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EFFECT OF DENSITY OF PLANTING ON IMMATURE RUBBER (*HEVEA BRASILIENSIS* MUELL. ARG.)

Mary Varghese, Annie Philip*, Jacob Pothen and K.I. Punnoose*
Rubber Research Institute of India, Central Experiment Station, Chethackal, Ranni-689 676
* Rubber Research Institute of India, Kottayam 686 009.

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The effect of planting density on rubber (*Hevea brasiliensis*) was studied in a trial which consisted of five densities as the main plot treatment and two methods of calculating fertilizer requirement by area and plant basis as sub plot treatment. Density of planting had significant effect on girth of plants by the ninth year from planting but the fertilizer treatments did not have any effect. Plants at the lowest density of 420 trees/ha recorded the highest girth increment, bark thickness and percent tappability. The general plant architecture was also balanced in the lowest density. However, plants at 479 trees/ha and 549 trees/ha also performed reasonably well. Plants in these densities had a comparable girth, bark thickness and percent tapability with those in the lowest density. A density above 549 trees/ha was observed to adversely affect girth, bark thickness and percent tappability.

Key words: Bark thickness, Canopy width, Crotch height, Girth increment, *Hevea brasiliensis*, Planting density.

INTRODUCTION

Rubber (*Hevea brasiliensis*) cultivation in India is undertaken with a planting density of 420-500 trees/ha. Plants tend to perform well in this density. However, since more than 80% of holdings in India are in the small-holding sector with an average holding size of <0.5 ha, it is necessary to explore the possibility of increasing the planting density. Increased planting density has been reported to cause reduction in the bark thickness and number of latex vessel rings (Rodeigo *et al.*, 1995). Increase in planting density could result in reduced per tree yield but may increase the yield per unit area. Therefore, a small holder is always attracted to high density planting to improve the productivity of his land. Ng *et al.*, (1979) has reported that lowering planting density results in greater vigour and higher yield per tree, while increasing density of planting reduces tree vigour and yield per tree, but increases the yield per unit area. Hence a study was conducted to examine the effect of density of planting on immature growth phase of rubber.

MATERIALS AND METHODS

The experiment was laid out at the Central Experiment Station, Chethackal during 1994 in a split plot design with five densities ranging from 420 to 749 trees per hectare as the main plot treatment and two methods of calculating fertilizer requirement *viz.* per unit area and per plant basis as sub plot treatments replicated four times. The

Correspondence: Annie Philip (email: anniephilip@rubberboard.org.in)

clone used was RRII 105. Each plot accommodated 25 to 49 plants depending on the density. The soil in the location was loamy. The annual average rainfall is more than 3500 mm.

The treatments in the main plots were D1-420 trees/ha (4.9 x 4.9 m), D2-479 trees/ha (4.6 x 4.6 m), D3-549 trees/ha (4.3 x 4.3m), D4-638 trees/ha (4.0 x 4.0m), D5-749 trees/ha (3.7 x 3.7m) and in the Sub plots M1-Recommended dose of Fertilizer (RDF) on unit area basis and M2-RDF on per plant basis.

Plant girth at 150 cm from bud union was measured annually from third year onwards. Annual girth increments were also worked out based on the girth measurements.

Measurements of photosynthetically active radiation (PAR) was made in the seventh year using AccuPAR model PAR-80. PAR under the rubber canopy was measured at two randomly selected points in each plot between 10 - 11 AM and 12 - 1 PM. Corresponding light measurements from open area were also taken for the calculation of light interception.

Plant height, crotch height and canopy width were measured in the seventh year and bark thickness was measured at the eighth year of planting. The thickness of virgin bark was measured using a bark gauge.

RESULTS AND DISCUSSION

The fertilizer treatments did not significantly influence any of the studied parameters throughout the period under observation. Therefore, the effect of only density of planting is discussed in this paper.

Girth

It was observed that density of planting did not have any significant effect on girth of plants up to the eighth year after planting (Table 1). However, plants in the higher densities had numerically higher absolute girth in the initial years. Rubber plants planted at a density of 549 and 638 trees per ha showed relatively higher absolute girth till the sixth year after planting. The initial advantage of higher density of planting could be the beneficial effect of mutual shading among rubber plants at these densities. A similar trend of better growth in the initial years for higher densities has been reported by Devakumar *et al.*, (1995). Plants in the highest density of 749 trees/ha showed an encouraging girth till the third year of planting which could not be sustained probably due to the intense competition among plants which set in subsequently. Plants in the lower densities of 420 and 479 trees per ha were observed to perform comparatively better after the seventh

Table 1. **Girth (cm) as influenced by planting density**

Density (trees/ha)	Years from planting						
	3	4	5	6	7	8	9
420	11.40	18.37	26.50	34.32	41.51	48.77	54.56
479	11.49	19.16	27.55	35.77	42.73	48.18	52.49
549	12.01	19.20	28.44	36.56	43.09	48.29	52.48
638	12.84	20.24	29.25	36.59	42.63	46.64	50.75
749	11.61	18.88	27.65	35.21	40.81	45.13	49.49
SE	0.49	0.86	1.14	1.23	1.14	1.22	1.50
CD (P≤0.05)	NS	NS	NS	NS	NS	NS	3.30

year. By the ninth year of planting, plants in the lowest density (420 trees/ha) attained significantly higher absolute girth as compared to all other densities. The better growth could be a result of relatively reduced competition for nutrients, moisture and sunlight.

