

Nutrition of Arecanut

K.B. ABDUL KHADER

1. INTRODUCTION

Arecanut palm (*Areca catechu* L.) is largely grown in high rainfall regions of Assam, Karnataka, Kerala, Orissa, West Bengal, Tamil Nadu, Maharashtra and Andamans in the laterite, alluvial and clay loam soils. Of all the soils, the deep fertile clay loams in the tank irrigated areas support excellent growth of arecanut palms. The acid soils of arecanut growing regions are low in soil fertility. This crop responds well to the addition of organic manures coupled with inorganic fertilizers and irrigation.

Nutritional requirements for arecanut is being studied since 1961 at Vittal (Karnataka) and Peechi (Kerala); 1962 at Hirehalli (Karnataka) and Kahikuchi (Assam); and 1967 at Mohitnagar (West Bengal) which are the major arecanut growing areas.

2. SOILS

The largest area under the crop is found in gravely laterite soils (red clay type) of southern Kerala and coastal Karnataka (Nambiar, 1949). In the plains or the Maidan part of Karnataka, arecanut is planted in fertile clay loam soils (Naidu, 1962). These soils have at places a large admixture of tank silt particularly in locations where tank irrigation is practised. Of all the soils, the deep blackish clay loams in the tank irrigated areas which are fertile support luxuriant tree growth. Sticky clay, sandy, alluvial, brackish and calcareous soils are not favoured for arecanut cultivation (Aiyer, 1966). In Malaysia and Fiji, arecanut is cultivated in the hot, moist, rich alluvial areas of the coastal belt (Nambiar, 1949).

2.1 Soil Types, Fertility Status and Availability

Khadilkar *et al.* (1964) described soil profiles from arecanut growing areas of Kolaba and Ratnagiri districts of Maharashtra. The major soils are lateritic, mildly acidic, rich in total N and micronutrients, low in bases, and also in P and K. The alluvial soils from the coastal region are found to be neutral, base saturated and rich in organic matter. The total K content of Nedumangad soils in Kerala, is very low (0.14-0.38%) compared to black and alluvial soils of other regions (Sekhon, 1986). The exchangeable K in the above soils ranges from 0.2 to 0.4 me/100 g which is low compared to other major soils (Tandon and Sekhon, 1988). Their buffering capacity is also very low and are prone

to leaching losses. The arecanut soils can be broadly grouped under entisols, alfisols and altisols.

Iyer and Gopaldaswamy (1982) studied the morphology, mineralogy and taxonomy of some arecanut soils of Trivandrum district of Kerala and observed that the soils of the region are of kaolinitic in nature and acidic in reaction, and can be classified as inceptisols, alfisols and entisols. Texturally the soils of Hirehalli are clay loam and that of Vittal are sandy clay loam while those from Peechi, Palode, Mohitnagar and Kahikuchi are sandy loam (Mohapatra, 1977).

Though a comprehensive survey of fertility status of soils of arecanut growing areas has not been carried out, some information on the native fertility status of the soils has been gathered from the Arecanut Research Stations situated in the various states of the country (Anon., 1973; Mohapatra, 1977). In general, the organic matter content and available P are higher in the soils of Peechi, medium in Mohitnagar and Kahikuchi, and low in the soils of Vittal, Hirehalli and Palode. Soils of arecanut growing tracts of all states except that of Mohitnagar are found to be medium to high in available K status. The pH of soils of all the research centres is acidic to neutral except that of Hirehalli where it is neutral to alkaline. The total CaO and MgO contents of soils from Vittal and Palode are lower than those of other areas. The Al_2O_3 content is more than that of P_2O_5 (Table 1).

Iyenger (1954) reported that the total N content of the soils varied from 0.03-0.22 per cent in some of the arecanut gardens of Karnataka.

3. UPTAKE OF NUTRIENTS

Rethinam (1990) reported that arecanut removes 79 kg N, 28 kg P_2O_5 and 79 kg K_2O /ha.

4. ROLE OF ORGANIC MANURE

Organic manures play an important role in the production and productivity of arecanut. In a manurial experiment conducted at Vittal showed that application of 14 kg of green leaf per palm had resulted in significantly more yield along with 100 g N, 40 g P_2O_5 and 140 g K_2O per palm (Abdul Khader, 1990).

Coleman and Rao (1918) outlined the aborate system of manuring with cattle manure and green leaves on the Malanad parts of the Karnataka and the use of tank and river silt or earth from paddy fields together with farm yard manure. Aiyer (1966) also mentioned about manuring system practised in the Malanad using green leaves cut from the adjoining areas (*Soffina Betta*).

