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# Influence of Spacing and Manuring on the Growth, Flowering and Yield in Coconut

BY

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ABSTRACT

The results of a spacing cum manurial experiment on coconut showed a marked and consistent response to the application of N, P, K fertilizers. There was indication of increased longevity of leaves due to manuring. The initiation of flowering was quickened by the application of fertilisers and to some extent by increased spacings. The initial yields were also higher under manuring. The wider spacing of 9.1 x 9.1 m appeared to be better than narrower spacings. The trend as judged from the initial growth, age at first flowering and initial yields was in favour of a combination of the widest spacing and the higher dose of fertilizers.

## INTRODUCTION

Population density and initial manuring are aspects of importance for successful cultivation of coconut. Spacings adopted in important coconut growing countries like India, Ceylon, Philippines and Java range from as close as 2.75 m to as wide as 14 m (Pieris, 1945 cited by Menon and Pandalai, 1958; Child, 1964). There are differences of opinion regarding the optimum spacing and response to manurial applications (Patel, 1938; Pieris, 1945; Copeland, 1931; Menon and Pandalai, 1958). It is, therefore, necessary to determine the optimum spacing and level of manuring for the crop through field experiments under varied agro-climatic conditions. The results of such an experiment to find out the optimum combination of spacing and manuring for the East coast conditions of Tamil Nadu are reported here.

## MATERIALS AND METHODS

The experiment was laid out under rainfed conditions at the Regional Coconut Research Station, Veppankulam where the soil is sandy loam and the average annual rainfall is 1064.1 mm in 55 rainy days.

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Nine combinations of three spacings and three levels of manuring form the treatments of the experiment. The lay out was a split plot design with spacings in the main plots and levels of manuring in the sub-plots in three replications. The details of the treatments are as follows:

**Main Plots-Spacings**

a] 6.1 m × 6.1 m (20' × 20')

b] 7.6 m × 7.6 m (25' × 25')

c] 9.1 m × 9.1 m (30' × 30')

**Sub-plots-Levels of manuring**

i] $n_0$ $p_0$ $k_0$

ii] $n_1$ $p_1$ $k_1$

iii] $n_2$ $p_2$ $k_2$

**Manurial dosage :**

1. $n_0$ $p_0$ $k_0$ (Control — No fertilizers)

| Nutrient | Quantity in grams per palm/year | | | | | | |
|---|---|---|---|---|---|---|---|
| | Year after planting | | | | | | |
| | I | II | III | IV | V | VI | VII onwards |
| 2. $n_1$ $p_1$ $k_1$ | (Level 1) | | | | | | |
| N | 45.4 | 90.7 | 136.1 | 181.4 | 226.8 | 272.1 | 340.2 |
| $P_2O_5$ | 45.4 | 68.1 | 90.7 | 113.4 | 149.7 | 185.9 | 226.8 |
| $K_2O$ | 90.7 | 136.1 | 181.4 | 226.8 | 294.8 | 362.9 | 453.6 |
| 3. $n_2$ $p_2$ $k_2$ | (Level 2) | | | | | | |
| N | 90.7 | 181.4 | 272.2 | 362.9 | 453.6 | 554.3 | 680.4 |
| $P_2O_5$ | 90.7 | 136.1 | 181.4 | 226.8 | 299.4 | 371.9 | 453.6 |
| $K_2O$ | 181.4 | 272.1 | 362.9 | 453.6 | 589.7 | 725.7 | 907.2 |

The N, P, K, nutrients were supplied in a single dose per year in the form of ammonium sulphate, super phosphate and muriate of potash respectively. The main plot consisted of six experimental palms and comprised of three sub-plots of two palms each allotted to the three levels of fertiliser treatments. Guard rows were provided around the main plots. The experiment was started in January, 1961 when selected coconut seedlings of the ordinary tall variety were planted at a depth of 60 cm from ground level, adopting the square system of planting.

