Journal of Plantation Crops 17: 39-50, April, 1990

MANURIAL EXPERIMENTS ON ARECANUT

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INTRODUCTION

Arecanut is cultivated under diverse agro-climatic conditions in a variety of soil types like laterite soils of the west coast, red loamy soils of Mettupalayam, alluvial soils of Assam and West Bengal. The cultivation is confined to 28° north and south of the equator within a temperature range of 14°C to 36°C. It is cultivated in low rainfall areas like the 'Maidan' part of Karnataka (annual rainfall 750 mm) as well as in heavy rainfall areas like 'Malnad' tract of Karnataka with an annual rainfall of 4000 mm (Shama Bhat, 1978). Arecanut plantation may be raised from the coastal belt to an altitude of 1200 m above mean sea level (Shama Bhat and Abdul Khader 1982).

The research and development aspects of arecanut were initiated in the country with the establishment of first Arecanut Research Station at Marthur by erstwhile Mysore Government (Nambiar 1949). Since then substantial information on the management of the crop was generated from a number of research stations established from early fifties in the country under different agroclimatic conditions. An attempt is made in this paper to review the results of the experiments conducted on nutritional requirements of the crop at the various research centres.

Earlier Research Work

Nambiar (1949) reported that arecanut palms were manured only in parts of Karnataka, South Malabar of Kerala and to some extent in Coimbatore district of Tamil Nadu. In these parts, green leaves and cattle manure were applied in large doses either annually or once in two or three years. The gardens in Mettupalayam get plenty of silt and soil through the irrigation water from Kallar and Coonoor rivers. The growers in this area have started the practice of applying farm yard manure besides groundnut cake and fertilizers in recent years. (Shama Bhat and Abdul Khaden 1982).

Coleman and Rao (1918) outlined the elaborate system of manuring with cattle manure and green leaves in the 'Malnad' parts of Karnataka and use of tank and river silt or earth from paddy fields together with farm yard manure. Aiyer (1966) also mentioned about the manuring system practised in the 'Malnad' using green leaves cut from 'Soppina bettas'.

The first scientific attempt to determine the manurial requirement of arecanut crop was made at Marthur Farm in Mysore (Karnataka). Primary objective of the study was to determine the extent to which fertilizers could be used and reduce the dependency of green leaves and cattle manure (Coleman and Rao, 1918; Iyengar, 1954). Based on the experiments carried out between 1920 and 1936 at Marthur, it was reported that application of 10 cart loads of farm yard manure and five cart loads of green leaves for 400 palms was adequate (Aiyer, 1966). This was followed by application of a mixture of 90.9 kg groundnut cake, 36.4 kg of ammonium sulphate, 90.9 kg of superphosphate and 136.4 kg of potassium sulphate every year. Iyengar (1954) summarising the results of manurial experiments at Marthur

farm indicated that a garden once brought to good yielding condition may be manured once in three years and that an yield of over 876.0 kg of chali/ 400 palms could be obtained by an application of 560 kg nitrogen, 84.0 kg phosphoric acid and 112.0 kg potash per hectare using groundnut cake as a source of nitrogen.

Manurial Experiments in Farmers' Plots

In the 1950s the erstwhile Indian Central Arecanut Committee had carried out manurial trials in the cultivators' fields (Lakshmanchar *et al*. 1966). The experiment was conducted in the sub-mountain and coastal regions of Kerala and Karnataka and plains of Karnataka, West Bengal and Assam. The N, P and K sources were ammonium sulphate, superphosphate and muriate of potash respectively. The levels of nutrients added were N at 22.7 and 45.4 kg, P_2O_5 at 18.1 and 36.3 kg and K_2O at 34.0 and 68.0 kg respectively per 500 palms. The fertilizers were applied for three years 1961-62 to 1963-64. In Kerala, the fertilized plots in the sub-mountain regions recorded on an average 20 per cent and in coastal regions 11 per cent increased yield during the experimental period, while during the post experimental period, the increase in the mean yield in the fertilized plots was 52 per cent for sub-mountain and 24 per cent for coastal regions. In the sub-mountain regions of Kerala, application of 22.7 kg of nitrogen, 18.1 kg of phosphoric acid and 34.0 kg of potash for 500 palms was found to be economical.

Manurial Experiments at Different Research Stations

Detailed field experiments were initiated with the establishment of Central Arecanut Research Station (present Regional and Research centres of CPCRI) from 1961 under different agro-climatic conditions. Late Dr. Shama Bhat and Dr. Bavappa with their associates laid out comprehensive manurial experiments to determine the manurial requirements of areca palms at Vittal, Hirehalli, Peechi, Mohitnagar, Kahikuchi and Palode.