Nambiar (1949) reported that arecanut palms were manured with green leaves and cattle manure were applied in large doses either annually or once in two or three years only in parts of Karnataka, south Malabar of Kerala and, to some extent, in

Table 1 : Nutrient status of soils (0-25 cm depth) of experimental stations under arecanut

Stations	pH	Organic carbon (%)	Total N (%)	Available nutrients (ppm)							
				P ₂ O ₅	K ₂ O	CaO (%)	MgO (%)	Fe ₂ O ₃ (%)	Al ₂ O ₃ (%)		
Karnataka											
Vittal	5.3-5.6	0.7-1.1	0.05-0.09	3.8-7.1	34-85	0.07-0.30	0.6-1.7	8.8-12.0	12.0-21.4		
Hirehalli (do)	6.5-8.2	0.3-1.4	0.04-0.19	Trace-5.5	30.108	0.30-0.38	0.6-1.1	7.2-19.2	11.3-39.0		
Kerala											
Peechi	5.1-5.6	1.0-2.0	0.06-0.16	50.0-81.0	115-130	0.53	1.7-2.3	8.0-11.2	17.1-24.6		
Palode	4.9-5.0	0.7-1.4	0.06-0.13	Trace-3.0	81-91	0.15-0.23	0.6-1.1	4.8-7.2	18.0-30.9		
West Bengal											
Mohitnagar	5.7-6.2	0.1-2.2	0.14-0.22	9.2-69.1	8-55	0.23-0.30	1.7-2.9	4.0-7.2	4.8-14.5		
Assam											
Kahikuchi	5.1-5.3	0.5-1.8	0.03-0.12	9.6-29.0	70-190	0.15-0.30	1.1-2.3	2.4-8.0	6.5-13.6		

Mohapatra and N.T. Bhat, 1982.

Coimbatore district of Tamil Nadu. Farm yard manures and groundnut cake and fertilizers are being applied in recent years in those states (Shama Bhat and Abdul Khader, 1982).

Based on the experiments carried out between 1920 and 1956 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).

Krishnappa (1962) reported that growing green manure crops inside the garden offers an easy solution for solving the problems of non-availability of green leaf for manuring. According to them, *Crotalaria anagryroides*, *Crotalaria striata*, *Tephrosia candida*, *Pueraria phasioloides*, *Calopogonium muconoides* and *Centrocema pubescens* are some of the green manure crops which can be grown for manuring arecanut gardens.

Mohapatra *et al.* (1970) recommended growing of leguminous cover crops in the arecanut garden to assimilate the atmospheric nitrogen and enrich the soil. They have also listed such cover crops which can be raised in arecanut gardens or in vacant spaces adjoining the arecanut gardens. They have also listed some agronomic information about the green manures and its nutrient content (Table 2).

Table 2 : Yield of green matter, nutrient content and amount of nutrients added by different green manure crops

Name of the crop	Mean yield of green matter 1970-72 (tonnes/ha)	Moisture (%)	Nutrient composition			Nutrient addition (kg/ha)		
			N	P %	K	N	P ₂ O ₅	K ₂ O
<i>Calopogonium muconoides</i>	7.14	78.37	2.63	0.23	2.80	40.50	7.92	51.91
<i>Pueraria javanica</i>	14.35	79.01	3.30	0.24	1.63	99.33	16.54	59.06
<i>Stylosanthes gracilis</i>	12.81	79.40	3.30	0.24	1.63	99.33	16.54	59.06
<i>Mimosa invisa</i>	12.62	77.63	3.96	0.34	2.00	111.67	21.62	67.90
<i>Sesbania speciosa</i>	5.18	77.50	2.70	0.17	1.12	31.32	4.51	15.64
<i>Centrocema pubescens</i>	6.90	75.20	2.54	0.24	1.75	43.43	9.21	36.02
<i>Crotalaria anagryroides</i>	3.39	78.30	2.81	0.27	2.12	20.51	4.51	18.62

Mohapatra *et al.*, 1970.

According to Bhat and Mohapatra (1989), the source of nutrients supplied did not influence the growth or yield of arecanut crop. They have further reported that in arecanut garden, 14 kg of fresh grass/palm is available as weed biomass which can be profitably recycled and incorporated into the soil instead of removing outside the garden (Table 3).

In addition, shed leaves, arecanut husks, arecanut bunches (inflorescence after separating ripe arecanuts) can also be recycled in arecanut garden. The nutrient contents of the above materials has been indicated by Bhat and Mohapatra (1989) along with other pertinent details (Table 4).

