Proc. of Second World Avocado Congress 1992 pp. 273-279

Close Planting of Avocado

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Abstract. **Three planting distances, 6x6, 5.5 x 3 and 4 x 2 m are being tried in an experimental grove of the cv. Bacon planted in 1984. Trees started to form dense hedges five and six years after planting at 4 x 2 and 5.5 x 3 m distances, respectively. Yield per tree started to be proportionally affected by closer distances by the fourth year. However, yield per hectare continued to increase in accordance with tree density up to the sixth year. Individual fruit weight, percent oil and percent dry weight decreased as planting density increased. Nitrogen, phosphorus and zinc content in the leaves decreased as planting density increased. Conversely, calcium and magnesium increased while potassium, iron, manganese and copper were not affected. This progress report covers the first six years of this trial, which is planned for 12 years.**

Traditionally, avocado has been planted quite sparse. Depending on vigour and growth habit of the cultivar, planting distances have ranged between 6 and 12 meters under square design (Alvarez de la Pena, 1981; Gaillard, 1987; Hodgson, 1947). These distances provide ample room for the development of a large trees and maximum utilization of light. However, full bearing capacity in terms of yield per surface unit is much delayed. Semipermanent planting has been employed in order to overcome this problem. Trees are initially planted at close distances to be successively thinned out in a symmetric pattern reaching eventually the definitive distance (Lee, 1973; Platt, 1976; Platt *et al.,* 1970). However, this system does not always offer the expected results, mainly due to delay in removal of temporary trees.

Definitive close planting distances are commonly used in deciduous orchards and it is becoming a frequent practice in evergreen ones, mainly citrus (Boswell *et al.,* 1982; Gallasch, 1983; Koo and Muraro, 1982; Phillips, 1974; Razeto, 1989; Wheaton *et al.,* 1988).

The present work was planned in order to determine the feasibility of close planting in avocado. Three planting densities were tried: a traditional one (6x6 m), a close one (5.5 x 3 m) and a very close one (4x2 m). The Bacon cultivar was employed due to its upright and stunted tree form and precocious production. Both properties fit very well with a high-density planting system, in addition to being characteristics selected for present day in avocado breeding programs.

Materials and Methods

'Bacon' trees grafted on Mexicola rootstock were planted in the spring of 1984 on a uniform and deep clay loam soil, located 50 km west of Santiago. Blocks of three rows were planted for each distance to be tried. Eight, 1 5 and 22 trees per row were planted at each distance, respectively. Planting distances being tried are 6 x 6, 5.5 x 3 and 4x2 meters. One row of 'Hass' trees was planted between blocks as a pollinator, leaving a 6 m space between blocks (Fig. 1).

Trees were grown without any pruning or thinning. Periodical furrow irrigation was done during spring, summer and fall. Yield per tree was weighed yearly. Fruit size, oil content and percent dry weight were determined in the 1990 harvest (July 23), taking a random sample of six fruits per tree. Leaf analysis was done in samples taken in late summer of 1990 (March 10). Trunk diameter and lateral root development were measured in March, 1990, and one year later. All measurements and samplings were done in six trees per treatment located in the central row of each block.

Results

Results obtained during the first six years of this research are presented in this paper. The total work is planned over a 12-year period.

Vegetative growth. Trees have grown very well throughout the experimental grove. Foliage from trees started to touch on the row four years after planting at the 4 x 2 m distance and five years after planting at the 5.5 x 3 m distance. Five years after planting, the closest planted trees started to form dense hedges within the row but left enough space between rows. The same happened in the 5.5 x 3 m distance one year later, while in the 6 x 6 m distance there is still plenty of room between trees.

Trunk diameter measured five and six years after planting was inversely proportional to planting density (Table 1).

Yield. Individual yield of trees as well as calculated yield per hectare are presented in Figures 2 and 3. Production per tree was very similar in all treatments at the third year, before trees started competition, which indicates a high uniformity in all trees used in the trial. Yield per tree started to be proportionally lower at closer distances starting the fourth year. However, yield taken on a per hectare basis continued to increase in accordance with planting density up to the sixth year, reaching a record of 35 tons per hectare at 4 x 2 m.

Fruit weight and maturity. Average individual fruit weight and maturity parameters measured in the sixth year harvest are presented in Table 2. Fruit weight decreased as planting density increased. Likewise, percent oil and percent dry weight decreased.

Level of mineral nutrients in the leaves. Nitrogen, phosphorus and zinc content in the leaves decreased as planting density increased (Tables 3 and 4). In contrast, calcium

and magnesium increased, while potassium, iron, manganese and copper were not affected.

