

## **Yield Advantages and Control of Vegetative Growth in a High-Density Avocado Orchard Treated with Paclobutrazol**

**J.S. Köhne and S. Kremer- Köhne**

Merensky Technological Services, P.O. Box 14, Duiwelskloof 0835, Republic of South Africa

**Abstract.** 'Hass' avocado trees on Duke 7 rootstock were planted in March, 1986, at a standard density of 400 trees/ha and also at a high density of 800 trees/ha. The growth retardant paclobutrazol was repeatedly applied to all trees in the high density planting (HDP) while the trees in the standard density planting (SDP) remained untreated. Paclobutrazol applications controlled tree size in the HDP which is reflected by significantly smaller trunk circumferences when compared to the untreated trees in the SDP. The cumulative yield for the first three years of cropping was 34.4 t/ha in the HDP and 17.6 t/ha in the SDP. Although the HDP is more expensive to plant and maintain, the economic break-even point is reached earlier than in the SDP.

In South Africa, many avocado orchards are currently planted at a density of 400 trees/ha. Avocado trees grow rapidly, and later removal of alternate trees is required in order to avoid crowding (Köhne, 1988). Less vigorous trees would allow closer tree spacing and thereby higher initial yields per hectare. Until such time as dwarfing avocado rootstocks may become available, the excessive vegetative growth of avocado trees can be controlled by applying the growth retardant paclobutrazol (Köhne and Kremer-Köhne, 1987; Symons and Wolstenholme, 1989).

The objective of this study was to put the concept of a high density planting to the test, using the growth retardant paclobutrazol to achieve dwarfing.

### **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 Lowveld (latitude 24°S). This is a summer-rainfall area (average 1300 mm/year). The soil type is a fine-loamy, mixed paleudult (USDA, 1975) with a clay content of approximately 40%.

Trees were planted at a density of 400 trees/ha (standard density planting, SDP) and 800 trees/ha (high density planting, HDP). Paclobutrazol (PB) was applied to all trees in the HDP while the SDP trees remained untreated. In 1987, when the one-year-old trees began to grow vigorously, foliar sprays and a stem injection of PB were applied as described by Köhne and Kremer-Köhne (1990). The growth control achieved by these

treatments lasted only for about four to six weeks. However, with a soil drench (0.4 g PB/m<sup>2</sup> canopy profile) applied in June, 1987, growth was controlled for four to six months. In 1988 and 1989, PB soil drench applications were repeated at the rate given above as soon as vigorous shoot growth resumed, i.e., two soil drench treatments per year. In 1990, PB treatment was discontinued.

For determination of tree size, trunk circumference was measured annually (July) for 50 randomly selected trees from each planting. Measurements were taken 20 cm above ground level. Individual tree yields were recorded for these trees in July 1988, 1989 and 1990.

Yield per hectare as well as cash flow (in South African Rand, R) were calculated using the yield data obtained from this trial. The calculations were based on the following assumptions:

- soil preparation, installation of micro-irrigation and planting of 400 trees (SDP) costs approximately R 15,000/ha. In the HDP, costs are R 19,000/ha due to the additional 400 trees.
- orchard maintenance (weed and disease control, irrigation, fertilization) costs approximately R 3000/ha per annum in the SDP, (for the HDP there was an additional cost for PB application of R 500/ha per annum).
- value of fruit "back on the farm", (i.e. proceeds minus cost of picking, packing, shipping and marketing) was R 1500/ton.
- neither inflation nor interest on investment were taken into account.

## Results

Considerable reduction of vegetative growth was obtained through PB-treatment of avocado trees. Trunk circumference of SDP trees was 41 cm in 1989 and 51 cm in 1990, while HDP trees measured 35 cm in 1989 and 41 cm in 1990. In other words, trees in the HDP took until 1990 to reach the trunk circumference that was measured in the SDP in 1989. With considerably smaller trees in the HDP, it was possible to produce fruit from twice the number of trees, i.e., 800 trees per hectare until August 1990, when crowding occurred and thinning became necessary.

In the HDP, the cumulative yield (1988-1990) per tree was 2% lower when compared to the SDP. However, this slight reduction in yield per tree in the HDP is irrelevant as the yield per hectare was increased by 95% in the HDP due to the fact that there are twice as many trees (Table 1).

Although the HDP is more expensive to plant and maintain, the point of break-even is reached at least a year earlier than in the SDP. While the money invested in the SDP has not yet been recovered by the end of year 5, the highly productive HDP is already showing a profit of R 15,100/ha (Table 2).

## **Discussion**

This study has shown that good tree size control in young avocado trees can be achieved with PB soil drench application. Due to effective tree size control, twice the number of trees were accommodated and early high yields per hectare were thus achieved. An additional advantage is the reduced crowding and consequent delay in the need to remove alternate trees.

In conclusion, this study proved that there are financial advantages in high density avocado plantings provided the individual tree produces enough fruit to cover its costs before it has to be removed in order to avoid crowding. The most economical way to control tree size is probably by the use of dwarfing rootstocks or inter-stocks. Investigations into the use of dwarfing rootstocks or interstocks for tree size control are warranted. It is clear that this holds great potential for increasing production.

## **Literature Cited**

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Table 1. The effect of planting density and paclobutrazol (PB) treatment on yield of young 'Hass' avocado trees.

Planting density	PB	Mean yield (kg/tree)			Cumulative yield <sup>z</sup>	
		1988	1989	1990	kg/tree	t/ha
HDP	yes	1.9	21.3	19.8	43.0	34.4
SDP	no	0.2	26.8	17.0	44.0	17.6

<sup>z</sup> 1988 - 1990

Table 2. Cumulative cash flow for one hectare of 'Hass' avocado planted at standard (SDP) or high density (HDP).

Years from planting	Cumulative cash flow (R)	
	HDP	SDP
0	- 19,000	- 15,000
1	- 22,500	- 18,000
2	- 26,000	- 21,000
3	- 27,220	- 23,880
4	- 5,160	- 10,800
5	+ 15,100	- 3,600