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# Response to Different Levels of NPK by Young Coconut Palms (*Cocos nucifera Linn.*) of High Yielding Types

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# Response to Different Levels of NPK by Young Coconut Palms (*Cocos nucifera Linn.*) of High Yielding Types

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ABSTRACT

*The response to three levels of NPK by young palms of three high yielding types of coconut was studied. The three types of palms tried were natural cross dwarf, tall × dwarf hybrid and pre-potent tall. The fertilizer levels per adult palm per year were no fertilizer, 0.5 kg N + 0.25 kg $P_2O_5$ + 0.75 kg $K_2O$ and the double of the above level. Application of fertilizers resulted in highly significant increase in all the growth characters studied. The mean percentage increase in height over 'no fertilizer' ranged between 191 and 301 in December, 1967 and between 193 and 283 in December, 1968. Similar trends were observed in respect of girth at collar and number of leaves produced. Difference in response due to the higher level of fertilizer mixture over the lower level was not significant. It would be of interest to observe whether the absence of difference in response between the two levels of nutrients would persist till the flowering stage and would be reflected in the yield of nuts as well.*

*The optimum level of fertilizer mixture was found to be near the higher level, viz., 1.0 kg N + 0.5 kg $P_2O_5$ + 1.5 kg $K_2O$ per adult palm per year.*

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Coconut is essentially a crop of the humid tropics. Under conditions of heavy rainfall and high temperature usually met with in these tracts and due to continuous cropping without adequate replenishment of the lost nutrients, the soils on which coconut is grown are generally low in available major plant nutrients. Marked increase in the production of coconut has been reported due to application of fertilizers from India (John & Jacob 1960), Ceylon (Nethasinghe 1966), West Africa (Villemain 1965), Trinidad (Romney & Smith 1966) and Pacific territories (Spencer 1963). Nethasinghe (1966) reported that a majority of the coconut soils in Ceylon are deficient in the major plant nutrients and that fertilizer application had resulted in an increase up to 200 per cent in the yield of coconuts. More striking results were obtained in the permanent observation plots at the Central Plantation Crops Research Institute,

Kasaragod, when intercultivation and manuring were combined (Pandalai & Marar 1964).

Based on the results of field experiments, Nethasinghe (1962) suggested an optimum dose of fertiliser consisting of 0.227 kg N + 0.227 kg $P_2O_5$ + 0.340 kg $K_2O$ per adult bearing palm per year, with a possibility of further increase in the level of N and K. In India, the results from the NPK fertilizer experiment on adult bearing palms on sandy loam soil at the CPCRI, Kasaragod, run from 1953 to 1964 showed the following trends. The optimum dose of nitrogen ranged between 0.45 and 0.60 kg and potash between 0.89 and 1.21 kg per palm per year. In the case of phosphate, significant response was not obtained during the early years of the experiment. However, due to the high genetic variability of the palm population, differential response to fertilizer application was exhibited by palms of different yield capacities (Marar 1962). The response due to the levels of fertilizers employed was negligible in case of palms yielding 50 or more nuts per year indicating that palms with high yield potential probably need a higher level of fertilizers. Nathaniel (1967) reported that there had been a progressive increase in the fertilizer dosages recommended by the Coconut Research Institute, Ceylon during the last decade.

In recent years, through hybridisation and selection certain types of coconut with high yield potential have been evolved and are becoming available in sufficient numbers for large scale planting. These new types of coconut possessing inherent high and early bearing potentialities are also found to exhibit superior vegetative growth even from the nursery stage. It thus became imperative to determine the fertilizer (NPK) requirement of such types right from the early stages of growth.

## EXPERIMENTAL

These investigations were carried out in Field II of the Main Block of the Central Plantation Crops Research Institute, Kasaragod. This Institute is located on the west coast of India where the mean annual rainfall is 3500 mm. The soil is sandy loam, deep and well drained. The mechanical composition of the soil and the available plant nutrient status are given below.