Vittal: An experiment was started in 1961 in a 3^4 confounded factorial design with nine plot blocks and a single replication. The N, P and K sources were ammonium sulphate, superphosphate and muriate of potash respectively. In 1971, the treatments were modified to include higher fertilizer levels. The original levels of NPK and green leaf were retained in one half of each plot and the revised doses were superimposed on the palms in the other half. There were 20 palms in each plot in the beginning excluding border rows all around. In the revised treatments there were 8 palms/plot in addition to guard rows in between. The original and the revised schedules are given in Table 1.

Combined analysis of initial five years yield data (1966-70 carried out prior to superimposition of the revised dose revealed that the response to nitrogen and green leaf was significant (Table 2). In the case of N, the yield increase was up to an application of 50 g/palm and the response comes down when the dose was increased beyond 50 g/palm. The highest yield was obtained by the

Table 1. *Original and revised manurial doses in the NPKG experiment at Vittal.*

Treatments	Original levels			Revised levels		
N (g/palm)	0	50	100	50	100	200
P_2O_5 (g/palm)	0	40	80	40	80	160
K_2O (g/palm)	0	70	140	70	140	280
Green leaf (kg/palm)	0	7	14	7	14	21

application of 50 g nitrogen per palm (1089 kg/ha). In the case of application of green leaf significant linear response was recorded. The highest yield was recorded in the plots receiving 14 kg of green leaf per palm (1082 kg/ha) as compared to control plots (533.kg/ha). When the different interaction were considered only the N, K interaction was found to be significant. Application of 100 g N with 70 g K_2O per palm gave significantly more yield (1248 kg/ha).

Table 2. *Yield of arecanut chali (kg/ha) in response to manures in initial 5 years (1966-70).*

	P_0	P_1	P_2	Mean		K_0	K_1	K_2
N_0	549.2	633.7	516.7	568.7	N_0	640.2	549.2	513.5
N_1	806.0	1176.5	1280.5	1088.7	N_1	1111.5	942.5	1212.2
N_2	910.0	877.5	932.7	906.7	N_2	526.5	1248.0	945.7
Mean	757.2	896.0	910.0		Mean	760.5	910.0	890.5
	G_0	G_1	G_2			K_0	K_1	K_2
N_0	344.5	575.2	786.5		P_0	487.5	695.5	1066.0
N_1	617.5	1228.5	1417.0		P_1	880.7	1066.0	747.5
N_2	633.0	1046.5	1043.2		P_2	890.5	981.5	861.2
Mean	533.0	949.0	1082.2		Mean	760.5	913.2	890.5
	G_0	G_1	G_2			G_0	G_1	G_2
P_0	477.7	929.5	861.2		K_0	448.5	877.5	949.0
P_1	445.2	916.5	1329.2		K_1	484.2	913.2	1378.0
P_2	672.7	1004.2	1053.0		K_2	663.0	767.0	916.5
Mean	533.0	949.0	1082.2		Mean	531.9	852.6	1081.2

CD = (P=0.05) For N = 263.25 For G = 263.25 For N × K = 455.00 SE/Plot = 477.75

Table 3. *Yield of arecanut chali (kg/ha) during later years (8 years mean 1974-82) with manurial doses at Vittal.*

	P_0	P_1	P_2	Mean	K_0	K_1	K_2	G_0	G_1	G_2
N_0	1371.5	1417.0	1394.2	1394.2	1423.5	1352.0	1407.2	1059.5	1517.7	1602.2
N_1	1192.2	1504.2	1875.2	1527.5	1397.5	1667.2	1514.5	1322.7	1530.7	1722.5
N_2	1417.0	1530.7	1400.7	1449.5	1108.2	1719.2	1524.2	1150.5	1703.0	1498.2
Mean	1329.2	1485.2	1556.7		1309.7	1579.5	1482.0	1176.5	1586.0	1608.7

	K_0	K_1	K_2		G_0	G_1	G_2		G_0	G_1	G_2
P_0	1228.5	1280.5	4725.5		1088.7	1426.7	1472.2	K_0	1049.7	1420.2	1459.2
P_1	1222.0	1010.2	1420.2		1134.2	1599.0	1719.2	K_1	1264.2	1608.7	1862.2
P_2	1478.7	1644.5	1553.5		1309.7	1720.0	1634.7	K_2	1218.7	1722.5	1504.7

CD (P=0.05) for K and G = 257.0
SE = 467.67

After superimposing the revised schedule, combined analysis for 8 years (1974-75 to 1981-82) was carried out. K_1 level viz., application of 70 kg K_2O per palm had given significantly more yield (Table 3) as compared to K_0 level. In the case of green leaf, a linear response was observed. Significantly the highest yield/ha was obtained by the application of 14 kg green leaf per palm while the lowest yield was recorded in the plots receiving no green leaf. Nitrogen at 50g/palm gave maximum yield. Response to phosphorus was also found to be linear but it was not significant.

