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Results of a high density avocado planting

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ABSTRACT

Hass avocado trees on Duke 7 rootstock were planted at 800 trees per hectare, ie twice the density of the industry's current standard of 400 trees per hectare, and were treated with the growth retardant paclobutrazol in order to achieve a dwarfing effect. Data on yield efficiency, fruit weight and fruit quality are presented for the first two years of cropping.

INTRODUCTION

Many avocado orchards in the South African Lowveld are currently planted at a density of 400 trees per hectare. As avocado trees grow rapidly, later removal of alternate trees is required in order to avoid crowding. A final stand of mature trees is reached after three thinnings, i.e. removal of 88% of the initial tree population. Less vigorous trees would have distinct advantages in terms of orchard maintenance and would allow closer tree spacing and thereby higher initial yields per hectare. With avocados, work on dwarfing rootstocks has been started only very recently and it will take years before practical use is possible. In the meantime, growth control can be achieved by the growth retardant paclobutrazol (Köhne & Kremer-Köhne, 1987; Wolstenholme *et al,* 1988).

The objective of this study was to evaluate two high density planting systems for avocado using paclobutrazol to keep the trees compact and to induce precocity.

MATERIALS AND METHODS

Hass avocado trees on Duke 7 rootstock were planted in March 1986 on an area of one hectare at Westfalia Estate, situated in the North-Eastern Transvaal. This is a summer-rainfall area (average 1300 mm per year) with deep lateritic clay soils. Trees were planted at a standard spacing of 5,0 x 5,0 m and at high density spacings of 2,5 x 5,0 m (hedge) and 5,0 x 2,5 m (bed). The densities were 400 trees per hectare in the standard planting and 800 trees per hectare in the high density hedge and bed plantings. Each of the three planting systems covers one third of the experimental orchard (Table 1).

TABLE 1 Planting systems of Hass trees on Duke 7 rootstock

Planting system		Trees/ha
	Standard	400
	Hedge	800
	Bed	800

The growth retardant paclobutrazol (PBZ) was applied to all trees planted at the high density (800 trees/ha) while trees planted at the standard density (400 trees/ha) remained untreated. In February 1987, when the one-year-old trees started to grow vigorously, the trees planted at high density received the first foliar spray at a concentration of 0,1% PBZ using a motorised knapsack sprayer (Echo, model DM9). Another four foliar sprays followed as soon as vigorous vegetative growth resumed. A stem injection using 2% PBZ dissolved in methanol was applied once (April 1987). In addition, soil drench treatments at 0,4 g PBZ/m^2 of canopy profile were applied; PBZ was made up to approximately two litres with water and poured into a narrow furrow around the trunk (July 1987, January and October 1988).

For tree size determination, trunk circumference was measured for 50 randomly allocated trees each of the standard, hedge and bed planting in July 1987, 1988 and 1989. Measurements were taken 20 cm above ground level. Individual tree yields were recorded for these trees in July 1988 and 1989. Yield efficiency was calculated as fruit weight/cm^2 trunk cross-sectional area. In 1989, all fruit underwent commercial grading and packaging. Samples consisting of 140 fruit (mass range 266-305 g) were taken from each of the three plantings and stored for four weeks at 5°C to simulate a sea voyage. After removal from the cool room the fruit was kept at 18°C to induce ripening. When soft-ripe, fruits were bisected and inspected for physiological disorders.

RESULTS

Considerable reduction of vegetative growth was obtained through PBZ-treatment of avocado trees. This is reflected by significantly smaller trunk circumferences in treated trees. Differences in trunk circumferences became evident in the second (1988) and third year (1989) of PBZ-treatment (Table 2).

