plot (Fig. 4). A regression line allows decisions to be made about promising selections.

A fruit size index can be developed by adjusting sizes to what they would be at constant yield or L:F, such as 100 kg or a L:F rating of 3. Perhaps a large-fruited selection is large because fruit does not set well and the tree never reaches a L:F rating of 3. This also is important information about the selection.

Since sweet cherries continue to grow after they first become sufficiently mature for fresh market harvest, it is important to harvest at a comparable, advanced maturity. Skin color of dark sweet cherries is the best criterion (6).

This relatively simple procedure improves cultivar evaluation. It utilizes measured fruit size, L:F ratios that may be estimated in several ways, and the physiological principle that L:F ratios largely determine fruit size.

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Influence of Rootstock on Response of 'Delicious' and 'Golden Delicious' Trees Treated with Paclobutrazol

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Abstract

Mature 'Golden Delicious' and 'Red Prince Delicious' on seedling, MM.106, MM.111 or M.7 rootstocks were treated with a high or low dosage of paclobutrazol by trunk crown drench in April 1985. Dosage varied with rootstock according to a hypothetical amount of natural growth reduction relative to trees on seedling rootstock. Length of current seasons growth of shoots was measured over the next 4 growing seasons. In the year of application treatment had no effect. The following year, terminal shoot length on both cultivars receiving the higher dosage was significantly less than controls and was controlled to the same degree on all 4 rootstocks. In the second and third years after treatment, differences among rootstocks became more apparent.

Managing vegetative growth of fruit trees is a challenge to fruit growers throughout the world. Many methods have been used to control tree growth including training, pruning, scoring, size-controlling clonal rootstocks, and chemicals.

The use of [(2RS,3RS)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazole-1-yl)pentan-3-ol] (paclobutrazol, PBZ, [ICI Americas, Goldsboro, NC]) to control vegetative growth of fruit trees has been investigated for many years with varying degrees of success. Fac-

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tors such as species and cultivar (2, 5, 6, 7), type of irrigation (3, 11), and method of application (1, 9) influence the efficacy and longevity of the response. Others (10, 12) have reported differential growth responses of young or potted apple trees on various rootstocks treated with triazole growth retardants at the same rate.

Observations of preliminary field trials in Wenatchee, WA suggested when the same rate of PBZ was applied as a trunk crown drench to mature 'Top Red Delicious' apple trees on either M.26 or seedling rootstock, the trees on the dwarfing rootstocks had a greater reduction of vegetative growth. From this observation, a hypothesis was developed suggesting the amount of material applied to trees on size-controlling rootstocks should be reduced commensurate with an hypothetical amount of natural growth reduction relative to seedling rootstocks. The objective of this experiment was to control terminal growth of mature apple trees on different size-controlling rootstocks to the same degree based on a compensatory dosage adjustment.

Materials and Methods

The experimental orchard consisted of 'Red Prince Delicious' and 'Golden Delicious' grafted on seedling, MM.111, MM.106 and M.7 rootstocks. Trees were planted in 1968 in sandy loam on a uniform site at Orondo, WA and irrigated by permanent set under-tree sprinklers. All trees were trained as central leaders.

The planting consisted of alternating pairs of rows of either cultivar. The pattern within a row consisted of groups of 5 trees on a particular rootstock followed by 5 trees on the next rootstock and so on until all 6 rootstocks were planted. Planting distance between rows was 6.0m. Distance between trees within the row varied with rootstock: seedling (3.6m), MM.111 (3.0m), MM.106 (2.4m), and M.7 (2.4m). During the 4 year study, trees carried moderate to heavy crop loads and received normal cultural practices. Ammonium nitrate was applied after harvest each year based on leaf mineral analysis and terminal growth and averaged 232 and 87 kg/hectare for 'Delicious' and 'Golden Delicious,' respectively, regardless of rootstock.

PBZ treatments were administered in April 1985 by trunk crown drench. The amount of chemical applied to each tree varied according to rootstock. Trees on seedling rootstock received a full dosage whereas trees on MM.111, MM.106 and M.7 received 0.8, 0.5 and 0.3 times, respectively, that applied to the seedling rootstocks. Trees treated with the high dosage received 0.4, 0.32, 0.20, and 0.12 g/cm trunk diameter for seedling, MM.111, MM.106, and M.7, respectively. Trees treated with the low dosage of PBZ received 0.2, 0.16, 0.10, and 0.06 g/cm trunk diameter for seedling, MM.111, MM.106, and M.7, respectively. Actual trunk diameter measurements in April 1985 for seedling, MM.111, MM.106, and M.7 were 18.1, 16.0, 15.5, and 14.5 cm, respectively, for the 'Delicious' trees and 18.5, 16.5, 15.0, and 14.5 cm, respectively, for the 'Golden Delicious' trees. Treatments were randomly assigned to groups of 5 trees. A tree in each group served as one of the 5 treatment replicates.

In September 1986, 1987 and 1988 after fruit had been harvested and extension growth had ceased the current seasons new growth on each tree was measured from 10 randomly selected upright (vertical angle greater than 45 degrees) terminal shoots and 10 watersprouts selected from main horizontal scaffold branches. Data were analyzed as a split block design with shoot type as sub-plot using the analysis of variance subroutines of the statistical analysis system (SAS Institute, NC).