In the revised schedule, the effect of nitrogen and green leaf were found to be significant on the yield of nuts (Table 4). N_2 level (100 g/palm) gave significantly more yield (1920.7 kg/ha), but there was drastic yield reduction at 200 g per palm. Similar trend was also noticed in the original schedule as indicated earlier (Table 3). Application of green leaf showed a significant as well as positive effect on the yield of nuts. The highest yield was obtained from the plots receiving 21 kg of green leaf (1917.5 kg/ha) and the lowest was from the plots receiving least quantity of green leaf ie., 7 kg/palm. Such a linear response was also noticed for green leaf in the original schedule

The overall results at Vittal centre indicated that application of 50 g nitrogen, 40g P_2O_5, 70g K_2O with 14.0 kg of green leaf/palm/year is optimum for young palms up to 8-9 years. For the adult palms application of 100 g N, 40g P_2O_5, 140g K_2O and 14 kg green leaf per palm per year is economical.

Peechi: The research centre Peechi is situated at an elevation of 49.6 m above MSL. The upper layer of soil is alluvial and good mixture of sand and silt and lower layer is lateritic. The pH of soil is 5.6-6.8. The experiment was started in 1961 with the same levels of NPK and green leaf in a 3^4 factorial confounded design as in the case of Vittal. The doses were revised in one-half of the experiment in 1971 using lime as subplot treatment keeping the other half unaltered, and all other levels were similar to that of Vittal (Table 1)

The results of the experiment with original levels carried out at Peechi were reported by Sadanandan (1972). Nitrogen and green leaf application significantly and individually increased the height, girth and leaf production while potash significantly increased only the

Table 4. *Yield of arecanut chali (kg/ha) during later years (8 years mean 1974-82) with revised doses at Vittal.*

	P_1	P_2	P_3	Mean	K_1	K_2	K_3	G_1	G_2	G_3
N_1	1885.0	1771.2	1888.2	1846.0	1774.5	1959.7	1810.0	1813.5	1761.5	1966.2
N_2	1833.0	1923.2	1920.7	1902.2	2164.5	1959.7	1582.7	1735.5	1807.0	2164.5
N_3	1706.2	1527.5	1582.7	1605.5	1586.0	1719.2	1508.0	1254.5	1943.5	1621.7
Mean	1807.0	1748.5	1797.2		1842.7	1878.5	1634.7	1599.0	1836.2	1917.5
	K_1	K_2	K_3	G_1	G_2	G_3		G_1	G_2	G_3
P_1	1862.2	1729.0	1833.0	1647.7	1885.0	1891.5	K_1	1709.5	1826.5	1989.0
P_2	1751.7	2005.2	1491.7	1508.0	1722.5	2018.2	K_2	1696.5	1940.2	1998.7
P_3	1911.0	1904.5	1576.2	1647.7	1901.2	1842.7	K_3	1397.5	1742.0	1764.7

CD (P=0.05) for N and G = 136.5
SE = 438.75

height and leaf production. N both at 100g and K_2O at 140g/palm significantly increased the production of spadices and percentage of spadices to leaf fall, nut production and its relative weight. N at 100g/palm significantly induced earliness in bearing. The influence of P was not significant on any of the characters studied except an initial increase of height and percentage of spadices to leaf fall. Green leaf at 14 kg per palm significantly increased the production of spadices, percentage of spadices to leaf fall and relative individual weight of nuts. In the revised levels response to green leaf alone was significant (Shama Bhat, 1978). Green leaf at 14 kg/palm had significantly more number of nuts than green leaf at 7 kg per palm.

The pooled analysis from 1973-74 to 1979-80 (7 years) showed that none of the main effects were significant (Table 5). No influence of interaction was also observed for the yield. Increasing trend in yield was observed in the case of green leaf application. Application of lime @ one kg/palm also did not influence the yield. The non-response in respect of yield of arecanut to the applied fertilizers may be due to the high fertility status of the soil and availability of native fertilizers and nutrients (CPCRI, 1974).

