

related, in part, to N supply. Unseasonably maximum temperatures exceeding 35°C were recorded in mid-June and during the last week of July 1982.

The possible advantages for using PP333 for improvement of pear production are many and include the following: a) increasing fruit set, especially on young trees with an established tree canopy; b) suppression of shoot growth, resulting in c) less pruning, d) better control of pear psylla and other insect and mite pests, and e) better spray coverage and penetration due to less interference from vigorous shoots; f) better control of weeds and rootsuckers under the tree (reduced herbicide treatment); g) more efficient use of N fertilizer; h) improved fruit quality by controlling excessive shoot growth and allowing penetration of sunlight throughout the tree; and i) a lower incidence of fruit disorders (cork spot). But freckle pit (a possible virus) remained a severe problem. Future tests are needed to determine optimum rates of soil applications of PP333 on different tree ages growing on various rootstocks in different types of soils. Other chemical treatments, such as GA and GA + BA (3), may improve pear shape and size on trees treated with PP333 if applied at the optimum time.

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## Promalin or GA<sub>3</sub> Increase Pedicel and Fruit Length and Leaf Size of 'Delicious' Apples Treated with Paclobutrazol

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**Abstract.** Paclobutrazol (PP333) is a promising new bioregulant for controlling size of trees and significantly reducing the need for dormant and summer pruning. 'Delicious' trees were treated with a high rate of PP333, which resulted in some smaller, flattened fruit with shorter pedicels. Application of either gibberellin A<sub>4+7</sub> plus 6-benzylamino purine (Promalin) or gibberellin A<sub>3</sub> (GA<sub>3</sub>) before or at full bloom increased fruit size, pedicel length, and leaf size on PP333-treated trees.

Paclobutrazol, the proposed British Standards Institute common name of (2RS,3RS)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)pentan-3-ol, is an experimental plant bioregulant thought to inhibit gibberellin biosynthesis (R. Couture, personal communication). Quinlan (3) and Greene (2) used foliar sprays of paclobutrazol (PP333) to control vegetative growth of apple trees. Williams (5, 6, 8) found spray applications unsatisfactory but obtained a desirable control of vegetative growth in apple trees with ground application. High concentrations of PP333 result in a reduction of leaf size as well as smaller flattened fruit with shorter pedicels (6). Parameters of apple quality, however, such as firmness, soluble solids, and color, are comparable with fruit from untreated trees (6). This experiment was initiated to determine if the deleterious effects following high concentrations of PP333 could be overcome

with either GA<sub>3</sub> or Promalin.

In Oct. 1979, six 25-year-old Wellspur 'Delicious' apple trees on seedling rootstock were treated with a ground application of PP333 at the rate of 20 g per 9.5 m<sup>2</sup> per tree. This rate was excessive to determine phytotoxicity. Treatments were spread evenly on the soil surface with a hand sprayer. Two untreated trees in an adjacent row served as controls. Full effect of the treatment was evident in all trees by Spring 1981 and persisted through 1982, resulting in a reduction of leaf size, fruit size, length (L)/diameter (D) ratio, and pedicel length (6). No phytotoxicity was evident even at the highest rate of PP333.

In Spring 1982, in an attempt to overcome these undesirable effects, GA<sub>3</sub> or Promalin were applied at 3 different stages of fruit development: pre-pink (April 20), balloon stage (April 30), and full bloom (May 4). Two limb units on each tree treated with PP333 were sprayed to run-off with either 25 ppm GA<sub>3</sub> or Promalin, to which was added a commercial non-ionic surfactant (Regulaid) to a final concentration of 0.1%.

Leaf-area measurements were made using a LI-COR area meter (Model LI-3000) after full leaf expansion on the single largest leaf from 10 separate fruiting spurs from each limb. Fruit measurements were taken about

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Table 1. Effect of GA<sub>3</sub> and Promalin on fruit size and pedicel length of paclobutrazol-treated 'Delicious' apple. Measurements taken June 30, 1982.

Treatment	Date treated	Pedicel length (mm)	Fruit diameter (D) (mm)	Fruit length (L) (mm)	L/D
Untreated	---	21.7 d <sup>c</sup>	36.0 c	36.1 c	0.98 b
PP333	Oct. 9, 1982	7.6 a	32.9 a	30.1 a	0.92 a
GA <sub>3</sub> (25 ppm)	April 20, 1982	17.3 c	36.8 c	38.5 d	1.05 c
Promalin (25 ppm)	April 20, 1982	18.9 c	35.8 c	38.8 d	1.08 c
GA <sub>3</sub> (25 ppm)	April 30, 1982	11.9 b	33.1 ab	32.8 ab	0.99 b
Promalin (25 ppm)	April 30, 1982	17.2 c	32.1 a	35.6 c	1.11 cd
GA <sub>3</sub> (25 ppm)	May 4, 1982	12.8 b	33.7 b	33.8 bc	1.00 b
Promalin (25 ppm)	May 4, 1982	17.5 c	31.4 a	35.3 c	1.12 d

<sup>c</sup>Mean separation within columns by Duncan's multiple range test, 5% level.