Data were also reported as percent of control using the mean shoot length

within a rootstock, year, and shoot type as control. These data were analyzed by the Waller-Duncan K-ratio T test for significance of mean differences between rootstocks within a year, treatment rate and shoot type.

Results

There was no treatment effect during the year of application, therefore these measurements were excluded from the overall analysis. The actual mean terminal shoot length measurement of control trees on seedling rootstock for 1986, 1987, and 1988 was 34.6, 60.5, and 63.8 cm, respectively, for 'Delicious' trees and 45.8, 55.8, and 49.7 cm, respectively, for 'Golden Delicious' trees. Over all 3 years the low and high dosage controlled shoot length to 88% and 76%, respectively, of untreated trees. Watersprouts were always longer than terminal shoots. Pooling all treatments over all three years indicated the seedling rootstock produced the longest shoots followed by M.7, M.106 and M.111.

Shoot length of 'Golden Delicious' on M.111 was reduced the most with either the low or high PBZ dosage over all 3 years whereas on MM.106 it responded the least (Fig. 1A, B, C)). Among rootstocks, the terminal growth was reduced to a similar degree in the first year after treatment at the high dosage, differed significantly the second year and showed no significance the third year (Fig. 1A). Lack of significance in the third year was due to large variations among treatments in terminal growth. Length of watersprouts was controlled to a similar degree on all but MM.111 rootstock which showed the greatest relative reduction in growth (Fig. 1B). At the lower dosage, both terminal and watersprout length were controlled to a similar level on all but MM.106 rootstocks which consistently showed the least control (Fig. 1C, 1D).

On 'Delicious' trees treated at the high dosage terminal shoot and water-

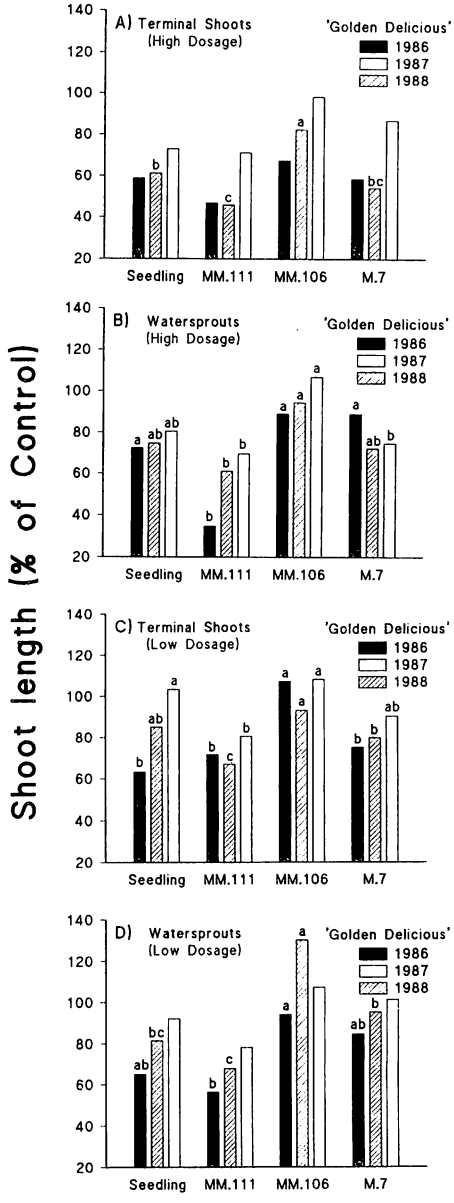

Figure 1. Mean shoot length expressed as percent of control in 1986, 1987, 1988 of 'Golden Delicious' trees on seedling MM.111, MM.106 and M.7 rootstock. Trees were treated with PBZ at 0.4. 0.32, 0.20 and 0.12 grams per cm trunk diameter (A,B) or at 0.2, 0.16, 0.10 and 0.06 grams per cm trunk diameter (C,D), respectively. Mean shoot length between rootstocks within a year not followed by the same letter were significantly different by Waller-Duncan, K-ratio t-test, 5% level. No letters indicate non-significance.

sprout length were controlled to a similar degree on all rootstocks in all 3 years (Fig. 2A, 2B). These values were different from the controls only in the first 2 years for seedling, MM.111 and MM.106 and only in the last year for trees on M.7. Watersprouts were shortest relative to the control in the 3rd year. At the low dosage, the variability was high enough to eliminate differences in watersprout length among rootstocks. Terminal growth was significantly different from controls for seedling, MM.106 and MM.111 in the first year after treatment and only for seedling and M.7 in the following 2 years (Fig. 2C).