Kahikuchi: The farm is 48m above MSL. The soil is new alluvium with a lower lateritic strata. The pH is 4.4-4.8 (Anonymous, 1974). The NPKG experiment was planted in 1962-63. The

Table 5. *Yield of arecanut chali (kg/ha) at Peech (7 years mean 1973-1981)*

	P_0	P_1	P_2	K_0	K_1	K_2	G_0	G_1	G_2	Mean
					With lime					
N_0	3464.5	3410.0	3283.1	3430.8	3414.9	3312.5	3462.5	3182.2	3513.7	3385.8
N_1	3143.2	3370.2	3422.7	3230.9	3345.4	3559.7	3472.6	3206.9	3256.1	3312.0
N_2	3322.3	3131.8	3348.3	3158.2	3131.4	3512.8	2915.2	3348.7	3538.4	3267.3
Mean	3310.1	3304.0	3351.5	3273.3	3297.2	3395.0	3383.4	3243.9	3436.0	—
	K_0	K_1	K_2	G_0	G_1	G_2	G_0	G_{12}	G_2	
P_0	3153.3	3275.2	3512.8	3338.9	3308.9	3286.5 K_0	3310.9	3211.8	3296.7	3273.3
P_1	3254.0	3416.9	3237.8	2948.5	3320.6	3642.8 K_1	3155.3	3420.6	3315.4	3297.2
P_2	3409.2	3219.2	3434.4	3562.8	3108.6	3382.8 K_2	3383.2	3106.2	3695.2	3395.0
					Without lime					
	P_0	P_1	P_2	K_0	K_1	K_2	G_0	G_1	G_2	
N_0	3528.0	3182.8	3461.2	3476.3	3427.5	3262.6	3133.4	3497.8	3535.2	3388.9
N_1	2890.5	3423.8	3535.6	3307.3	3236.6	3306.0	3319.4	3217.0	3313.4	3283.3
N_2	3045.2	3185.0	3224.8	3124.5	3057.4	3272.7	2841.7	3265.0	3347.5	3151.6
Mean	3152.6	3263.8	3407.8	3302.8	3240.2	3280.5	3098.0	3326.7	3398.7	—
	K_0	K_1	K_2	G_0	G_1	G_2	G_0	G_1	G_2	
P_0	3348.3	2987.5	3123.2	3090.3	3146.0	3321.9 K_0	3246.7	3334.5	3426.7	3302.8
P_1	3173.6	3365.4	3251.6	3077.7	3258.1	3454.7 K_1	3037.9	3335.3	3348.3	3240.2
P_2	3386.1	3368.6	3466.5	3248.4	3575.4	3519.3 K_2	3010.3	3410.0	3420.6	3280.5

CD (P=0.05) NS for all the main effects as well as interactions.

levels of nutrients and green leaf were similar to that at Vittal.

The combined analysis of pooled data on the yield of arecanut for 12 years (1967-1978) was carried out and the data are presented in Table-6. Application of phosphorus alone had significantly influenced the yield of nuts. The main effects as well as their interactions were found to be not significant in the case of all the other nutrients.

In the case of nitrogen the highest yield was obtained by the application of 50g N/palm. Between 50 and 100g there was no difference in yield. When the response of P was considered, the maximum yield was observed from P_1 level (40g P_2O_5/palm) and there was no significant difference between P_1 and P_2 levels. In the case of potash a non-significant linear trend in yield was observed. Similarly trend was also noticed with green leaf application. The overall results of the experiment at Kahikuchi Centre showed that application of 50g N, 40g P_2O_5, 140g K_2O and 14 kg green leaf per palm is advantageous.

Mohitnagar: The sub-station is in Jalpaiguri district of West Bengal located 10 km of north-west of Jalpaiguri. The soil is alluvium and its pH is 4.5-6.0. The fertilizer experiment laid out on a $3^3 \times 2 \times 3 \times$ factorial design in 1967 (CRRS, 1969) with 3 levels of N (0,100 and 200g N/palm), 3 levels of P_2O_5 (0, 40 and 80g/palm) and 3 levels of K_2O (0, 140 and 280g/palm) as main treatments with lime (0 and 1 kg/palm) in the sub plot.

The pooled analysis of yield data for 6 years (1976-77 to 1981-82) showed a significant effect of potash on the yield (Table 7). Application of 140g K_2O per palm resulted in significantly more yield as compared to no potash application. Between K_1 and K_2 levels (140 and 280g/palm) there was no significant difference. Application of nitrogen did not influence the yield of arecanut. However, the highest yield was obtained from the plots receiving 100g nitrogen/palm. Phosphorus did not show significant difference between the treatments but P_1 level (40g P_2O_5/palm) gave the maximum yield.

