.) growing at the Kuchinotsu Branch. Fruitlets from single-flowered leafy inflorescences on three secondary scaffold branch per tree were used for all experiments. Uniconazole-P, (1E,3S)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)-1-penten-3-ol (an active optical isomer of S-3307, uniconazole) was kindly supplied by Sumitomo Chemical Co., Hyogo. One ml of uniconazole-P (5%) was mixed with 2 g of lanolin, and 1 ml of water was mixed for a control.

On 6 June, 21 days after full bloom, 60 fruitlets of 10-mm diameter per secondary scaffold branch were tagged, totalling 540. About 10 mg of the uniconazole-P mixture was applied to the stylar end (circle in shape, about 8 mm in diameter) of 30 fruitlets per secondary scaffold branch, and remaining 30 fruitlets were treated with about 10 mg of the water mixture as a control in the same way. Periodically, the equatorial diameter and number of retained fruitlets were measured for 40 days after treatment. The abscission rate of fruitlets was expressed per secondary scaffold branch. For the hormonal analysis, 40 fruitlets were sampled each time, 7 and 21 days after treatment from all the treated branches. The sampled fruitlets were weighed immediately, and stored at −80°C until analyzed.

1H-ABA and 13C6-IAA as internal standards were added to the sample, which was homogenized and fractionated as described previously. 5, 6 ABA was measured by a gas chromatography system with a 24Ni electron capture detector. 7 IAA was measured by gas chromatography-selective ion monitoring. 8 The GAs fractions were diluted successively 3 times with 90% acetonitrile and assayed by a ‘modified micro-drop rice-assay’. 9

Figure 1 shows changes in the diameter of mandarin fruitlets after uniconazole-P treatment. Fruitlets continued to grow linearly in diameter from 6 June to 16 July. Uniconazole-P did not affect the growth of mandarin fruitlets definitely. However, uniconazole-P promoted the abscission of mandarin fruitlets markedly (Fig. 2). Twenty-eight days after treatment, fruitlets treated with uniconazole-P dropped by 96%, although fruitlets of the control dropped by 41%.

Table shows concentrations of endogenous ABA, IAA, and total GAs in mandarin fruitlets after uniconazole-P treatment. ABA levels in fruitlets treated with uniconazole-P were about 4-fold higher than those in the control both 7 and 21 days after treatment. In rice shoots, it was reported that there was no

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Abbreviations: ABA, abscisic acid; GA, gibberellin; IAA, indole-3-acetic acid.
Uniconazole-P reduced IAA level 7 days after treatment (Table). Reduction in IAA level by uniconazole, a racemic form of uniconazole-P, was also reported in peas.\textsuperscript{11} While in rice shoots, the endogenous level of IAA was similar between control and uniconazole-P treatment.\textsuperscript{10} Huberman and Goren reported that auxin inhibited the rise in cellulase and polygalacturonase activity in abscission zones and delayed the separation of orange fruits.\textsuperscript{12} Thus IAA reduction in mandarin fruitlets might also contribute to promotion of fruitlet abscission to some extent. However, 21 days after treatment, the IAA level in fruitlets treated with uniconazole-P was higher than that in the control. This higher level of IAA may result from the inhibition of IAA transport from fruitlets to branches by the formation of the abscission zone.

Uniconazole-P reduced the total level of GAs by less than one-tenth 7 days after treatment, confirming that uniconazole-P acts as an inhibitor of GA biosynthesis (Table). However, 21 days after treatment, the total GAs level of fruitlets treated with uniconazole-P increased to a level similar to that of the control. This increase may be due to the breakdown of the applied uniconazole-P. Thus, there is possibility that the reduction of total GAs level in mandarin fruitlets may contribute to the promotion of fruitlet abscission to some extent, although it has not been reported that GA controls fruit abscission in citrus as well as in most fruit trees when applied to trees in the field.\textsuperscript{11}

In this study, we clearly demonstrated that uniconazole-P treatment increased abscission and ABA concentration of mandarin fruitlets.

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References