Table 3 : Nutrient composition of weed growth and nutrient added per palm

Nutrient element	Nutrient composition (%)	Nutrient added per palm per year by 1 kg of fresh weed
Nitrogen (N)	1.83	32 g
Phosphorus (P_2O_5)	0.39	7 g
Potash (K_2O)	3.00	52 g

Bhat and Mohapatra, 1989.

Table 4 : Nutrient content and quantity of nutrients added by non-marketed produce in arecanut garden

Name of the by-product	Mean dry wt. of biomass per year/palm (kg)	Nutrient content (%)			Nutrient added/year/palm (kg)		
		N	P	K	N	P	K
Arecanut leaves (fallen)	4.0	1.59	0.16	1.01	63.6	6.4	40.4
Leaf sheath	1.7	0.66	0.08	1.51	11.2	1.4	25.6
Arecanut husk	1.7	1.00	0.12	2.40	17.0	2.0	40.0
Arecanut bunch	0.3	1.04	0.07	1.10	3.1	0.2	3.63
Total nutrients added	—	—	—	—	94.9	10.0	109.63

Bhat and Mohapatra, 1989.

The rate of release of nitrogen from different organic manures commonly applied to arecanut, viz., *Glyricidia*, *Mimosa*, forest leaf compost, cattle manure and fish manure was estimated from an experiment at Vittal (Table 5 and 6). The mineralisation of these substances was found to be complete in four months and thereafter the rate was very slow (Mohapatra and Bhat, 1982). It is evident that easily decomposable material gets oxidised in the course of about four months. The fish manure contributed more to the

Table 5 : Ammoniacal nitrogen in soil samples incorporated with different organic manures

Sampling intervals (months)	Ammoniacal nitrogen (ppm)						Mean
	<i>Glyricidia</i>	<i>Mimosa</i>	Forest laeaf	Cattle manure	Compost	Fish manure	
1	4.35	1.87	1.11	0.72	0.82	10.91	3.30
2	2.18	1.30	0.97	0.53	0.66	2.20	1.17
3	0.50	1.34	0.06	0.37	0.03	2.04	0.72
4	0.22	0.50	Trace	Trace	0.17	0.32	0.26
5	0.33	0.34	0.22	0.27	0.19	0.15	0.23
6	0.18	0.30	0.32	0.20	0.20	0.13	0.22
Mean	1.29	0.94	0.45	0.33	0.35	2.62	—

C.D. (P = 0.05). Treatment = 0.42. C.D. (P = 0.05). Month = 0.29.
Mohapatra and Bhat, 1982.

Table 6 : Organic carbon in soil samples at different periods following incorporation of organic manures

Sampling interval (months)	Organic carbon (%)						Mean
	Glyricidia	Mimosa	Forest leaf	Cattle manure	Compost	Fish manure	
1	0.21	0.26	0.31	0.34	0.29	0.28	0.28
2	0.24	0.27	0.32	0.32	0.32	0.25	0.29
3	0.21	0.24	0.36	0.29	0.30	0.26	0.29
4	0.38	0.35	0.40	0.34	0.42	0.29	0.36
5	0.25	0.25	0.35	0.27	0.24	0.24	0.27
6	0.29	0.32	0.38	0.40	0.31	0.33	0.34
Mean	0.26	0.28	0.35	0.33	0.31	0.29	—

C.D. (P = 0.05). Treatment = 0.042. C.D. (P = 0.05) Month 0.022.
Mohapatra and Bhat, 1982.

NH₄-N content and also increased soil acidity. Lime reduced the contents of NH₄-N and available K. Forest leaf and cattle manure increased organic matter content of soil (Anon., 1972). The study indicated that discontinuing of organic manure application to areca palms as practised by some farmers is not a desirable practice.

An experiment to study the long term effect of applying organic, inorganic and a combination of both without intercultivation on the composition of arecanut growing soils and areca palm was carried out at Vittal from 1969 to 1981. The nutrients applied were 100 g N, 40 g P₂O₅ and 140 g K₂O per palm in the form of organic and inorganic manures. Application of organic manures significantly increased organic matter in soil to a higher degree than inorganic fertilizers. The plant nutrients in the soil was found to build up as a result of fertilizer application. Both organic manures and inorganic fertilizers were equally effective in building up soil available plant nutrients. Application of nutrients in the form of organic sources, meets the needs of the crop (Anon., 1981). The rhizosphere of palms in treatments receiving organic manures had a higher microbial population (Bopaiah and Bhat, 1981) (Table 7).