When different interactions were considered, only the interactions of N × P was found to be significant. Application of lime had significantly decreased the yield. No evidence of interactions of NPK with lime was also noticed. Based on the

Table 6. *Yield of arecanut chali (kg/ha) at Kahikuchi (12 year mean 1967-1978)*

	K_0	K_1	K_2	G_0	G_1	G_2	G_0	G_1	G_2	Mean
N_0	1371.5	1722.5	1566.5	1582.7	1495.0	1537.2	1514.5	1459.2	1690.0	1553.5
N_1	1599.0	1917.5	1956.5	1758.2	1813.5	1901.2	1761.5	1911.0	1800.5	1823.2
N_2	1602.2	1898.0	1976.0	1771.2	1855.7	1852.5	1823.2	1690.0	1790.7	1826.5
Mean	1572.5	1846.0	1833.0	1703.0	1735.5	1764.7	1699.7	1742.0	1761.5	--
	K_0	K_1	K_2	G_0	G_1	G_2	Mean	G_0	G_1	G_2
P_0	1459.2	1569.7	1543.7	1478.7	1618.5	1475.5	1527.5 K_0	1758.2	1634.7	1719.2
P_1	1768.0	1933.7	1836.2	1764.7	1833.0	1940.2	1846.0 K_1	1647.7	1781.0	1781.0
P_2	1885.0	1703.0	1911.0	1855.7	1777.7	1865.5	1833.0 K_2	1696.5	1816.7	1794.1

CD (P=0.05) for P = 26.00
SE = 157.95

results of this experiment an annual application of 100g N, 40g P_2O_5 and 140g K_2O/palm was found to be the optimum dose.

Hirehalli: The substation Hirehalli is at an elevation of 845m above MSL. The soil is clay to clay loam with a pH of about 6.2. The NPKG experiment was planted in 1962 on 3^4 confounded factorial design as a single replicate in nine plot blocks with 20 seedlings/treatment (CARS, 1963).

The levels of NPK and green leaf were similar to that at Vittal. Pooled analysis of yield of 12 years (1968-1980) indicated that application of nitrogen and green leaf had significant effect on the yield of nuts (Table 8). N dose of 50g per palm gave significantly highest yield when compared to no nitrogen application. There was no difference between N_1 and N_2 levels. Significant linear response was observed in green leaf application. The highest yield was obtained with the application 14 kg per palm followed by 7 kg of green leaf per palm.

When the different interactions were considered, the interactions of N×P, N×K and P×K were found to be significant (Table 8). In the case of N×P, the highest yield was obtained from the treatment combination of N_1P_1 ie., application of 50g N with 40g P_2O_5/palm. Regarding NK, the highest yield was observed from the treatment combination of N_2K_1 (application of 100g N with 70g K_2O per palm). When the PK interaction was considered, the treatment combinations of P_1K_1 and P_0K_1 were found to be superior to the rest of the combinations. The overall results showed that a recommendation of 50g N, 40g P_2O_5 and 70g K_2O with 14 kg green leaf per palm is the optimum dose.

Effect of Split application of Fertilizers

Experiments to determine the effects of application of fertilizers in split doses were laid out at Peechi and at Vittal. At Peechi, the experiment was laid out during 1968 and concluded in 1975. The treatments consisted of (1) N,P and K full dose in one application in September; (2) N,P and K two split applications in September and January, (3) N,P and K three split applications in September, January and April; (4) P and K in one dose in September and

Table 7. *Yield of arecanut chali (kg/ha) at Mohitnagar (6 years mean 1976-1982)*

	P_0	P_1	P_2	K_0	K_1	K_2	L_0	L_1	Mean
N_0	2096.2	1831.5	1872.0	1748.5	2154.7	1881.7	2122.2	1735.5	1894.7
N_1	1862.2	2083.2	1982.0	1807.0	1959.7	2161.2	2317.2	1634.7	1976.0
N_2	1683.5	2063.7	2093.0	1686.7	2076.7	2080.0	2063.7	1833.0	1950.0
Mean	1881.7	1989.0	1982.5	1748.5	2063.7	2041.0	2167.7	1735.5	--

	M_0	K_1	K_2	L_0	L_1		L_0	L_1	Mean
P_0	1722.5	2063.7	1859.0	2119.0	1644.5	K_0	1823.2	1673.7	1748.5
P_1	1680.2	2106.0	2177.5	2216.5	1758.2	K_1	2294.5	1836.2	2063.7
P_2	1842.7	2034.5	2083.2	2164.5	1800.5	K_2	2385.5	1696.5	2041.0

CD (P=0.05) for K = 196.62
CD (P=0.05) for L = 184.27
CD (P=0.05) for NP = 341.25

SE for NPK = 120.57
for L = 184.27
for interaction=120.57

N in two split applications in September and January; (5) N and P in one dose in September and K in two split applications in September and January; and (6) P in one split application in September and N and K in two doses in September and January. The full annual dose in all the treatments consisted of 100g N, 40g P_2O_5 and 140g K_2O per palm (CPCRI, 1976). Pooled analysis of yield data showed that the split application of fertilizers did not affect the yield of arecanut significantly at Peechi.