Girth increment

The density of planting did not have any significant effect on girth increment of the rubber trees up to the seventh year of planting. However, the girth increment of plants in the lower densities (420 & 479 trees/ha) was numerically higher compared to other treatments for the period between sixth and seventh year (Figure 1). Between the seventh and eighth year, plants in the lowest density of 420 trees/ha had significantly higher girth increment compared to all other treatments. This trend was sustained even in the ninth year after planting. The better growth rate in the lower densities from sixth year onwards is a result of optimum growth factors available to these plants.

Bark thickness

It was observed that plants in the lower densities had significantly higher bark thickness (Table 2). A similar trend has been reported by Rodrigo *et al.*, (1995). Thinner virgin bark in higher planting densities has been reported from Malaysia (Planter's Bulletin, 1993).

Tappability

The lower densities had a higher number of trees that had attained tappable girth at nine years after planting (Table 2). Plants

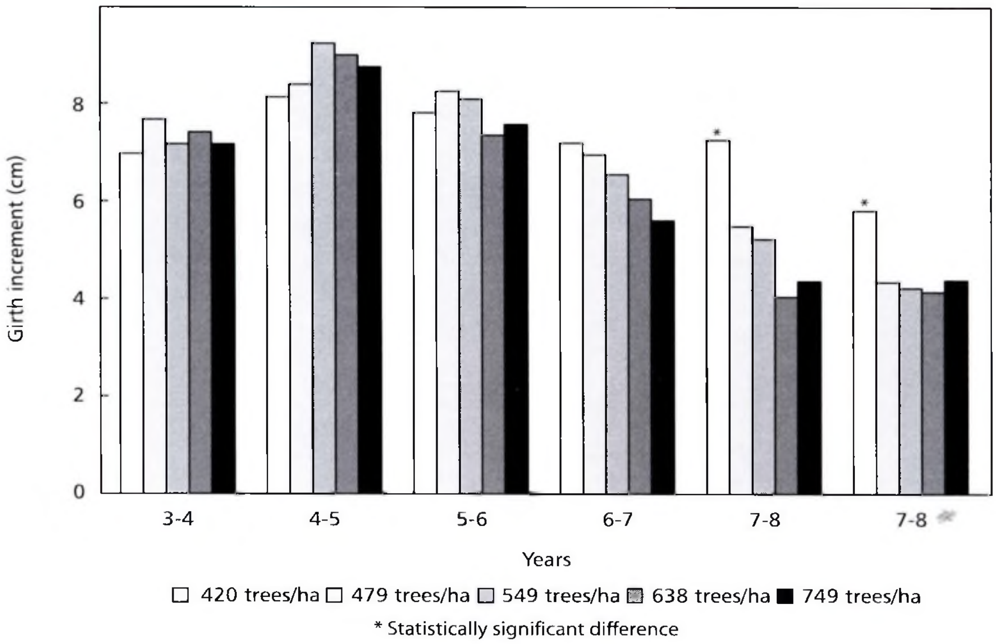

Fig. 1. Girth increment of plants

Table 2. **Effect of planting density on bark thickness, tappability and plant architecture**

Density (trees/ha)	Bark thickness (mm)	Tappability at nine years from planting (%)	Plant architecture		
			Crotch height (m)	Plant height (m)	Canopy width (m)
420	7.90	69.8	2.54	10.34	6.88
479	7.80	66.6	2.64	10.83	6.07
549	7.55	60.7	2.55	11.17	5.98
638	7.18	60.2	2.79	11.65	5.66
749	7.13	47.0	2.71	11.52	5.69
SE	0.19	3.52	0.04	0.28	0.22
CD ($P \leq 0.05$)	0.41	7.67	0.09	0.61	0.48

in the lower density of 420 trees/ha had significantly higher number of tappable trees when compared to the higher densities and were on par with the density of 479 trees/ha. Only 47% of plants had attained tappable girth in the highest density of plating of 749 trees/ha.

Light interception

Observations on light interception revealed that the quantity of light that diffused to the ground level was significantly higher in the lowest density (Table 3). The higher penetration of light in lower density of planting is due to the wider spacing adopted resulting in less overlapping of canopies. A similar trend has been reported by Devakumar *et al.*, (1995).