Lateral root development. Observations carried out in the sixth year showed root intercrossing at the 4x2m distance both on the rows and between them. At 5.5 x 3 m there was intercrossing on the rows, while lateral development between rows was of 2 m. At 6 x 6, roots had a 2.5 m radius lateral spread.

Discussion

Results presented up to the sixth year look positive for close planting. Tree size is reduced allowing them to fit in the smaller assigned space. Although the formation of hedges caused a progressive reduction in growth and yield of individual trees, yield in terms of tons per hectare increased, reaching very high values.

Reduction in fruit size at shorter planting distances could be due to a delay in maturity rather than being an actual effect of density on fruit growth. In fact, oil and dry matter concentrations in the pulp were lower as distances decreased. This effect is not necessarily negative depending on market behavior.

The effects of close planting on growth, yield and fruit maturity can be attributed to leaf shading and/or root competition for some nutrients like nitrogen, phosphorus and zinc.

In spite of the preliminary nature of these results and not knowing yet what will happen in the following years as trees continue to grow, close planting appears as a promising system for the Bacon cultivar. Conical shape, slow growth and precocious bearing habit of this tree fit very well for hedge formation. Other cultivars of similar characteristics could behave in a similar manner.

This trial will be continued for several years in order to obtain more definitive results.

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Table 1. Effect of planting distance on trunk diameter.

	Trunk diameter (cm)	
Planting distance (m)	Fifth year[z]	Sixth year[z]
6 x 6	14.89 a	17. 34 a
5.5 x 3	13.43 ab	15.56 ab
4 x 2	12.24 b	13.51 b

[z] Values in a column followed by the same letter do not differ significantly at P<0.05.

Table 2. Effect of planting distance on fruit weight, oil, and dry matter concentration in the pulp for the sixth year harvest.

Planting distance (m)	Fruit weight (g) [z]	% oil [z]	% dry weight[z]
6 x 6	231.4 a	9.08 a	21.12 a
5.5 x 3	221.3 ab	7.82 b	20.05 b
4 x 2	196.1 b	6.80 b	19.46 b

[z] Values in a column followed by the same letter do not differ significantly at P<0.05.

Table 3. Effect of planting distance on macronutrient concentrations in the leaves collected in March, 1990.

	Macronutrient[z]				
	N	P	K	Ca	Mg
Planting distance (m)	(% dry weight)				
6 x 6	2.37 a	0.17 a	1.12 a	1.44 a	0.27 a
5.5 x 3	2.12 b	0.15 b	1.37 b	1.60 ab	0.31 a
4 x 2	2.09 b	0.15 b	1.24ab	1.86 b	0.38 b

[z] Values in a column followed by the same letter do not differ significantly at P<0.05.

Table 4. Effect of planting distance on micronutrient concentrations in the leaves collected in March, 1990.

	Micronutrient[z]			
	Fe	Mn	Zn	Cu
Planting distance (m)	(ppm dry weight)			
6 x 6	74.0 a	51.5 a	36.1 a	6.0 a
5.5 x 3	71.5 a	45.5 a	33.3 ab	7.0 a
4 x 2	67.5 a	48.0a	29.1 b	6.0 a

[z] Values in a column followed by the same letter do not differ significantly at P<0.05.

Fig. 1. Layout of the experimental grove.