TABLE 2 The effect of paclobutrazol (PBZ) treatment on trunk circumference of young Hass avocado trees

Planting	PBZ	Trunk circumference (cm)		
		July 87	July 88	July 89
Bed	yes	17,5a	27,6a	34,7a
Hedge	yes	16,8a	27,0a	33,9a
Standard	no	17,5a	31,9b	40,7b

Mean separation in colums by LSD, 5% level

Foliar application as well as stem injection of PBZ resulted in noticeable growth retardation within a few days after application. The first symptom of growth retardation observed was a wrinkling and slight downward cupping of the youngest leaves. The same symptom eventually developed after soil drench application of PBZ. In contrast to the quick response achieved with foliar sprays and stem injections of PBZ, it took 4-8 weeks with soil drench treatments before first symptoms of growth retardation became apparent. Shoot length of trees that received a soil drench treatment of PBZ was significantly reduced due to shortening of the internodes. Shortly after injecting trees with PBZ dissolved in methanol, yellowing and subsequent shedding of leaves were observed, while neither foliar sprays nor soil drench treatments of PBZ were phytotoxic. Stem injection of PBZ was therefore discontinued. The immediate growth retarding effect of PBZ foliar sprays lasted for about 4-6 weeks after application whereas the shoot growth suppression through soil drench application of PBZ lasted for about six months.

In spring 1987 more profuse flowering was observed on the PBZ-treated trees as compared to the untreated trees. Subsequently, the PBZ-treated trees bore a heavier crop in 1988 than the untreated trees. In 1989, the untreated trees had the highest yield per tree. However, in 1988 and 1989 the best yield efficiency and the highest production per hectare, were obtained from PBZ-treated trees in the high density bed planting (Table 3). The grading of the fruit indicated no differences between the different plantings concerning the percentage of first, second and third grade fruit as they all averaged 80%, 5% and 15% respectively. The average weight of fruit obtained from the bed planting (212 g) was slightly higher than that of the hedge planting (208 g) and the standard planting (207 g). On average, fruit reached the soft-ripe stage within nine days after the temperature was increased to 18°C. The incidence of physiological disorders was very low, with only 0,7% of the fruit showing symptoms. There were no differences between fruit from the standard, hedge and bed planting regarding the ripening or the occurrence of physiological disorders.

TABLE 3 The effect of paclobutrazol (PBZ) treatment and planting system on yield and yield efficiency of young Hass avocado trees

Planting	PBZ	Yield (kg/tree)		Yield eff. (kg/cm^2)		Yield (t/ha)	
		1988	1989	1988	1989	1988	1989
Bed	yes	1,91b	21,32b	0,032b	0,229c	1,5	17,1
Hedge	yes	1,60b	15,64a	0,027b	0,177a	1,3	12,5
Standard	no	0,23a	26,78c	0,002a	0,205b	0,1	10,7

Mean separation in colums by LSD, 5% level

DISCUSSION

Vegetative growth of avocado trees in this study was effectively controlled by PBZ applications without adversely effecting fruit size or quality. Trunk growth was significantly suppressed in the second and third season of PBZ application. With continued use of PBZ, trees in both high density planting systems, i.e. bed and hedge (800 trees/ha), stayed significantly smaller than untreated trees planted at the density currently recommended (400 trees/ha).

Foliar application of PBZ only resulted in short term growth-control. Injecting PBZ into the stem induced leaf shedding, which is thought to be caused by the solvent used (methanol) rather than by PBZ. The long lasting growth control achieved with PBZ soil drench indicated that by using this method of application an effective threshold concentration of PBZ could be maintained in young avocado trees for much longer than by using foliar sprays.

Applications of PBZ promoted flowering and fruiting in very young avocado trees at the expense of vegetative growth. Although the yield per tree of the chemically dwarfed trees of both high density planting systems dropped below the level of the untreated trees in the second year of fruiting, the highest yield efficiency was observed in both years in the high density bed planting. The reduced yield efficiency noted in 1989 in the high density hedge planting can be attributed to competition for light between trees. Little flowering occurred where neighbouring trees were shading each other in the hedge row. Shading is not yet a problem in the high density bed planting where each tree has a more open stand and is fully exposed to solar radiation.

In conclusion, this study has shown that good tree size control in young avocado trees can be achieved with PBZ soil drench application. Strong evidence is provided that orchard productivity can be increased by increasing tree planting density while controlling vegetative growth. Reduced crowding and consequently a delay in removing alternate trees, are additional advantages. Further investigations into the use of growth retardants for tree size control are warranted as an interim measure until dwarfing rootstocks become available.

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