To study the effect of fractional application of NPK fertilizers on the productivity of arecanut an experiment was laid out at Vittal during 1977 in an existing 10 year old areca garden adopting a 6×5 RBD with nine palms per treatment. The treatments consisted of: (1) NPK one application in September; (2) NPK in two split applications in September and March; (3) NPK in three split applications in September, January and May; (4) P and K in one application in September and N in two equal splits in September and March; (5) P and K in one application in September, N in three splits in September, January and May; (6) P in one application in September and N and K in two splits in September and March. The annual dose of fertilizers viz., 100g N, 40g P_2O_5 and 140g K_2O/palm applied as urea, single superphosphate and muriate of potash respectively and 12 kg green leaf were applied per palm (CPCRI 1979).

Pooled analysis of yield data for the year 1977-78 to 1982-83 showed no significant effect of split applications of fertilizers on the yield (CPCRI 1984a). However, split application of fertilizers could bring about a non-significant positive increase in the production of nuts in all the treatments except in treatment No.2. Application of P in one dose during September and N_1 and K in two equal splits during September and March showed the maximum increase in yield over single application (Fig.1).

The economics of split application of NPK fertilizers in comparison with single application were compared (CPCRI, 1984b). Two equal split applications of N and K fertilizers in March and September and full dose of phosphate fertilizers in September (T_6 recorded maximum net profit of Rs4522/ha. with an extra labour input of Rs230 per ha, followed by application of NPK fertilizers

Table 8. *Yield of arecanut chali (kg/ha) at Hirehalli (12 years mean 1968-1980)*

	P_0	P_1	P_2	K_0	K_1	K_2	G_0	G_1	G_2	Mean
N_0	2063.7	1651.0	1641.2	1881.7	1670.5	1803.7	1313.0	1690.0	2184.0	1784.2
N_1	2216.5	2661.7	2450.5	2418.0	2437.5	2473.2	1982.5	2551.7	2600.0	2444.0
N_2	2294.5	2548.0	2440.7	2496.0	2655.2	2132.0	2162.2	2531.7	2587.0	2427.7
Mean	2193.7	2288.0	2242.8	2262.0	2255.5	2112.5	1885.0	2314.0	2457.0	--
	K_0	K_1	K_2	G_0	G_1	G_2	G_0	G_1	G_2	
P_0	1998.7	2431.0	2148.2	1768.0	2340.0	2470.0 K_0	2015.0	2229.5	2548.0	
P_1	2427.7	2994.5	2138.5	1914.2	2444.2	2502.5 K_1	1933.7	2437.5	2392.0	
P_2	2369.2	2337.7	2122.2	1972.7	2161.2	2395.2 K_2	3281.2	2275.0	2427.7	

CD (P=0.05) for N and G = 169.00 SE for main effect = 59.15
for interaction = 390.00 for interaction = 102.37