Growth measurements viz., height, girth at collar, number of leaves on the crown and number of leaves produced during the year were recorded annually. With regard to the height, the height of palm from the base to the tip of the youngest fully emerged leaf was measured till the trunk was formed i. e., till 1965 and thereafter only the height of trunk was measured. The date of commencement of flowering was recorded for individual palms. From the time of commencement of yield, the yield of nuts was recorded for each inflorescence.

## RESULTS AND DISCUSSION

The differences in the vegetative characters due to the spacings have not been significant for any of the years (Table 1). The difference due to the levels of manuring alone were significant from the second year (Table 2).

Palms receiving fertilisers (both the lower and higher levels) were con-

TABLE 1. Effect of spacing

a) Height : Total height of palm upto 1965 and height of trunk from 1966

| Year | Mean height in metres 6.1m × 6.1m | 7.6 m × 7.6 m | 9.1 m × 9.1 m | S. E.$_D$ |
|---|---|---|---|---|
| 1962 | 1.74 | 1.87 | 1.89 | 0.135 |
| 1963 | 2.80 | 2.91 | 2.98 | 0.06 |
| 1964 | 3.48 | 3.62 | 3.83 | 0.246 |
| 1965 | 5.54 | 5.49 | 5.48 | 0.047 |
| 1966 | 0.47 | 0.53 | 0.66 | Not analysed |
| 1967 | 0.95 | 0.74 | 0.99 | 0.073 |
| 1968 | 1.45 | 1.40 | 1.64 | 0.081 |
| 1969 | 2.13 | 1.85 | 2.08 | 0.074 |

b) Girth at collar :

| Year | Mean girth at collar in cm 6.1 m × 6.1 m | 7.6 m × 7.6 m | 9.1 m × 9.1 m | S. E.$_D$ |
|---|---|---|---|---|
| 1962 | 0.29 | 0.32 | 0.36 | 0.021 |
| 1963 | 0.64 | 0.67 | 0.75 | 0.051 |
| 1964 | 0.84 | 0.83 | 0.99 | 0.066 |
| 1965 | 1.22 | 1.20 | 1.24 | 0.052 |
| 1966 | 1.14 | 1.04 | 1.05 | 0.190 |
| 1967 | 0.85 | 0.82 | 0.79 | 0.028 |
| 1968 | 0.75 | 0.71 | 0.71 | 0.019 |
| 1969 | 0.72 | 0.70 | 0.77 | 0.013 |

c] Number of leaves produced per palm

| Year | Mean No. of leaves produced 6.1 m × 6.1 m | 7.6 m × 7.6 m | 9.1 m × 9.1 m | S. E$_D$ |
|---|---|---|---|---|
| 1962 | 6.11 | 6.94 | 7.33 | 0.390 |
| 1963 | 7.61 | 7.00 | 6.88 | 0.112 |
| 1964 | 5.94 | 5.61 | 6.00 | 0.164 |
| 1965 | 10.90 | 10.60 | 10.60 | 0.638 |
| 1966 | 10.20 | 10.20 | 10.50 | 0.910 |
| 1967 | 11.10 | 10.10 | 12.10 | 0.455 |
| 1968 | 11.10 | 10.60 | 11.60 | 0.354 |
| 1969 | 11.90 | 11.00 | 12.60 | 0.373 |

d] Number of leaves on crown

| Year | Mean number of leaves on crown 6.1 m × 6.1 m | 7.6 m × 7.6 m | 9.1 m × 9.1 m | S. E$_D$ |
|---|---|---|---|---|
| 1962 | 7.11 | 7.39 | 7.61 | 0.288 |
| 1963 | 8.11 | 7.05 | 8.00 | 0.112 |
| 1964 | 9.84 | 9.39 | 9.83 | 0.288 |
| 1965 | 18.00 | 16.60 | 18.40 | 1.800 |
| 1966 | 20.60 | 19.60 | 19.80 | 2.550 |
| 1967 | 20.60 | 20.20 | 20.80 | 0.610 |
| 1968 | 20.80 | 19.30 | 19.80 | 0.500 |
| 1969 | 23.60 | 20.90 | 21.70 | 0.601 |