Discussion

Length of terminal and watersprout growth on the treated trees exceeded that on untreated trees in several instances on both 'Golden Delicious' and 'Delicious' trees, especially in the second and third year after treatment. This has been seen elsewhere. When the dosage of PBZ has been insufficient to suppress vegetative growth greater than approximately 50% of controls, growth rate of treated trees has exceeded that of untreated trees (8). This may be due to a temporary diversion of carbohydrate from shoot production to root growth. Then, after the chemical effects have subsided, the large root reserve pool may become available for sustained shoot growth (12). It is also possible cropping played a roll in the amount of growth achieved during a current season although this was not evaluated. With the degree of growth reduction in 1986, it is possible yield may have been enhanced in 1987 followed by a light cropping year in 1988. Thus, shoot length on treated trees may have exceeded that of controls in 1988 due to trees being in an "off year" as suggested by Forshey (4). The greater response of 'Golden Delicious' may also have been due in part to reduced nitrogen applied in the fall compared with 'Delicious' trees.

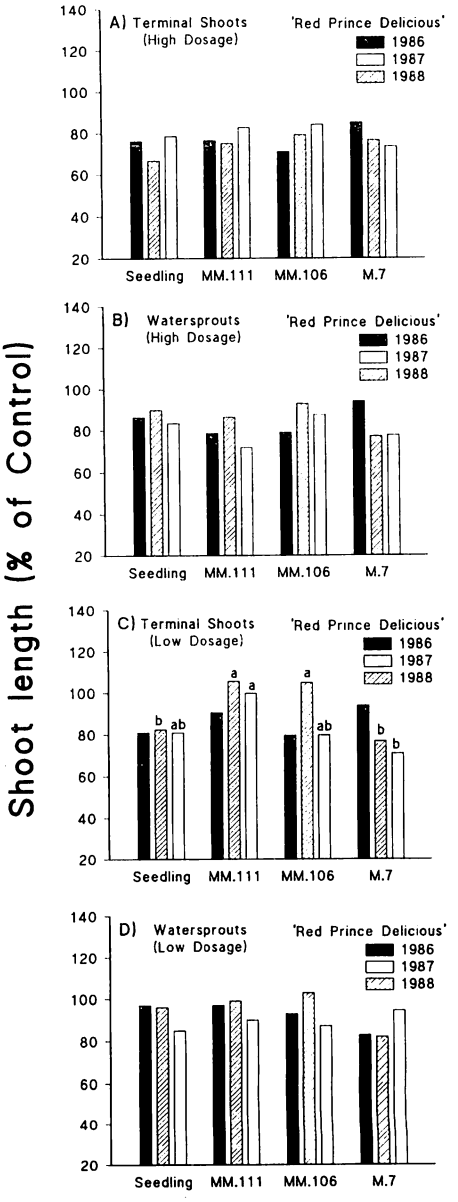

Figure 2. Mean shoot length expressed as percent of control in 1986, 1987, 1988 of 'Delicious' trees on seedling, MM.111, MM.106 and M.7 rootstock. Trees were treated with PBZ at 0.4, 0.32, 0.20 and 0.12 grams per cm trunk diameter (A,B) or at 0.2, 0.16, 0.10 and 0.06 grams per cm trunk diameter (C,D), respectively. Mean shoot length between rootstocks within a year not followed by the same letter were significantly different by Waller-Duncan, K-ratio t-test, 5% level. No letters indicate non-significance.

Based on results reported here, it is possible to achieve a specific amount of growth control for a particular scion/rootstock combination by adjusting the amount of retardant applied. Other factors, however, such as cropping, and tree vigor must also be considered.

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Oregon Apple Variety Trial 1987-1989 Progress Report

This trial started with 65 cultivars in 1985 and now has over 160 accessions under study (71 have not yet fruited). Detail profile sheets have been developed for 15 culitvars that the authors feel they have tested sufficiently and are promising. A summary of the major findings from this study are included below:

1. 'Braeburn' and 'Fuji' usually rate highest in taste tests, and are about equal.
2. 'Braeburn' matures before 'Fuji.'
3. 'Fuji' will mature with good quality in the Willamette Valley.
4. 'Braeburn,' 'Fuji,' 'Granny Smith' and 'Newton' store well in air at 30-32° F into late February.
5. Taste ratings for 'Golden Delicious' are higher than for 'Delicious.'
6. The following varieties sometimes rated higher in taste tests than 'Golden Delicious': 'Jonagold,' 'Brock,' 'Mutsu,' 'Elstar,' 'Spigold,' 'Golden Supreme,' 'Arlet,' 'Gala,' 'Royal Gala,' and 'Newgold.'
7. 'Liberty' and 'Empire' are rated equal to each other and better than 'McIntosh' or 'Delicious,' but not as good as 'Braeburn' or 'Fuji.'
8. 'Granny Smith,' 'Earlee Granee,' 'Granspur,' and 'Newton' are rated very consistently equal.
9. 'Granspur' is much less productive than 'Granny Smith.'
10. 'Earlee Granee' is not earlier maturing than 'Granny Smith.'
11. The following clones received one rating as high as those received by 'Fuji' and Braeburn': OSU 31-19, Coop 15 (both scab-immune), Coromandel Red, NJ55, #29, NJ100, Toko.

From R. L. Stebbins, A. A. Duncan, C. O. Compton, D. Duncan. 1990 Apple Variety Trial 1987-1989 Progress Report. Oregon State University, Extension Service.