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Effect of Paclobutrazol Bloom Sprays on Fruit Yield and Quality of cv. Hass Avocado Growing in Subtropical Climates

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Abstract. **Bloom foliar sprays of paclobutrazol (PB) at 2.5, 1.25 and 0.62 g a.i./L on avocado *(Persea americana* Mill, cv. Hass) trees reduced spring flush shoot length and redistributed dry matter among the components of fruiting shoots. There was an increase in the allocation of dry matter to fruit on treated trees with a corresponding reduction in the allocation to the stem and leaves. The spray treatments of 2.5 and 1.25 g a.i./L PB at bloom increased the mean fruit size at harvest by 16 and 11%, respectively. Fruit yield was not significantly affected by PB applications on an annual basis. However, the PB spray treatments of 1.25 and 0.62 g a.i./L significantly increased the two year cumulative yield by about 63%. In a second experiment, calcium concentrations in fruit from trees receiving a bloom foliar spray of 1.25 g a.i./L of PB were higher compared to fruit on untreated trees during the first 8 weeks after fruit set. The results are discussed in relation to yield and fruit quality management of cv. Hass avocados.**

Paclobutrazol (PB), a triazole plant growth regulator which inhibits gibberellin biosynthesis (Davis *et al.,* 1988), reduces vegetative growth of avocado trees when applied as soil or foliar applications (Köhne and Kremer-Köhne, 1987; Symons *et al,* 1990; Wolstenholme *et al.,* 1990). Suppression of vegetative growth of avocados during spring, improves fruit retention (Biran, 1979) and increases the calcium content of developing fruit (Witney *et al.* 1990) thereby improving post-harvest life (Eaks, 1985). Results of Wolstenholme *et al,* 1990, indicated potential yield benefits in 'Hass' from foliar sprayed paclobutrazol at mid-anthesis. The reduction in vegetative growth at a critical stage of fruit development may increase the allocation of calcium to the fruit. This paper reports on the effects of mid-anthesis foliar sprays of

PB on growth, fruit calcium concentration and yield of 'Hass' avocado trees.

Materials and Methods

Vegetative growth and yield (Expt. 1). Seven-year-old cv. Hass trees in a commercial orchard in subtropical south east Queensland (latitude 27°S, altitude 30 m) were selected for this experiment. All trees were grafted to seedling Guatemalan race rootstocks and were planted at 6 m x 8 m. They were irrigated by micro-sprinklers programmed with tensiometers (Whiley *et al.,* 1988) and trunk-injected with phosphonate for protection against *Phytophthora* root rot (Pegg *et al,* 1985). Tree nutrition was managed by soil and leaf analyses with nutrients applied as required on a schedule described by Whiley *et* a/. (1988). Most leaf nutrient concentrations at summer leaf maturity in 1987 and 1988, prior to application of PB treatments, were within the optimum ranges reported by Embleton and Jones (1964). However, leaf nitrogen concentrations at summer leaf maturity were 2.45% and 2.38% for 1987 and 1988, respectively (Whiley, 1982).

Paclobutrazol treatments of 2.5, 1.25 and 0.62 g a.i./L were formulated with a non-ionic surfactant (0.05%) and applied at mid-anthesis with a motorized knapsack sprayer. Trees were sprayed to the point of run-off and treatments were applied to the same trees in two consecutive years.

At termination of the spring growth, 20 fruiting shoots from each tree were collected for measurements. Shoot length, leaf area, and dry weight of leaves, stem and fruit were determined for each shoot. The lengths of 20 non-fruiting shoots per tree from the summer growth flush were measured when growth had ceased.

Experimental treatments were replicated 5 times in a randomized block design using single tree plots. Statistical analyses were by ANOVA and significant differences were judged at $P < 0.05$.

