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EFFECT OF PLANTING DENSITY ON THE YIELD OF COCONUT

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ABSTRACT

An analyses is presented of the yield components of coconut established under densities varying from 128 palms/ha to 239 palms/ha from a spacing trial conducted by the Coconut Research Institute. Analysis of yield data during 1976-1980 from 24 palms from 4 replicates analysed for each density treatment revealed significant differences in nuts/palm and copra/palm for the densities tested. The nuts/palm decreased with increasing density but the yield/ha maximised at a density of 171 palms/ha and decreased beyond 171. Significant differences were absent in yield of copra/nut for the densities tested. The differences in copra/palm were due to the effect of nut number/palm. At a density of 179 palms/ha, copra/ha maximised to 2260 kg and decreased beyond 179. The results of the present analysis indicate that a density ranging from 171-179 palms per hectare is the optimum for planting coconut in dry-intermediate zone where the study was conducted.

INTRODUCTION

Coconuts are generally planted at spacings determined from past experience influenced by traditions which have been developed in particular countries. As a result, a variety of plant- to- plant spacings are used for planting in different coconut growing countries mainly determined on a hypothetical basis. In Sri Lanka the range of plant population density for commercial tall variety varies from 123 to 210 palms/ha (50 to 85 palms/Ac) and different systems of planting such as square, rectangular and triangular are adopted to obtain the relevant densities.

However, experimental evidence on optimum spacing for coconut is meagre and the available information leads to contradictions (Smith 1972). The first systematic experiment on coconut densities was initiated at the Pothukulama Research Station, Coconut Research Institute, Sri Lanka in 1964 (Manthriratne 1976) and an interim analysis of data revealed that spacings that were experimented with had no significant influence on total leaf production or time taken for initial flowering but had a significant effect on the length of fronds and girth of the trunk. Subsequently Manthriratne (1979) using nut yield data during 1973-1976 from the same trial showed that significant differences exist in the mean yield per palm for both between and within row spacings. Further the number of nuts/palm decreased with increasing density but a high yield per unit area was obtained from high density systems.

However, Manthriratne (1979) highlighted the necessity of a complete examination of the yield components and total yield of palms, giving a reasonable duration of time for yield stability for different densities before a final judgement is made on optimum densities. Therefore it was considered to use the past experimental data on spacings to reach consensus on optimum densities for future plantings. This paper elaborates on yield data under different densities after yield stabilization of the trial at the Pothukulama Research Station, with the objective of recommending the appropriate plant population density for the grower under specific agroecological conditions.

MATERIALS AND METHODS

A set of experimental data has been selected from the planting distance trial initiated in 1964 at the Pothukulama Research Station(PRS). The site is located in the dry-intermediate zone of north-western Sri Lanka. The soil type is a sandy-loam (regosol), and the average rainfall at the site during the period of study was 1399.4 mm/yr (Estate Management Division, PRS).

The design of the experiment was 4*4 strip plot, where within each replicate the columns were allotted the within row spacings. There were two replicates with 6 palms per plot (Fig 1). The spacings and resulting number of palms are given in Table 1. The planting material used for the experiment were selected hand pollinated

Table 1. *Between-row and within-row spacings and number of palms per hectare(in bold) (densities used for data analyses are underlined).*

		Between-row spacing (m)			
		7.6	9.1	10.6	12.2
Within-row	4.6	**290**	**<u>239</u>**	**<u>205</u>**	**<u>179</u>**
spacing	5.3	**<u>239</u>**	**199**	**<u>171</u>**	**<u>150</u>**
(m)	6.3	**<u>205</u>**	**<u>171</u>**	**146**	**<u>128</u>**
	7.3	**<u>179</u>**	**<u>150</u>**	**<u>128</u>**	**112**

F1 seedlings of *Typica x Pumila* (CRIC65) hybrids.The crop yield for the 5 year period 1976-1980 were used for the analysis. Planting densities ranging from 128 to

239 palms/ha were only considered for the present analysis. Moreover data from a dual set of planting systems (each with 2 replicate plots) commmon to a single density were pooled together resulting in 24 palms for each density. eg. data from plots with spacings 6.3 x 9.1 and 5.3 x 10.6 resulting in 171 palms/ha were considered together. Based on the earlier results, the effect of densities was considered important than the planting systems (Manthriratne, 1979) since the yield per/palm of a specific density did not vary significantly with the planting system whether it was a square or a rectangular. Data from systems 5.3 x 9.1 and 6.3 x 10.6 were excluded from the analyses since they resulted in densities which were almost similar to the densities under consideration. Densities 290 palms/ha and 112 palms/ha were not considered as these densities were believed to be too high and too lower respectively on empherical evidence.