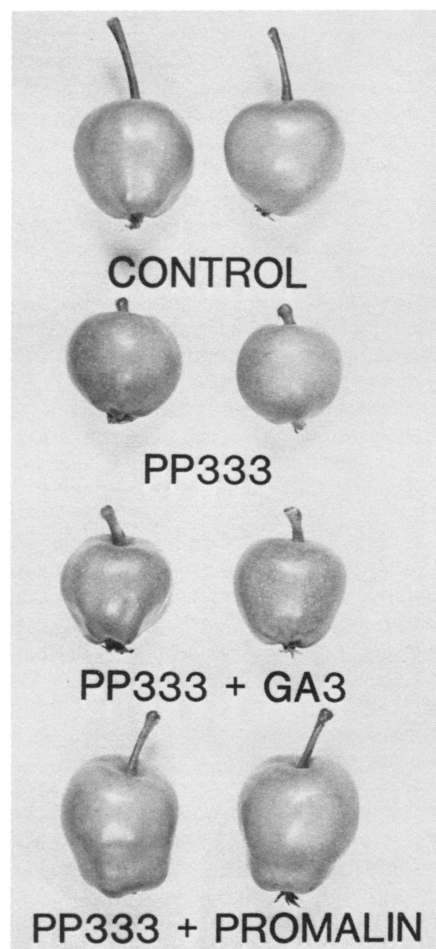


Fig. 1. Effect of GA<sub>3</sub> or Promalin on fruit size, fruit pedicel length, and fruit shape of 'Delicious' apples treated with paclobutrazol.

4 weeks after full bloom, after cell division had ceased, on 10 randomly chosen fruits per limb.

Both GA<sub>3</sub> and Promalin increased pedicel length on PP333-treated fruits. When applied at the pre-pink stage both treatments significantly increased fruit diameter and fruit length. In addition, the fruit L/D ratio and fruit typiness were improved when compared with those of untreated controls (Table 1). The L/D ratio of Promalin-treated fruit increased significantly over those of both untreated fruit and GA<sub>3</sub>-treated fruit (Fig. 1). These results agree with those of Williams and Stahly (9) and Williams and Billingsley (7) that Promalin increased calyx lobe size compared with that of GA<sub>3</sub>-treated fruit and resulted in more type 'Delicious' fruit.

GA<sub>3</sub> or Promalin markedly increased leaf size on PP333-treated trees (Table 2). In these limited trials, the increase in leaf size was greater with GA<sub>3</sub>. On 'Granny Smith', Promalin was equally as effective as GA<sub>3</sub> for increasing leaf area (6).

The increase in fruit size of GA<sub>3</sub>- or Promalin-treated fruit may be due to the increase in photosynthetic leaf area of supporting spurs. Promalin has also been shown to cause fruit thinning, which may lead to larger fruit (1, 7). The high concentrations of PP333 used in this experiment caused a large increase in fruit set on these trees (6) and any thinning achieved from Promalin is likely to be beneficial.

The bioregulant PP333 is proving to be a useful material to control the growth of apple trees and increase tree efficiency (3, 4, 8). The use of high concentrations may result in

Table 2. Reversal of paclobutrazol leaf size reduction with GA<sub>3</sub> or Promalin.

Treatment <sup>a</sup>	Avg leaf size (cm <sup>2</sup> )	Avg leaf wt (mg)
Paclobutrazol <sup>b</sup>	19.2 a <sup>x</sup>	550 a
Promalin (25 ppm)	27.0 b	720 a
GA <sub>3</sub> (25 ppm)	37.1 c	870 b

<sup>a</sup>Promalin or GA<sub>3</sub> applied April 20, 1982.

<sup>b</sup>Applied to soil Oct. 1979 at 20 g/9.5 m<sup>2</sup>.

<sup>x</sup>Mean separation within column by Duncan's multiple range test, 5% level.

some adverse effects on leaf size, fruit size, and shape. The use of GA<sub>3</sub> or Promalin can moderately reverse these undesirable effects and will permit greater control of growth and fruiting of apple trees.

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