*Mechanical composition* (%)

| Clay | Silt | Fine sand | Coarse sand |
|---|---|---|---|
| 15.5 | 2.0 | 4.5 | 75.3 |

*Chemical composition (ppm)*

| Available N | Available $P_2O_5$ | Available $K_2O$ |
|---|---|---|
| 90 | 12 | 50 |

*pH* 5.6

The data show that the soil is inherently low in all the three major plant nutrients.

*Coconut types :* The following three types of coconut were tried in the experiment : (1) Dwarf natural cross (2) Tall ♀ × dwarf hybrids and (3) pre-potent tall progenies. Work done in the Genetics Division at the CPCRI, Kasaragod and elsewhere has shown these types of coconut to have inherent potentialities for early and heavy bearing and excel the commonly cultivated tall variety in respect of yield of nuts, copra content per nut as well as total out-turn of copra per year.

*Fertilizer levels :* Based on the experimental evidence obtained, the NPK mixture dosages for adult palms per year were fixed as follows :

$m_0$ — Control — no fertilizer
$m_1$ — 0.50 kg Nitrogen + 0.25 kg $P_2O_5$ + 0.75 kg $K_2O$
$m_2$ — 1.00 kg Nitrogen + 0.50 kg $P_2O_5$ + 1.50 kg $K_2O$

The nutrients were given in the form of ammonium sulphate, superphosphate (ordinary) and muriate of potash, respectively. The young palms were given one eighth the above dosage for every year of growth as given in table 1.

TABLE 1

*Schedule of fertilizer application for the young palms*
(kg/palm)

| Age of palm | Year | $m_1$ | | | $m_2$ | | |
|---|---|---|---|---|---|---|---|
| | | N | $P_2O_5$ | $K_2O$ | N | $P_2O_5$ | $K_2O$ |
| 1 year | Aug. 1966 | 0.063 | 0.031 | 0.094 | 0.125 | 0.063 | 0.188 |
| 2 years | Aug. 1967 | 0.125 | 0.063 | 0.188 | 0.250 | 0.125 | 0.375 |
| 3 years | Aug. 1968 | 0.188 | 0.094 | 0.282 | 0.375 | 0.188 | 0.563 |
| 4 years | Aug. 1969 | 0.250 | 0.125 | 0.375 | 0.500 | 0.250 | 0.750 |
| 5 years | Aug. 1970 | 0.313 | 0.156 | 0.469 | 0.675 | 0.313 | 0.988 |
| 6 years | Aug. 1971 | 0.375 | 0.187 | 0.563 | 0.750 | 0.375 | 1.125 |
| 7 years | Aug. 1972 | 0.439 | 0.218 | 0.657 | 0.875 | 0.439 | 1.344 |
| 8 years and after | Aug. 1973 | 0.500 | 0.250 | 0.750 | 1.000 | 0.500 | 1.500 |

Randomised block design, replicated thrice was adopted. The treatments consisted of all possible combinations of three types of palms and three levels of fertilizer mixture. Each plot consisted of one row of six palms, spaced 7.9 m apart, either way. In the case of pre-potent tall, all the seedlings in each replication were the progenies of the same mother palm ; while in the case of Tall × Dwarf hybrids, crosses between the same parents were planted in each replication. However, in the case of the Natural Cross dwarf, seedlings of uniform growth characters were used for planting.

Planting of one year old seedlings was done in July, 1965 in three feet cube pits prepared in advance. No fertilizer or manure was applied at the time of planting. The young palms were shaded and watered twice a week during the dry periods of 1965-66, 1966-67 and 1967-68. The annual dose of fertilizers was applied in August, starting from 1966.

The following growth characters were observed and recorded, first at the time of planting and later at half-yearly intervals.

1) Height of the palm
2) Girth at collar
3) Number of leaves produced

## RESULTS AND DISCUSSION

The coconut palm, generally, takes over five years to attain the bearing stage and the vigour of the palms during the early stages, as measured by the growth characters, provides a fair estimate of their later performance. Patel (1938) found that the number of leaves is correlated with early flowering and heavy yield. Satyabalan et al. (1964) expressed the view that the vigour in the vegetative characters exhibited by young palms may foreshadow subsequent high yield.