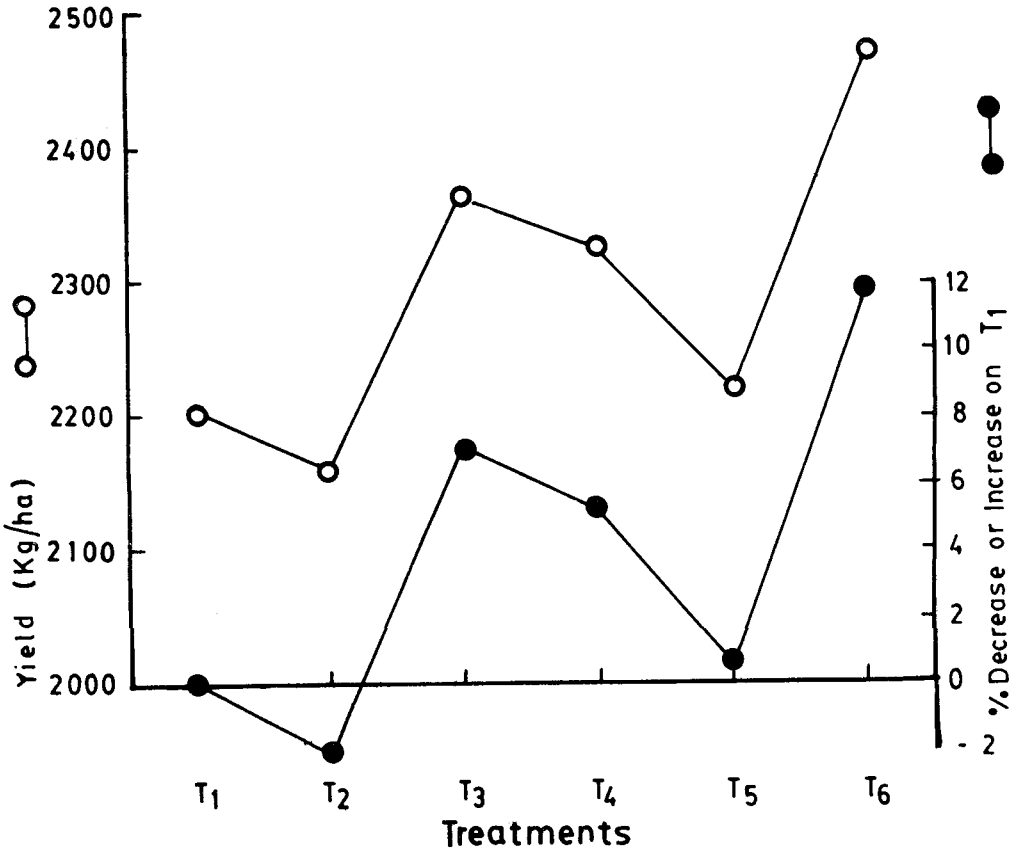

Fig.1. Yield of Arecanut by split application of fertilizers at Vittal

in three equal splits during January, March and September (T_3) which gave an extra income of Rs2384 per ha with an extra input of Rs460/ha over single application (Fig.2)

Effect of applying NPK in organic and inorganic forms

A field experiment to study the effect of applying nutrients in organic and inorganic form on the yield performance of areca palms was carried out at Vittal during 1963-1969 (Shama Bhat and Abdul Khader 1982). The yield data for the various years showed no significant difference between the two forms of nutrients.

Effect of macro and micro nutrients with and without irrigation

Application of NPK with or without micro nutrients but with irrigation resulted in significantly superior yield performance as compared to NPK with or without micronutrients and without irrigation at Palode (CRRS, 1969). The yield data of the above experiments are presented in Table 9.

NPK experiment with and without lime at Palode

Another experiment laid out at Palode to determine the effect of application of NPK with and without lime revealed no significant influence of lime (CRRS, 1969).