Plant architecture

Observations on crotch height, plant height and canopy width revealed that there were remarkable differences between trees in different densities (Table 2). Significantly higher plant height and crotch height were observed in plants in the higher densities.

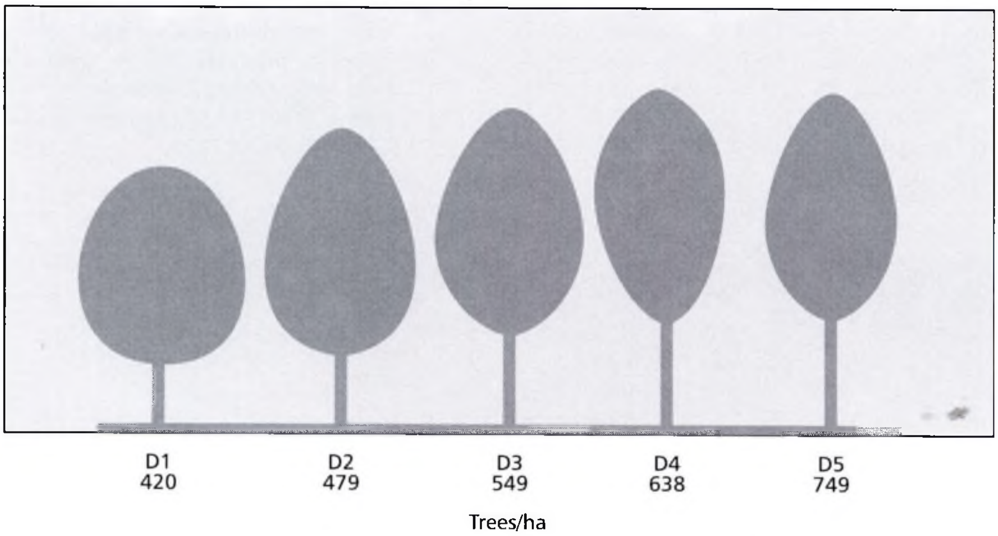

Fig. 2. Tree architecture at different densities of planting

When the canopy grows, there was overlapping and competition for light at higher densities. Under such circumstances trees undergo certain modifications like increase in height with higher crotch height and reduced canopy width. The trees tend to grow taller and thinner in order to harvest more sunlight (Webster, 1969) and this type of plant response is referred to as co-operative interaction (Yoda *et al.*, 1957). Plants in the lowest density of 420 trees/ha had significantly higher canopy width. A schematic representation of the canopy architecture is presented in Fig. 2. The modification in the canopy architecture in different densities is a mechanism of the plant to intercept maximum solar radiation effectively (Ryajihashimoto, 1991). This study revealed that the density of 420 trees/ha favour early tappability and was comparable to densities upto 549 trees/ha, above which growth was adversely affected.

REFERENCES

Devakumar, A.S., Potty, S.N., Chaudhuri, D., Mandal, D., Varghese, M., Pothen, J. and Sethuraj, M.R. (1995). Influence of plant density on growth and canopy architecture in *Hevea brasiliensis*. *Indian Journal of Natural Rubber Research*, 8(1): 57-62.

Ng, A.P. (1993). Density of planting. *Planter's Bulletin*, 216, pp.87-99.

Ng, A.P., Abdullah, S., Ooi, C.B., Leong, W., Lew, H.L. and Yoon, P.K. (1979). Reports on various aspects of yield, growth and economics of a planting trial. *Proceedings of RRIM Planter's Conference*, 1979, pp.303-322.

Rodrigo, V.H.L., Nugawela, A., Pathirathna, L.S.S., Waidyanatha, U.Pde S., Samaranayake, A.C.I., Kodikara, P.B. and Weeralal, J.L.K. (1995). Effect of planting density on growth, yield, yield related factors and profitability of rubber (*Hevea brasiliensis* Muell. Arg). *Journal of the Rubber Research Institute of Sri Lanka*, 76: 55-71.

Ryajihashimoto (1991). Canopy development in young Sugi *Cryptomesia japonica* stands in relation to changes with age in crown morphology and structure, *Tree Physiology*, 8(2):129-143.

Webster, G.W. (1969). Cultural manipulation of higher yields. In: *Physiological Aspects of Crop Yield.* (Eds. J.D. Eastin, F.A. Haskin, C.Y. Sullivan and C.H.M. Vanbavel). American Society of Agronomy, Wisconsin, USA, pp.327-339.

Yoda, K., Tautokira and Kajuho, Z. (1957). Interspecific competition among higher plants: 9. Further analysis of the competitive interaction between adjacent individuals. *Journal of Institute of Polytechnic Osaka City University*, 8 (D): 24-38.