EFFECT OF AUXIN TRANSPORT INHIBITORS ON FRUIT GROWTH AND FRUIT SET OF 'DELICIOUS' AND 'GOLDEN DELICIOUS' APPLES

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ABSTRACT

It has been proposed that auxins are intimately involved in the process of fruit abscission and that they may play a central role in the promotion of abscission caused by chemical thinners applied to apples. Three auxin transport inhibitors were selected: 2,3,5-triiodobenzoic acid (TIBA), N-1-naphthphthalamic acid (NPA), and 1-pyrenonylbenzoic acid (PBA). All inhibitors were incorporated into the lanolin paste at a concentration of 250 $mg \cdot L^{-1}$ and applied to the pedicels of fruit when fruit were 9-14 mm in diameter. All inhibitors caused fruit abscission but it required 2 to 3 weeks for fruit to actually drop. However, fruit treated with a chemical thinner frequently slow growth and stop growing within 7 to 10 days of application. Fruit that did drop as a result of auxin of inhibitor application frequently continued to grow, but at a reduced rate for some time after treatment before they finally abscised.

INTRODUCTION

Chemical thinning remains one of the most important management activities an orchardist must do to appropriately regulate crop load in an apple tree. This activity has been practiced for many decades, yet there is no unanimity of opinion about how a thinner actually causes fruit abscission. Lakso et al. (1998) and Stopar et al. (1997), among others have suggested that individual thinner may cause a carbohydrate imbalance in a tree which leads to a carbohydrate deficit at a critical time, resulting in fruit abscission. Bangerth (2000) and others have suggested that the primary cause of thinner action is hormonally related, specifically via indoleacetic acid (IAA). Bangerth (2004) suggested that a dominant fruit in a cluster or a shoot can influence growth and/or abscission on a smaller lateral fruit. This may be accomplished by inhibition the basipital movement of IAA from the fruit to the abscission zone. As a result of a reduction in IAA transport through the abscission zone of the dominated fruit, IAA declines to a level where its resistance to its own endogenous ethylene is lowered to a threshold level, thus the abscission process is initiated.

The purpose of this investigation was to explore the possibility that auxins may be involved in the abscission process during the June drop period. The premise in this investigation was that the effects that these compounds have on fruit abscission are attributed to their effect on reducing auxin transport from the fruit to the abscission zone in the pedicel (Yuan et al., 2003).

MATERIALS AND METHODS

Forty spurs bearing two fruit of similar size were selected and tagged on six mature 'Golden Delicious' apple trees. Forty spurs with one rapidly growing and similar sized fruit were

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selected and tagged on mature 'Delicious' apple trees. Average fruit size at the time of selection and auxin inhibitor application averaged 13.2 mm for 'Golden

Delicious' and 10.2 mm for 'Delicious'. Auxin transport inhibitors were weighed and then dissolved in either 1 ml of ethanol [2,3,5-triiodobenzoic acid, (TIBA)] or in 1 ml of dimethylsulfoxide [N-1-naphthylphthalamic acid (NPA), and 1-pyrenoylbenzoic acid (PBA)]. These were then stirred into warm lanolin (approximately 42˚ C) to achieve a final concentration of 250 mg· L^{-1} (w/w). Treatments on 'Golden Delicious' were (1) an untreated control, (2) NPA on fruit #1, (3) PBA on fruit #1, and (4) PBA on fruit #1 and fruit #2. Treatments on 'Delicious' were (1) lanolin only on the pedicel and 250 mg·L^{-1} (2) TIBA, (3) NPA, and (4) PBA. The lanolin preparations were poured into 10 ml syringes and carried to the orchard in warm water. Lanolin containing the auxin transport inhibitors was applied from the syringe in a wide band around the pedicel of the selected and tagged fruit. The diameter of the fruit was measured just prior to treatment and again periodically thereafter using a digital caliper. Fruit set was monitored periodically after application and final set was determined at the end of June drop in July. Treatments were replicated either 5 times ('Delicious') or 6 times ('Golden Delicious') with individual trees serving as replications. At least 10 spurs per treatment per tree were used.