[ a to d : Not significant ]

sistently taller than the control :Table 2 a)

Girth at collar in the manured palms was significantly greater than the control in 1963 and 1964 (Table 2b). In 1965, the differences were not significant while in the next year, the control palms had significantly thicker collar than the manured ones. The differences in girth became less marked in the next year and in the following year(1968),the differences were not significant. In 1969, manured palms had a greater girth at collar reflecting once again the earlier trend. The apparently erratic trends in the middle years might probably have arisen from the difference in the measurements before and after the formation of trunk.

The number of leaves produced per palm per year did not show any marked differences between the treatments except in the initial years. But it is seen that manured palms carried a significantly larger number of leaves on the crown consistently every year except for 1969.

Flowering was advanced by 12 and 16 months due to manuring at the lower ($n_1p_1k_1$) and higher ($n_2p_2k_2$) levels (Table 3). The differences in the flowering age between the different spacings were much less marked than those due to manuring. The data on the age at first flowering had not been subjected to statistical analysis, as first flowering under the experiment was not complete (Table 4). The palms which had not been receiving fertilizers (control) one in each of the spacings

TABLE 2 Effect of manuring

a] Height : (Total height of palm upto 1965 and height of trunk from 1966)

| Year | Mean height in metre | | | C. D. (P=0.05) |
|---|---|---|---|---|
| | $n_0p_0k_0$ | $n_1p_1k_1$ | $n_2p_2k_2$ | |
| 1962 | 1 73 | 1.90 | 1.86 | 0.131 |
| 1963 | 2.38 | 3.11 | 3.19 | 0.146 |
| 1964 | 2.74 | 3 99 | 4.19 | 0.202 |
| 1965 | 5.11 | 5.67 | 5.73 | 0.285 |
| 1966 | ... | 0.45 | 0.59 | 0.410 |
| 1967 | 0 61 | 0.96 | 1.11 | 0.171 |
| 1968 | 1.20 | 1.65 | 1.75 | 0.203 |
| 1969 | 1.70 | 2.15 | 2.21 | 0.220 |

b] Girth at collar .

| Year | Mean girth at collar in cm | | | C. D. (P=0 05) |
|---|---|---|---|---|
| | $n_0p_0k_0$ | $n_1p_1k_1$ | $n_2p_2k_2$ | |
| 1962 | 29.7 | 35.3 | 32.3 | N. S. |
| 1963 | 46.3 | 74.3 | 84.3 | 0.239 |
| 1964 | 56.7 | 102 1 | 106.9 | 0.063 |
| 1965 | 120.0 | 127.0 | 120.0 | N. S. |
| 1966 | 128.0 | 107.0 | 89.0 | 0.184 |
| 1967 | 88.4 | 81.3 | 76.1 | 0.071 |
| 1968 | 71.0 | 74.0 | 72.0 | N. S. |
| 1969 | 68.0 | 73.0 | 72.0 | 0.021 |

c] Mean Number of leaves produced per palm

| Year | $n_0p_0k_0$ | $n_1p_1k_1$ | $n_2p_2k_2$ | C. D. P=0.05 |
|---|---|---|---|---|
| 1962 | 6.77 | 6.30 | 7 22 | N. S. |
| 1963 | 5 67 | 7.78 | 8.11 | 1.29 |
| 1964 | 4.72 | 6.11 | 6.72 | 0.63 |
| 1965 | 9.80 | 10.90 | 11.30 | N. S. |
| 1966 | 9 6[illegible] | 10.60 | 10.70 | ,, |
| 1967 | 11.30 | 11.40 | 11.00 | ,, |
| 1968 | 10 44 | 11.39 | 11.37 | ,, |
| 1969 | 11.28 | 12.11 | 12.11 | ,, |