The data on growth characters recorded at the time of planting in July, 1965 and after one and half years (December 1967) and two and half years (December 1968) from commencement of the fertilizer treatments are presented in table 2, alongwith the results of statistical analysis.

A scrutiny of the results of analysis shows a highly significant (0.1% level) difference in the growth characters of palms receiving fertilizer and those receiving 'no fertilizer', irrespective of the type. However, the difference between the responses of the higher ($m_2$) and lower ($m_1$) levels of fertilizer application was not significant. Levels of fertilizer × types of palm interaction was also not significant.

## TABLE 2

*Effect of fertilizer application—Mean increase of growth characters, December, 1967 & December, 1968*

| Treatments | | Height (cm) | | | Girth at collar (cm) | | | No. of leaves produced | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variety | Fertilizer level | at planting (July '65) | Increase since planting | | at planting (July '65) | Increase since planting | | at planting (July '65) | Increase since planting | |
| | | | Dec. '67 | Dec. '68 | | Dec. '67 | Dec. '68 | | Dec. '67 | Dec. '68 |
| Dwarf natural cross | $m_0$ | 145·67 | 73.84 | 111.42 | 14.97 | 14.78 | 23.83 | 7.17 | 11.58 | 16.17 |
| | $m_1$ | 149.89 | 162.11 | 258.89 | 14.87 | 34.30 | 57.58 | 7.00 | 13.78 | 20.00 |
| | $m_2$ | 148.72 | 168.94 | 275.22 | 15.31 | 34.91 | 59.41 | 7.06 | 14.05 | 20.61 |
| Tall×Dwarf hybrids | $m_0$ | 126.00 | 65.44 | 100.22 | 13.17 | 12.61 | 18.78 | 5.83 | 10.89 | 15.22 |
| | $m_1$ | 119.50 | 125.72 | 193.52 | 12.62 | 23.53 | 35.39 | 5.61 | 12.56 | 17.15 |
| | $m_2$ | 121.71 | 124.67 | 204.84 | 12.76 | 22.30 | 37.74 | 5.72 | 12.61 | 17.83 |
| Pre-potent tall | $m_0$ | 155.45 | 45.22 | 82.00 | 12.93 | 15.18 | 21.91 | 6.17 | 10.61 | 15.11 |
| | $m_1$ | 149.44 | 125.67 | 203.64 | 12.76 | 29.02 | 44.60 | 5.83 | 12.94 | 18.30 |
| | $m_2$ | 146.78 | 135.94 | 231.88 | 12.58 | 34.08 | 54.14 | 5.78 | 13.39 | 18.83 |
| Average | $m_0$ | 142.37 | 61.50 | 97.88 | 13.69 | 14.19 | 21.51 | 6.39 | 11.03 | 15.50 |
| | $m_1$ | 139.61 | 137.83 | 218.68 | 13.42 | 28.95 | 45.86 | 6.15 | 13.09 | 18.48 |
| | $m_2$ | 139.07 | 143.18 | 237.31 | 13.55 | 30.43 | 50.43 | 6.19 | 13.35 | 19.03 |
| Whether treatment means are significantly different | | | | | | | | | | |
| (a) for varieties (at 1% level) | | | Yes | Yes | | Yes | Yes | | Yes | Yes |
| C.D. | | | 19.16 | 33.96 | | 4.65 | 7.34 | | 0.66 | 1.11 |
| Inference | | | $\overline{V_1V_3V_2}$ | $\overline{V_1V_3V_2}$ | | $\overline{V_1V_3V_2}$ | $\overline{V_1V_3V_2}$ | | $\overline{V_1V_3V_2}$ | $\overline{V_1V_3V_2}$ |
| (b) for fertilizer (at 0.1% level) | | | Yes | Yes | | Yes | Yes | | Yes | Yes |
| C.D. | | | 19.16 | 33.96 | | 4.65 | 7.34 | | 0.66 | 1.11 |
| Inference | | | $\overline{m_2m_1m_0}$ | $\overline{m_2m_1m_0}$ | | $\overline{m_2m_1m_0}$ | $\overline{m_2m_1m_0}$ | | $\overline{m_2m_1m_0}$ | $\overline{m_2m_1m_0}$ |