RESULTS AND DISCUSSION

The analysis of variance on the plot means for the 6 densities, revealed significant differences for nuts/palm/yr and husked nut wt/palm/yr (Table 2). However, significant differences were absent among the 6 planting densities for mean husked nut wt indicating that the differences in husked nut wt/palm/yr were due to the control exercised by number of nuts. It was obvious that the total assimilate available for the formation of a bunch of nuts is partitioned between number of nuts and weight of nuts. The present investigation shows that for the range of densities tested, only the number of nuts/palm/yr varied significantly due to differences in densities and the variation in total husked nut wt/palm and copra weight/palm is a consequence of the latter phenomenon.

The mean number of nuts on the basis of per palm and per ha during the period 1976 to 1980 appear in Table 3. A steady increase in nut yield/palm is observed from the closest spacing to the widest (Fig 2) but the per hectare yield maximised at the density of 171 palms/ha for number of nuts (Fig 3). The mean husked nut weight/palm decreased steadily with increasing density, with the yield stabilising in the plant population density range 171 to 179 palms/ha (Fig 4).

In parallel with the results for nut yield, mean husked nut weight/ha maximised at 179 palms/ha. The mean husked nut weight/ha varied between 6230 kg for the density of 239 palms/ha and 7065 kg for the density of 179 palms/ha (Table 03). Copra yield was estimated as 32% of the husked nut weight (Pieris, 1935) and copra/ha/yr varied from 1993 kg to 2261 kg for densities of 239 palms/ha and 179 palms/ha respectively (Fig 5).

In contrast to the previous analysis of nut yield data (1973-1976) of Manthriratne (1976) indicating a linear increase in yield of nuts/ha with increasing density of palms, the present analysis of yield of nuts and copra showed an increase in the nuts/ha and copra/ha upto 171 palms/ha and 179 palms/ha respectively and then

	Ft.	40	40	40	40	25	25	25	25	30	30	30	30	35	35	35	35 Ft
REPLICATE I	24.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	24.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	24.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	21.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	21.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	21.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	15.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	15.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	15.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	18.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	18.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	18.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

	Ft.	30	30	30	30	35	35	35	35	40	40	40	40	25	25	25	25 Ft
REPLICATE II	18.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	18.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	18.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	24.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	24.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	24.	.	.	.	.	.	.	.	.	.	.	.	.	.	.		.
	15	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	15.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	15.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	21.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	21.	x	x	x	.	x	x	x	.	x	x	x	.	x	x	x	.
	21.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

. GUARD ROW PALMS

X EXPERIMENTAL PALMS

Figure 1. Spacing trial (Poththukulama) (Strip plot design)
Extracted from Manthriratne (1979)

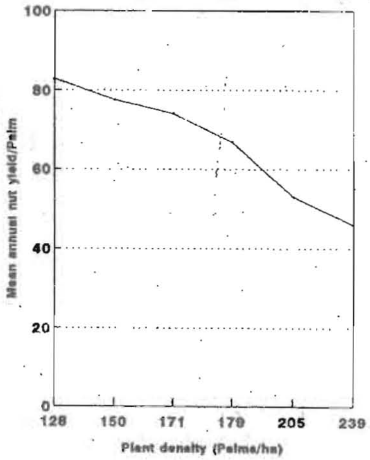

Figure 2 - Variation in nut yield/ palm with plant densities.