d] Mean Number of leaves on crown

| Year | $n_0p_0k_0$ | $n_1p_1k_1$ | $n_2p_2k_2$ | C. D. P=0.05 |
|---|---|---|---|---|
| 1962 | 6.56 | 7 72 | 7.83 | 0.83 |
| 1963 | 6.94 | 8.06 | 8.67 | 0.67 |
| 1964 | 8.33 | 10.33 | 10.39 | 0.79 |
| 1965 | 14.60 | 18.40 | 20.10 | 2.38 |
| 1966 | 17.10 | 21.40 | 21.50 | 4.05 |
| 1967 | 18.33 | 22.11 | 21.22 | 1.94 |
| 1968 | 18.22 | 21.11 | 20.67 | 1.87 |
| 1969 | 21.00 | 22.83 | 22.33 | N.S. |

N. S. Not significant

6.1 × 6.1 m and 7.6 × 7.6 m were yet to flower.

The manured palms have given consistently higher yield than control in all the years. Palms under the spacing of 9.1 × 9.1 m yielded higher than those under narrower spacings.

In a perennial crop like coconut which takes a considerable number of years to flower and to come to normal yield, the response to any agronomic treatment has to be judged by the vegetative characters during the initial years of its growth. In coconut, height of trunk, girth at collar and number of leaves on the crown are considered to be the characters indicative of vigour of the palm. But, as the trunk does not begin to form until about five years from planting (Child, 1964), the total height of the palm (including the crown) is taken for comparison during this period.

Statistical analysis of the data on the vegetative characters for each of the years showed marked responses to the levels of manuring. But the differences due to the spacings were not significant in any of the years so far. The spacings x levels of manuring interaction effects were also not significant, i. e the responses to manuring were consistent under the three spacings.

Marked response to the application of fertilisers was evident from the increased height and the greater number of leaves on the crown due to the application of fertilisers at either of the two levels was consistently maintained in the subsequent years. While no trunk was formed in the 'no fertiliser' palms even six years after planting(till 1966), the trunk was formed in the sixth year itself in the manured palms. Thereafter the height of trunk was also significantly greater in the manured palms every year.

TABLE 3. Mean age at first flowering

| Particulars | Treatments | Mean age at first flowering in months |
|---|---|---|
| Effect of manuring | $n_0p_0k_0$ | 84 |
| | $n_1p_1k_1$ | 72 |
| | $n_2p_2k_2$ | 68 |
| Effect of spacing | 6.1 m × 6.1 m | 77 |
| | 7.6 m × 7.6 m | 74 |
| | 9.1 m × 9.1 m | 72 |

The increases in the number of leaves produced during the year due to manuring at the two levels were not appreciable except in the initial years. At the same time there was significant and consistent increase in the number of leaves borne on the crown year after year which in the absence of a marked increase in the leaf production per year would show that the leaves of manured palms have greater longevity.

TABLE 4. Number of palms flowered (Yearwise)

| Treatment (Manuring/ spacing) | Total No. of palms planted | 1965 | 1966 | 1967 | 1968 | 1969 | 1970 | Total |
|---|---|---|---|---|---|---|---|---|
| $n_0\ p_0\ k_0$ | 18 | ... | 1 | 7 | 7 | ... | 1 | 16 |
| $n_1\ p_1\ k_1$ | 18 | ... | 10 | 6 | 2 | ... | ... | 18 |
| $n_2\ p_2\ k_2$ | 18 | 6 | 7 | 3 | 2 | ... | ... | 18 |
| 6.1 m × 6.1 m | 18 | 1 | 5 | 6 | 4 | ... | 1 | 17 |
| 7.6 m × 7.6 m | 18 | 1 | 7 | 6 | 3 | ... | ... | 17 |
| 9.1 m × 9.1 m | 18 | 4 | 6 | 4 | 4 | ... | ... | 18 |