*Height of palm:* Application of fertilizer resulted in marked increase of the height of palms (Fig. 1). The palms receiving the

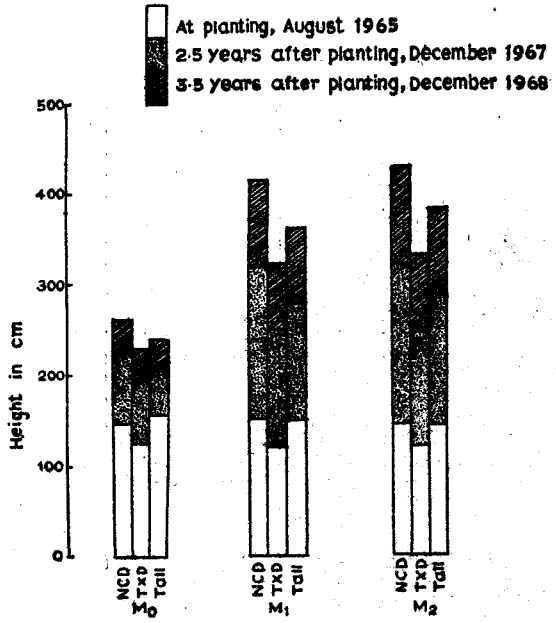


Fig. 1. Effect of fertilizer treatments on height of plams

treatment $m_2$ were the tallest, followed by the palms in $m_1$. The mean heights of palms in $m_0$, $m_1$ and $m_2$ in December, 1967 were 203.9, 277.4 and 282.3 cm, respectively. The corresponding figures in December, 1968 were 240.2, 358.3 and 376.4 cm. It was found that the difference in height due to the different fertilizer treatments was more pronounced in 1968.

Among the types, NCD palms were significantly taller than pre-potent tall and T × D palms, the latter two being at par.

*Girth at collar:* As in the case of height, the mean girth at collar of palms showed significant difference between $m_0$ and $m_1$ or $m_2$ treatments. In 1967, the mean girth of the palms in $m_2$ and $m_1$ treatments were 44.0 and 42.4 cm respectively, compared to 27.9 cm in $m_0$. The difference was more marked in 1968 when the mean girths were 64.0, 59.3 and 35.2 cm, in $m_2$, $m_1$ and $m_0$, respectively.

Among the types, NCD and pre-potent tall were at par and both were significantly superior to T × D.

*Number of leaves produced:* Fertilizer application resulted in the production of significantly larger number of leaves (Fig. 2). The

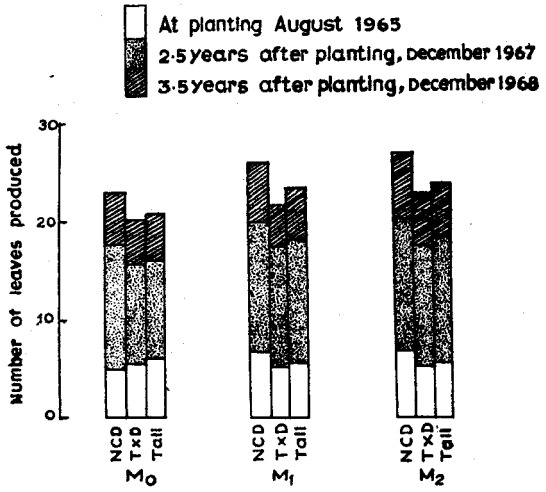


Fig. 2. Effect of fertilizer application on leaf production of palms

mean number of leaves produced by the end of 1967 were 17.4, 19.2 and 19.5 respectively in $m_0$, $m_1$ and $m_2$. The corresponding figures for 1968 were 21.9, 24.6 and 25.3.