<u>Fruit calcium concentration (Expt. 2).</u> Seven-year-old 'Hass' trees grafted to seedling Duke 7 and growing in a commercial orchard in subtropical South Africa (latitude 25°S, altitude 660 m), were used for fruit calcium studies. The trees were growing in a Mutton series Doveton soil (Durand and Claassens, 1987) with a calcium concentration before starting the experiment of 213 mg/kg. Ten uniform trees were selected at flowering. Five of these were sprayed during mid-anthesis with 1.25% paclobutrazol plus a non-ionic surfactant (0.05%) using a powered knapsack sprayer, wetting the trees to the point of run-off.

Twenty fruit were collected from each of the 10 trees at two week intervals beginning two weeks after flowering had finished. Composite samples from each tree were prepared using longitudinal sections from each of the 20 fruit harvested. The samples were freeze-dried, milled, acid digested and analyzed for calcium.

Results

<u>Vegetative growth and yield (Expt. 1).</u> All trees sprayed with PB had shorter spring fruiting shoots with less leaf area relative to untreated trees (data not presented). On average, PB sprays reduced leaf area by 37%, spring shoot length by 44% and summer shoot length by about 20% compared to untreated trees.

The PB treatments reduced the leaf and stem dry weights of fruiting spring shoots and generally increased dry weight allocation to the fruit (Table 1). Total shoot (shoot, leaves and fruit) dry weight of trees receiving higher concentrations of 2.5 and 1.25 g a.i./L of PB had about 25% less total shoot dry weight than those from untreated trees.

The spray treatments of 2.5 and 1.25 g a.i./L PB at mid-anthesis increased the mean fruit size at harvest by about 16 and 11%, respectively, compared with the untreated trees (Table 1).

There were no significant differences in fruit yield among treatments in 1988 or 1989 (Fig. 1). However, treatments of 0.62 and 1.25 g a.i./L of PB mid-anthesis in each of the two years of the experiment gave significantly higher cumulative yields than untreated trees.

Fruit calcium concentration (Expt. 2). Fruit calcium concentrations were greater in fruit from trees sprayed with paclobutrazol for the first 8 weeks after the set but thereafter there was no significant difference (Fig. 2).

Discussion

The results from our research show that foliar PB applied at mid-anthesis on to cv. Hass avocado trees reduces spring shoot growth and increases fruit size and yield. In our second experiment it was also shown to increase fruit calcium concentrations during the first 8 weeks of fruit growth. This confirms some earlier results on the effect of PB on spring shoot growth (Wolstenholme *et al.,* 1990) and fruit calcium concentrations (Whiley, unpublished data). However, a major difference is that we observed growth reduction from correctly timed foliar bloom sprays at much lower PB concentrations, viz. 0.62 and 1.25 g a.i./L compared with 4.0 g a.i./L, Köhne and Kremer-Köhne (1987); 2.5 and 5.0 g a.i./L, Wolstenholme *et al.,* (1990). This result is of economic importance in view of the relatively high cost of foliar spray treatments of PB (about $A4.80 per 6 m diameter tree using the 2.5 g a.i./L rate).

The reductions in spring shoot growth were reflected in larger fruit and greater yield over the two years of the experiment. Fruit size is an important issue with older trees of cv. Hass in subtropical environments. As trees age, fruit size becomes smaller with a higher percentage of the crop falling into lower valued market categories, viz. up to $A2.00 less per 6.2 kg of fruit for counts less than 23 per tray. Hence there is some economic significance in increasing the mean size of the fruit. Similarly the 30 percent increase per annum in yield with the best PB treatments is extremely profitable to producers of this cultivar, viz. in our experiment yield was increased from 19.6 t/ha/year (untreated) to 27.9 t/ha/year (best PB treatment).

The availability of calcium in fruit during the period when structural components, such as cell walls and membranes are determined, is later reflected in cell stability (Bangerth, 1979). This is of particular importance under postharvest stress conditions such as low temperature storage when chilling injury can occur (Eaks, 1985). Hence the enhanced calcium concentration in fruit from PB treated trees during their first 8 weeks of development should be of benefit to post-harvest fruit quality. Other techniques of increasing fruit calcium concentrations in avocado have either failed or been commercially impractical (Eaks, 1985; Trochoulias, personal comm.).