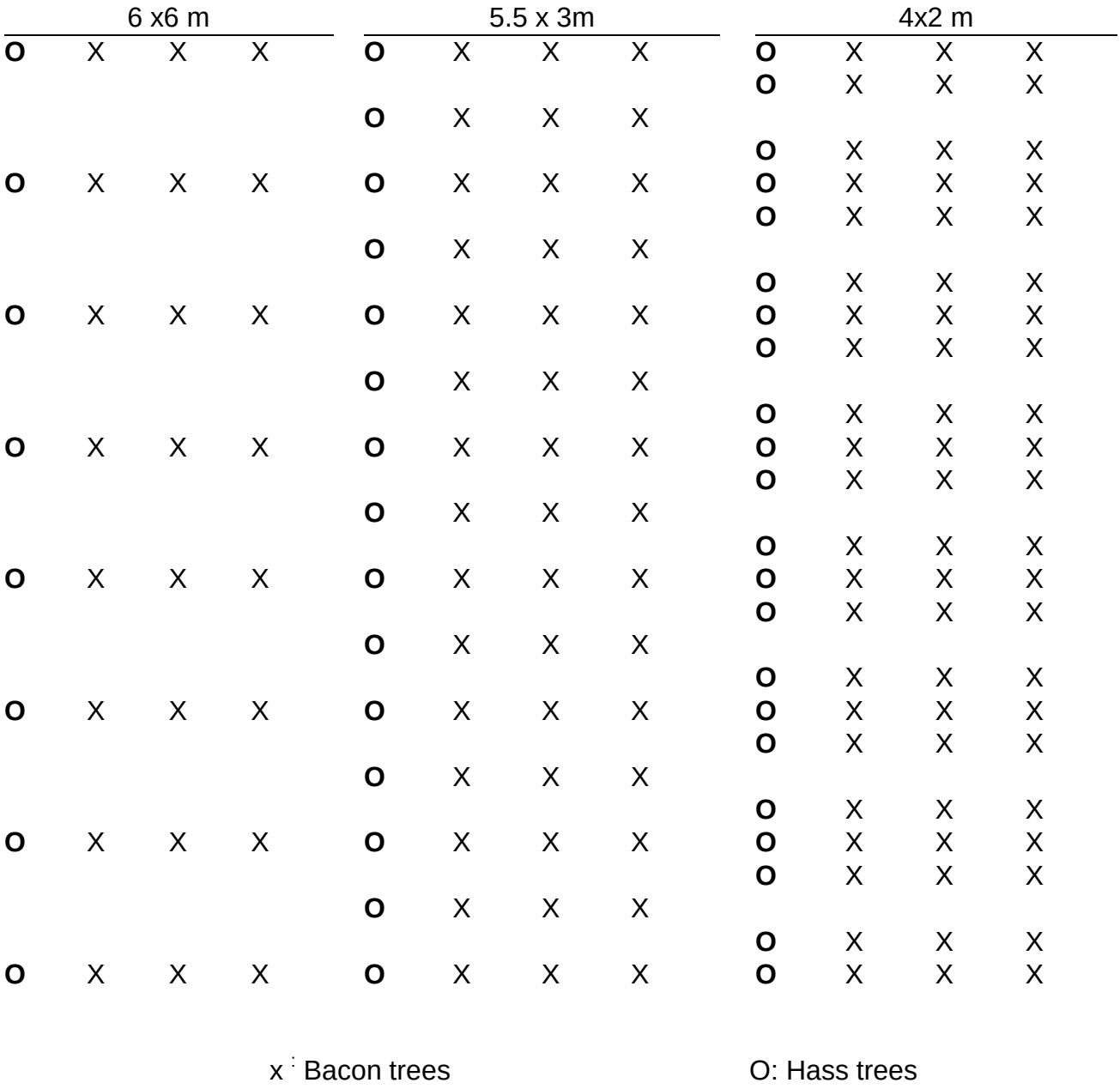

Fig. 2. Effect of planting distance on yield per tree.

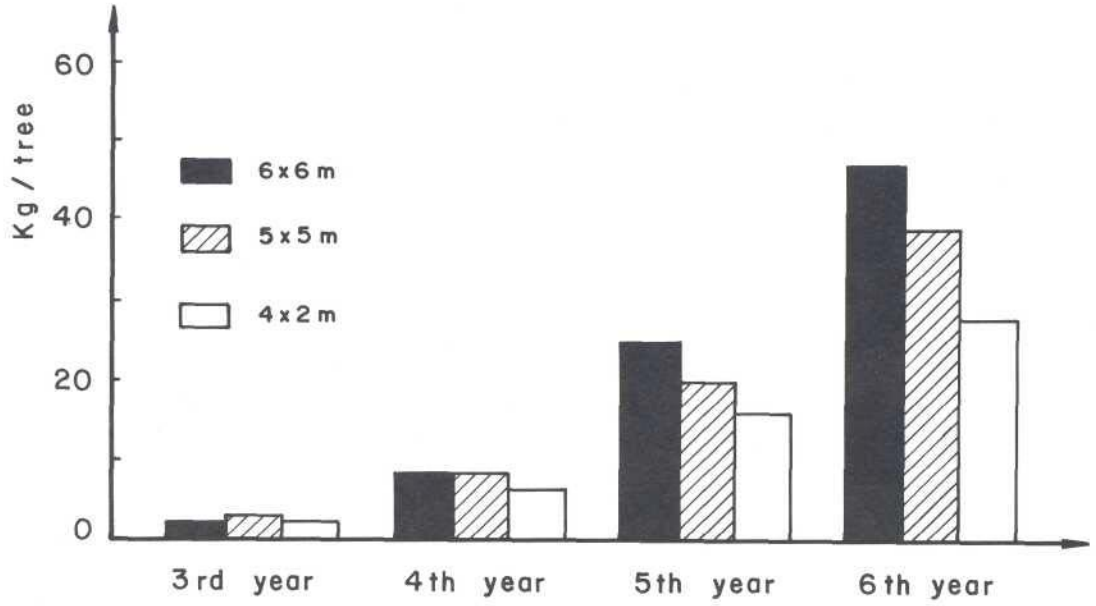

Fig. 3. Effect of planting distance on yield per hectare.