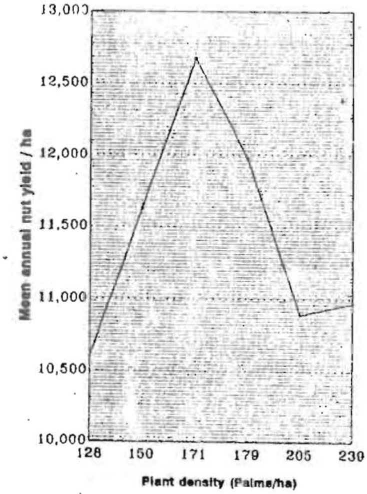

Figure 3 - Variation in nut yield/ ha with plant densities

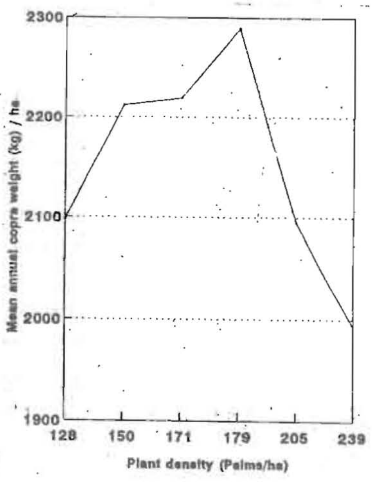

Figure 5 - Variation in copra yield/ ha with plant densities

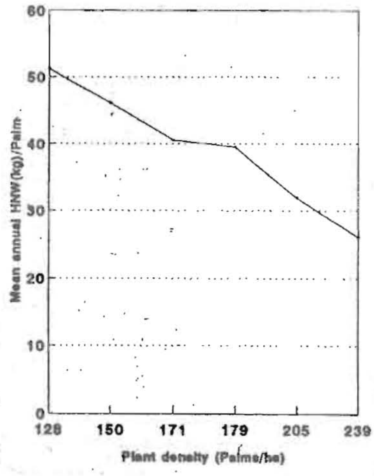

Figure 4 - Variation in husked nut weight/palm with plant densities

Table 2. *Results of the analysis of variance tests for yield components.*

	Between MS	Within MS	F	P
Nuts/palm/yr	839.202	11.995	7.49	0.0006***
HNW/palm/yr	335.624	59.269	5.66	0.0026**
HNW/ha/yr	78905.59	249980.47	0.32	0.8971
Cop.wt/nut/yr	0.00033	0.00059	0.56	0.7296
Cop.wt/palm/yr	34.368	6.069	5.66	0.0026**

Table 3. *Mean annual nut yield, husked nut weight and copra yieldof the different densities.*

Plant density (Palms/ha)	Nut yield per palm	Nut yield per ha	Husked nut wt (kg) per palm	Husked nut wt (kg) per ha	Copra wt (kg) per ha
128	82.83	10602	51.23	6557	2098
150	77.53	11595	46.09	6913	2212
171	74.12	12674	40.56	6936	2219
179	66.93	11980	39.47	7065	2260
205	53.13	10892	31.94	6548	2095
239	45.91	10972	26.07	6230	1993

decreased with increasing density without a compensation for the loss of yield/palm due to increase in population density. Results indicate that eventhough the palms at higher density produced a higher yield at the early stage of growth, the competition over time has caused a reduction in yield leading to a lower total yield for densities above 179 palms/ha.

Eventhough the husked nut weight per ha varied from 6230 kg for 239 palms/ha to 7065 kg for 179 palms/ha, the differences were not significant (Table 2). Furthermore based on the argument of Smith(1972), that the fertile moisture rich soils can accomodate more palms than the less fertile moisture stressed soils, growers opting for higher densities and within the moisture rich soils of the wet and wet-intermediate zones, a maximum density of 200 palms per ha could be used following the tradition of using an optimum spacing of 7.6m (25 ft) in a triangular system.

Experimental evidence on root biomass studies of different planting densities in coconut show that there is a greater tendency for lateral root expansion particularly in the form of primary roots in lower density systems and the development of more feeder roots in the higher density systems (Mohd et. al., 1982). Planting at a high density, however, is likely to result in intense competition between the young palms as they approach maximum leaf area, resulting in an extended period of rapid stem elongation, to the detriment of yield (Foale, 1993).

CONCLUSION

The choice of spacing and resultant density for coconut is influenced by the decision whether to grow the crop in monoculture or to grow it in association with intercrops. According to the results of this study, it is beneficial to plant at high plant population density, but within the range 171-179 palms per hectare if grown in monoculture in dry-intermediate zone.

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