Our research has shown that the use of PB as a strategically-timed foliar spray during flowering produces a sustainable yield increase (a third year's data from the same trees shows similar trends). However, experience with the product where trees prior to treatment had stress related problems (viz. nutritional, water, leaf chloride, root rot) gave a negative impact on fruit quality and yield. There is clear evidence that PB, while an effective tool when used on healthy, vigorous 'Hass' trees, is not the panacea for changing poor management practices into easy profits.

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Table 1. Effect of foliar sprays of paclobutrazol at mid-anthesis on dry matter distribution in fruiting spring flush shoots and mean fruit weight at harvest of cv. Hass. Shoot data are means of 20 shoots from each of 5 trees and fruit weight data are pooled means (1988 and 1989) from each of 5 trees. Means in columns followed by different letters are significantly different ($P < 0.05$).

Paclobutrazol[z] (g a.i./L)	Dry weight of components of fruiting shoots (g)				Mean fruit weight (g)
	Leaves	Stem	Fruit	Total	
0	88.7 a	12.3 a	40.4 b	141.4 a	238.6 b
2.5	54.4 b	6.2 b	53.5 a	114.1 b	277.1 a
1.25	48.5 b	5.9 b	49.4 a	103.8 b	265.1 a
0.62	57.2 b	6.7 b	56.4 a	120.3 ab	244.0 b

[z]Paclobutrazol was sprayed to run-off on trees at about 50% anthesis.

Fig. 1. Fruit yield from cv. Hass trees foliar sprayed at mid-anthesis with various concentrations of paclobutrazol. Data are means from five trees. Bars with different letters are significantly different at $P < 0.05$.

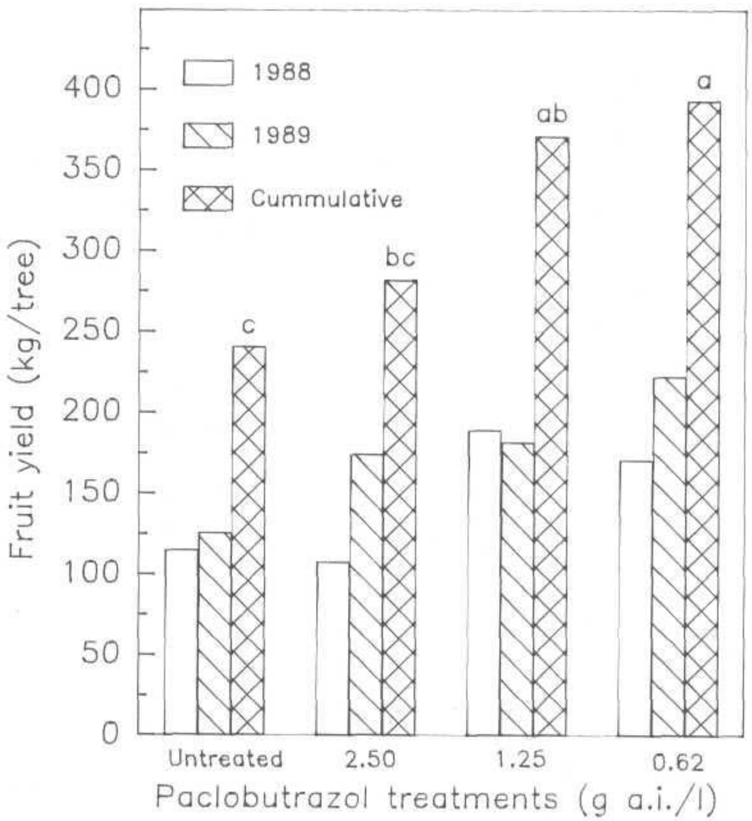

Fig. 2. Calcium concentration in fruit from untreated and trees foliar sprayed at mid-anthesis with 1.25 g a.i./L paclobutrazol. Standard errors of the mean are shown as vertical bars through datum points (n = 5).