TABLE 5. Initial yields of the palms

| Level of Manuring/ Spacing | No. of yielding palms | | | | Mean yield of nuts/palm | | | |
|---|---|---|---|---|---|---|---|---|
| | 1966 | 1967 | 1968 | 1969 | 1966 | 1967 | 1968 | 1969 |
| $n_0\ p_0\ k_0$ | ... | ... | 3 | 11 | ... | ... | 13 | 6 |
| $n_1\ p_1\ k_1$ | ... | 7 | 14 | 17 | ... | 28 | 10 | 15 |
| $n_2\ p_2\ k_2$ | 2 | 9 | 14 | 16 | 10 | 35 | 24 | 17 |
| 6.1 m × 6.1 m | 1 | 4 | 11 | 14 | 4 | 39 | 13 | 10 |
| 7.6 m × 7.6 m | ... | 3 | 10 | 14 | ... | 14 | 14 | 12 |
| 9.1 m × 9.1 m | 1 | 4 | 10 | 16 | 15 | 48 | 24 | 17 |

Apparently, the results with regard to the girth at collar were not consistent over the years. In the initial years, the palms under manuring had a greater girth at collar than the control but in the subsequent years, this trend seems to have been reversed for a few years and thereafter the results seem to

follow the earlier pattern. The nature of development of the stem in the first few years of growth of the coconut palm would, however, show that there are no real inconsistencies with regard to the effect of manuring on the girth of the palm. From the time of establishment of the coconut seedling there is a continuous expansion in the thickness of the stem due to the meristematic activity of the single terminal bud, which increases with the age of the seedling (Patel, 1938). The stem thus becomes thicker as the palm increases in age as well as in height for a few years. Thereafter the girth remains more or less uniform. Due to this process of stem development, the basal portion which is the thickest part of stem development takes on the shape of an inverted cone and is termed the bole which is the root forming region of the coconut palm. It could be seen that the process of bole formation was much slower in $n_0$ $p_0$ $k_0$ which attained the maximum girth onlyin 1966 whereas the manured palms reached this stage in 1965 itself. Once the bole development was completed and the girth of the palms became steady, the girth at collar once again reflected the significant effects of manuring.

The above differences noticed in the vegetative characters were only between manuring and no manuring. The two levels of manuring were found to be on a par indicating that the higher dose of fertilisers did not induce any marked increase in the vegetative characters over the lower dose.

Studying the rate of increase in the number of leaves on the crown with the age of the palm, it is seen that there was a rapid increase during the first five years after planting and thereafter the increase was not appreciable. The pattern of increase seemed to be almost similar under all the treatments

The earliest palms to commence following were those under the treatment $n_2p_2k_2$. Flowering under this experiment was still incomplete. But the data on the mean age at first flowering worked out for those palms which had already flowered shows that manuring at the lower and higher doses induced earlier flowering by 12 and 16 months respectively. There was also some indication of earlier flowering under wider spacings, though the differences were not as marked as those due to manuring.

The first bunch of nuts under this experiment was harvested in December, 1966. Though the palms will reach the normal bearing stage only after some more years, there is clear indication of greater productivity of the manured

palms. Though the effects of spacings are less clear, the widest spacing of 9.1 × 9.1 m seems to score over other spacings However, it is too early to make a valid assessment of the effects of spacing and manuring on the yield.

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REFERENCES

CHILD, R. 1964. *Coconuts*. Longmans, Green and Co. Ltd., London

COPELAND, E. B. 1931. *The Coconut*. Macmillan & Co. Ltd., London.

MENON, K. P. V. and K. M. PANDALAI. 1958. *The Coconut Palm - A Monograph* Indian Central Coconut Committee, Ernakulan

PATEL, J. S. 1938. *The Coconut - A monograph* Superintendent, Govt. Press, Madras.

PIERIS, W. V. D. 1945. Regeneration of coconut plantations. *Coconut Research Scheme (Ceylon) Bull. No.* 5.