Table 7 : Microbial population in rhizosphere of areca palms (0-30 cm)

Treatments	Soil pH	organic carbon (%)	Bacteria 10 ⁴	Fungi 10 ³	Actinomy-cetes 10 ³
Organic manures	7.38	2.23	129.0	29.0	10.5
Inorganic fertilizers	5.78	1.62	18.0	22.0	5.0
Organic manures + inorganic fertilizers	6.87	2.41	47.0	18.5	11.5
Organic manures + inorganic fertilizers + cultivation	6.85	1.85	136.0	22.5	34.5
Organic manures + cultivation	7.43	1.82	130.0	19.0	22.5
Inorganic fertilizers + cultivation	5.52	1.09	51.0	17.5	9.0

Bopaiah and Bhat, 1981.

The soils of arecanut gardens are slightly acidic and low in general fertility. Liberal application of organic matter buffers soils reaction. Lime could be added to soil whose pH is below 5.0 to correct acidity. Micronutrient application do not have a pronounced effect on growth and yield of arecanut (Mohapatra, 1977).

5. ROLE OF INORGANIC MANURES

Arecanut like any other crop requires nitrogen, phosphorus and potassium in adequate quantities and in suitable proportions for its growth and yield. Being a perennial crop, its nutrient need is continuous all over the year and also for the long period. Unless the plant food removed by the palm from the soil is annually replenished, a decline in yield and deterioration in the nut quality are expected to occur. This calls for a judicious fertilizer application in order to get the maximum yield.

5.1 Fertilizer/Manurial Application Experiment with Nutrient Interaction

In the 1950s, the erstwhile Indian Central Arecanut Committee had carried out manurial experiments in the cultivators fields (Lakshmanachar *et al.*, 1960). The experiment was conducted in the submountain 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 18.0 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 submountain 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-experiment period, the increase in the mean yield in the fertilized plots was 52 per cent for submountain and 24 per cent for coastal regions. In the submountain regions of Kerala, application of 22.7 kg nitrogen, 18.1 kg phosphoric acid and 34.0 kg potash for 500 palms was found to be economical.

Detailed field experiments were initiated with the establishment of Central Arecanut Research Station (now Regional Centre of CPCRI) from 1961 under different agroclimatic conditions. Comprehensive manurial experiments to determine the manurial requirements of areca palms at Vittal, Hirehalli, Peechi, Mohitnagar, Kahikuchi and Palode, and the results of the above experiments were reported by Abdul Khader (1990).

A field experiment was started in 1961 in 3^4 confounded factorial design with nine plot blocks with a single replication. The N, P and K sources were ammonium sulphate, superphosphate and muriate of potash, respectively.

Pre-treated soils were collected and analysed and the data are given below:

pH	Organic C (%)	Available P_2O_5 (ppm)	Available K_2O (ppm)
Surface soil (0-50 cm) 5.7	0.8	Traces	35.5
Sub soil (50-100 cm)	0.4	Traces	61.0

Application of ammonium sulphate to supply 50 and 100 g N/palm had significantly decreased the soil pH. Application of higher dose of ammonium sulphate (100 g N/palm) significantly increased the exchangeable acidity while application of 14 kg of green leaves/palm had significantly decreased the soil acidity compared to the treatments where green leaves were not applied.

The organic carbon content of soil was significantly increased by the application of green leaves and there was significant increase in the available P_2O_5 content of the soil by the application of 40 g P_2O_5 /palm. In respect of potassium, N_0 level had shown significantly higher soil potassium than that of 50 and 100 g N/palm respectively. Application of 140 g K_2O /palm with no nitrogen application gave significantly higher value compared to rest of the treatment combinations. As regards calcium, N_0 level had shown higher exchangeable calcium in the soil than that of application of 50 and 100 g N/palm respectively.

Combined analysis of initial five years yield data (1966-70) showed that in the case of N, the yield increase was up to an application of 50 g/palm. In respect of green leaf, the positive response was obtained after an application of 14 kg of green leaf/palm. 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.

After superimposing the revised schedule, combined analyses for 8 years (1974-75 to 1981-82). The analysis showed that application of 70 g K_2O /palm produced significantly more yield and this combined with an application of 14 kg of green leaf/palm gave the highest yield. In the revised schedule, application of 100 g N/palm produced the highest yield. The results at Vittal indicated that application of 50 g N, 40 g P_2O_5 , 70 g K_2O along with 14 kg of green leaf/palm/year is optimum for young palms and for the adult palms, application of 100 g N, 40 g P_2O_5 , 140 g K_2O and 14 kg green leaf/palm year is economical.

The results of the manurial experiment conducted at Peechi was 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 height and leaf production. N at 100 g and K_2O at 140 g per palm significantly increased the yield. P did not have any significant effect on yield and application of 14 kg of green leaf per palm significantly increased the yield. Application of lime at one kg/palm did not influence the yield.