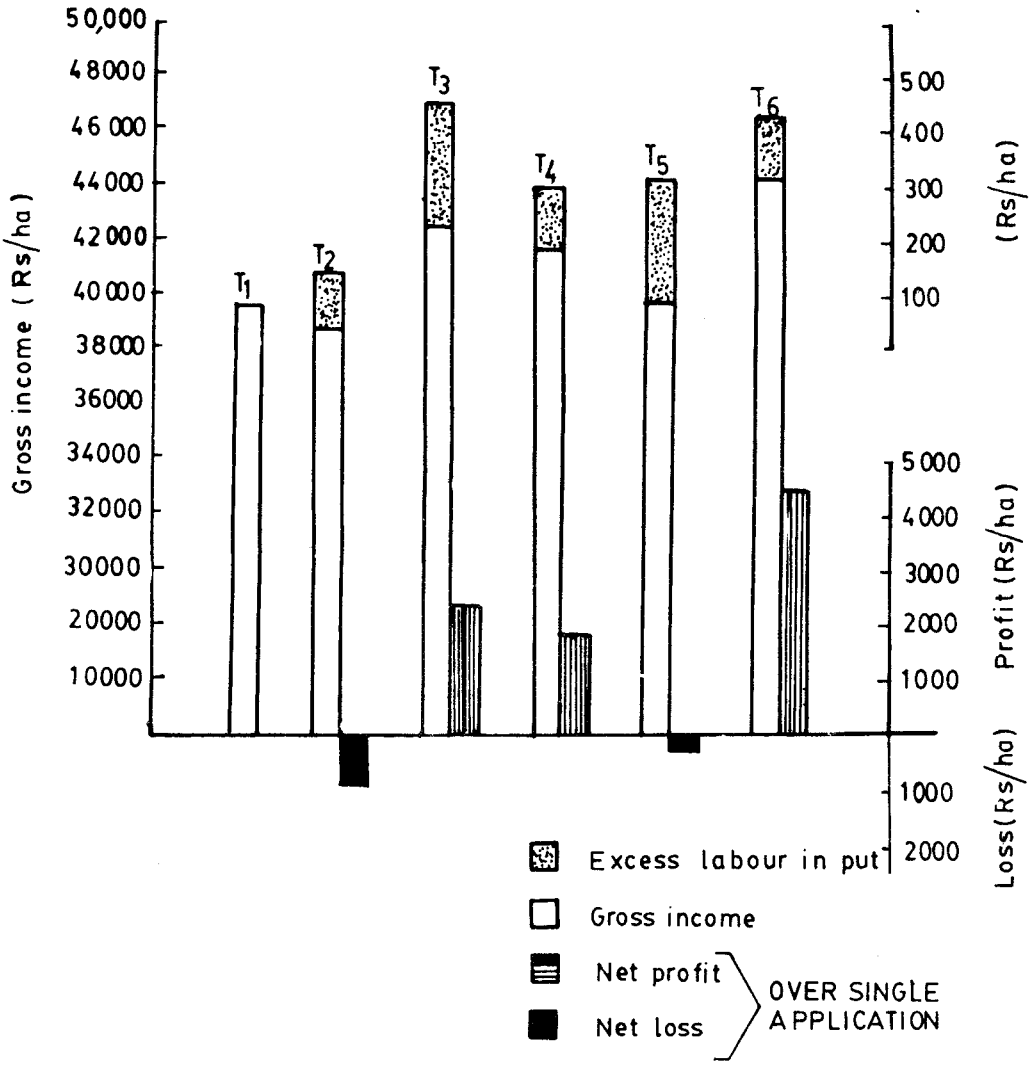

Fig.2. Economics of split application of NPK fertilizers in comparison with single application at Vittal

Table 9. *Yield of arecanut in relation to macro and micro nutrients with and without irrigation at Palode (Mean of initial two years)*

	Treatments	No. of nuts per palm	Weight of nuts per palm (g)
1.	No cultivation and no manuring	1.13	33.67
2.	NPK with irrigation	88.60	2244.56
3.	NPK without irrigation	25.91	665.11
4.	NPK+Micronutrients with irrigation	108.87	2839.39
5.	NPK+Micro nutrients without irrigation	37.56	968.89
	SE/plot	28.72	700.17
	CD (P=0.05)	52.41	1370.38

The manurial experiments on arecanut as detailed above were conducted under various agroclimatic zones in the different parts of the country where it is cultivated. Therefore it is quite natural that the response to different nutrients cannot be expected to be uniform on all the tracts under such diverse conditions. Yet the results of the studies carried out have helped to standardize the manurial schedules to a large extent for diverse agroclimatic regions.

Based on the results of the experiments, the following conclusions may be drawn.

1. In arecanut the maximum response observed was green leaf application in almost all the centres.
2. Application of lime did not show any advantage and at the Mohitnagar centre it had adverse effect on the yield
3. At Vittal, application of 50g N, 40g P_2O_5, and 140g K_2O per palm was found to be advantageous for younger palms and for adult palms the present recommendations of 100g N, 40g P_2O_5 and 140g K_2O per palm was found to be optimum.
4. At Peechi, no response was noticed to the fertilizer application.
5. At Kahikuchi application of 50g N, 40g P_2O_5, 140g K_2O with 14 kg of green leaf per palm was found to be economical.
6. At Mohitnagar as in the case of Vittal 100g N, 40g P_2O_5 and 140g K_2O per palm appears to be optimum. Application of lime @ 1 kg/palm showed adverse effect on the yield.
7. Considering the results of the experiments of Hirehalli, application of a lower dose viz. 50g N, 40g P_2O_5, 70g K_2O with 14 kg of green leaf appears to be the optimum.
8. The experiments conducted on fractional (split) application of fertilizers at Vittal showed that two equal split applications of nitrogen and potash in September and March and full dose of phosphatic fertilizers in September is beneficial.
9. At Vittal application of recommended dose of NPK either in organic or inorganic forms did not show any difference.
10. At Palode application of NPK and micronutrients with irrigation gave significantly the highest yield.

ACKNOWLEDGEMENTS

The data presented in this paper are the contributions of various workers associated with arecanut manurial experiments both at the

CPCRI, Regional Station, Vittal and in the Research Centres since 1961. The contributions made by way of conducting the experiments and collection of data by the following Research workers who were associated at various times during the course of investigation are gratefully acknowledged.

Late Dr. K. Shama Bhat, Dr. KV Ahamed Bavappa, Dr. P. Muddappa Gowda, Mr. E. Velappan, Dr. P. Harishu Kumar Dr. M. Achuthan Nair, Dr. M. Sannamarappa, Dr. A.R. Mohapatra, Mr. K.N. Murthy, Mr. A.R. Roy, Mr. Mahvirsingh, Dr. R.K. Singh, Dr. T.V.R. Nayar, Dr. A.K. Roy, Dr. S.N. Sampath Kumar, Shri N. Yadukumar, Shri B. Nagaraja, Shri K.P. Padmanabhan Nambiar, Shri S.C. Paul, Shri R.K. Bhattacharya, Shri C. S. Abraham, Dr. A.K. Sadanandan, Shri G. Biswas, Shri N. Narayana Bhat, Shri K.J. Abraham and Shri G.V.B. Naidu.

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