The NCD palms produced significantly more leaves than either T × D or pre-potent tall palms. The latter two were at par.

As there was a perceptible, though not significant, increase in the characters studied due to the higher level of fertilizer application over the lower level, it was deemed necessary to fit the regression equations and determine the optimum levels of fertilizer. The regression equations and calculated optimum fertilizer dosages are furnished in table 3.

From the computed values of Y, it is evident that the optimum dose of NPK fertilizer for these high yielding types during the pre-bearing stage of growth in respect of most of the characters lies between the two levels tried and that it approaches the higher level. The general optimum dose of fertilizer mixture was found to be 0.2 kg N + 0.1 kg $P_2O_5$ + 0.3 kg $K_2O$ for the third year (Y = 1.63) and 0.3 kg N + 0.15 kg $P_2O_5$ + 0.45 kg $K_2O$ for the fourth year (Y = 1.66). A comparative study of the optimum doses for the third and fourth years showed that the optimum dose increased steadily with age, indicating that the requirement of nutrients by the palms is greater as they approach the bearing stage. Since the optimum dose of the fertilizer for certain characters was found to be greater than the higher level tried, it may be possible to obtain

TABLE 3

*Fertilizer application—Regression equations and optimum levels—1967 and 1968*

| Year | Growth character | Variety | $Y=Dx-Cx^2$ | Optimum level of fertilizer mixture |
|---|---|---|---|---|
| December 1967 | Height | NCD | $Y=128.990x-40.720x^2$ | 1.58 |
| | | T×D | $Y=90.945x-30.665x^2$ | 1.48 |
| | | Tall | $Y=115.540x-35.090x^2$ | 1.65 |
| | Girth | NCD | $Y=28.975x-9.455x^2$ | 1.53 |
| | | T×D | $Y=16.995x-6.075x^2$ | 1.40 |
| | | Tall | $Y=18.230x-4.390x^2$ | 2.08 |
| | Number of leaves | NCD | $Y=3.165x-0.965x^2$ | 1.64 |
| | | T×D | $Y=2.475x-0.805x^2$ | 1.54 |
| | | Tall | $Y=3.270x-0.940x^2$ | 1.74 |
| December 1968 | Height | NCD | $Y=213.040x-65.570x^2$ | 1.62 |
| | | T×D | $Y=134.290x-40.990x^2$ | 1.64 |
| | | Tall | $Y=168.340x-46.700x^2$ | 1.80 |
| | Girth | NCD | $Y=49.710x-15.960x^2$ | 1.56 |
| | | T×D | $Y=23.740x-7.130x^2$ | 1.66 |
| | | Tall | $Y=29.265x-6.575x^2$ | 2.23 |
| | Number of leaves | NCD | $Y=5.440x-1.610x^2$ | 1.68 |
| | | T×D | $Y=2.555x-0.625x^2$ | 2.04 |
| | | Tall | $Y=4.520x-1.330x^2$ | 1.70 |

a significant difference in the response with a further increase in the level of fertilizer application.

It may thus be seen that application of fertilizers has resulted in definite and marked increases in the growth characters, *viz.*, height, girth at collar and leaves produced and that these values were greater in $m_2$ than in $m_1$. Although, in general, a wider difference in the responses due to the lower and the higher levels of fertilizer application was obtained with the increase in age of the palms, it did not attain the level of significance. It may, therefore, be of interest to observe whether such an absence of significant difference in response would be manifested or not at the bearing stage in terms of yield of nuts.

The highly significant response (0.1% level) obtained due to fertilizer application over 'no fertilizer' is indicative of the low nutrient status of the soil. Marked increases obtained in the growth characters show that the availability of plant nutrients in such soils can be improved considerably by application of fertilizers. It is, therefore, imperative that to obtain the maximum expression of the potentialities of these high yielding types of coconut, high rate of

fertilizer application is necessary even from the early stages of growth.

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