RESULTS AND DISCUSSION

NPA and PBA were applied during the normal thinning time to the pedicels of one of two fruit on 'Golden Delicious' spurs. Application of either one of these auxin transport inhibitors resulted in a significant and comparable reduction in final set (Table 1). NPA had no influence on abscission of the second fruit in the luster. The influence of PBA on abscission of the second fruit in the cluster is inconclusive since the increase in abscission on the untreated fruit in the cluster was not significant at P=0.05, but it was significant at P=0.10. Application of PBA to both fruit in the cluster resulted in a significant increase in abscission of both fruit. One could speculate, based upon information in the literature, that if there is abscission of one fruit in a cluster, set of the second may occur. This is not occur. PBA may have increased abscission of the second untreated fruit. One possible explanation is that there may be some mobility of PBA from one fruit to the adjacent fruit in the same cluster.

'Delicious' spurs were reduced to one healthy king fruit per spur. TIBA, NPA, and PBA were applied at 250 mg· L^{-1} during the normal thinning time to the pedicels of tagged fruit. All three auxin transport inhibitors significantly and comparably reduced set between 10 and 20 days after application (Figure 1). When final fruit set was taken at the end of June drop in July some additional fruit abscission had occurred on fruit treated with NPA and PBA. However, there was a substantial reduction in fruit set on fruit treated with TIBA resulting in fruit set of only 4%. A characteristic of all fruit treated with auxin inhibitors was that the abscised fruit were always larger than abscised fruit on untreated control spurs. It is well documented in the literature that small fruit with low seed number are usually the first to abscise. Fruit are generally most vulnerable to chemical thinners at the 7 to 12 mm fruit size. The fact that significantly larger fruit abscised gives an indication that an interruption in auxin being transported to the abscission zone of a fruit may be another physiological area to examine to achieve fruit abscission of the larger more difficult to thin fruit.

Table 1. Effect of auxin transport inhibitors in lanolin paste applied to the pedicels of fruit of 'Golden Delicious' apple spurs on final fruit set.

Treatment ($mg \cdot L^{-1}$)	Fruit #1	Fruit #2	Percent set (%) Fruit #1	Fruit #2
Control	No	No	42a	47a
NPA	Yes	No	12b	47a
PBA	Yes	No	7b	28ab
PBA	Yes	Yes	18b	10b

Treatments applied 7 June 2005 when fruit size averaged 13.2 mm.
Mean separation for both fruit #1 and fruit #2 by Duncans multiple range test, P=0.05.

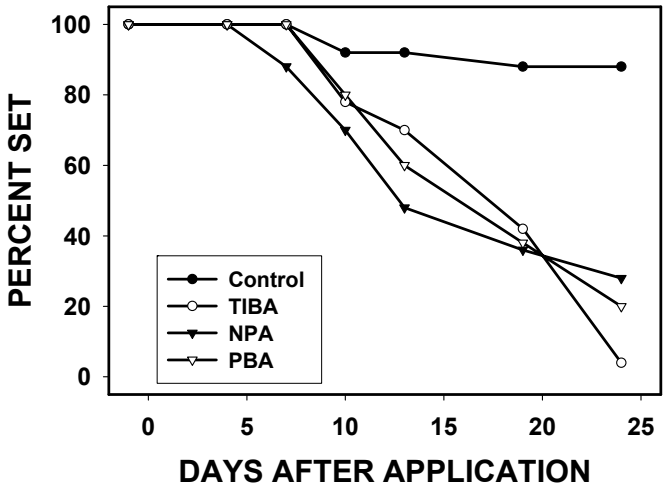

Figure 1. Effect of 2,3,5-triiodobenzoic acid (TIBA), N-1-naphthylphthalamic acid (NAP), and 1-pyrenoybenzoic acid (PBA) on fruit set of treated 'Delicious' fruit.

Results from this investigation confirm that auxin transport inhibitors can cause fruit to abscise, presumably due to the reduction of auxin moving from the fruit to the abscission zone. More work is required to confirm how consistent this response is and to determine if this may be a line of investigation that may lead to a different approach to chemical thinning of apples.

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