The results of NPK experiment at Kahikuchi revealed that application of 50 g N, 40 g P_2O_5 , 140 g K_2O and 14 kg green leaf palm/year is advantageous (Abdul Khader, 1990).

At Mohitnagar, application of 100 g N, 40 g P_2O_5 and 140 g K_2O /palm year was found to be optimum dose. Application of lime at 1 kg/palm significantly decreased the yield.

At Hirehalli, the results of NPK manurial experiment showed that a recommendation of 50 g N, 40 g P₂O₅ and 70 g K₂O with 14 kg green leaf per palm is the optimum dose (Abdul Khader, 1990).

6. EFFECT OF SPLIT APPLICATION OF FERTILIZERS

Trials conducted on split application of fertilizers on arecanut at Vittal, application of P in one dose during September and N and K in two equal splits during September and March gave maximum yield over single application.

7. FERTILIZER INTERACTIONS

7.1 Effect of Application of Organic and Inorganic Forms of Nutrients

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 1963-69. The yield data for the various years showed no significant difference between the two forms of nitrogen (Shama Bhat and Abdul Khader, 1982).

7.2 NPK Experiment With and Without Lime

Another experiment laid out at Palode to determine the effect of application of NPK with and without lime revealed no significant influence of lime (Abdul Khader, 1990).

7.3 Fertilizer × Irrigation Experiments

7.3.1 Effect of Macro and Micronutrients with and without Irrigation

Application of NPK with or without micronutrients but with irrigation resulted in significantly superior yield performance as compared to NPK with or without irrigation at Palode (Table 8).

Table 8 : Yield of arecanut in relation to macro and micronutrients with and without irrigation at Palode (mean of initial two years)

Treatments	No. of nuts/ palm	Weight of nuts/ 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 + micronutrients without irrigation	37.56	968.89
SE/plot	28.72	700.17
(CD P = 0.05)	52.41	1370.38

Abdul Khader, 1990.

8. FERTILIZER MANAGEMENT

8.1 Doses

Annual application of 100 g N, 40 g P₂O₅ and 140 g K₂O in the form of fertilizer and 12 kg each of green leaf and compost or cattle manure for bearing palms is recommended. Application of 150:50:210 g N, P₂O₅ and K₂O/palm/year in two split doses are recommended for high yielding varieties of arecanut, viz., Mangala, Sumangala, Sreemangala and Mohitnagar.

8.2 Sources

For manuring aracanut palm, the ideal sources of N, P and K were found to be urea, superphosphate/Mussorie rock phosphate and muriate of potash respectively. For the supply of green leaf, fresh leaf cut from the adjoining forest area or the cover crops raised *in situ* may be applied and incorporated in the soil. Cattle manure may be applied as cow dung or compost manure at the recommended dose, i.e., 12 kg per palm.

8.3 Time and Method of Application

Optimum moisture availability in the soil is a prime requisite for efficient utilization of applied fertilizers and decomposition of organic manures. In most of the arecanut growing tracts, the south-west monsoon starts during last week of May and continues up to August-September. After the south-west monsoon, September-October is the best suitable period for fertilizer application. Green leaf and compost can be applied in single dose in September-October. For young plants, full dose of green leaf and compost or cattle manure may be applied from first year of planting itself, one-third of the recommended quantity of fertilizer in the first year, two-thirds in the second year and the full dose from the third year onwards. Fertilizer may be applied after opening the basins around the palm (0.75 to 1.0 m radius), dug to a depth of 15 to 20 cm. First, the chemical fertilizers may be applied separately as per the recommended dose and over which green leaf may be applied and finally compost or cattle manure may be put. After completing the fertilizer and manure application, the basins may be covered with a thin layer of soil.

8.4 Management of Manuring Basins

Basin management is very important in arecanut plantations. The study of arecanut roots under different densities of planting had been reported by Bhat and Leela (1969). Under a recommended spacing of 2.7 m × 2.7 m, it was observed that more than 75 per cent of feeding roots are concentrated up to a radius of 75 cm from the base of the palms. Therefore, for manuring, the basins should be opened up to a radius of 75 cm around the palms up to a depth of 15 to 20 cm depending upon the silt deposited in the basins. After the manurial operation is completed, the basins will have to be covered with a thin layer of soil. During rainy seasons, there should not be water stagnation in the basins of arecanut as stagnation of water is detrimental to the arecanut palms

(Abdul Khader, 1983). If there is water stagnation, excess water must be drained out by providing drainage channel. A light digging may be required when the monsoon ends in October-November to break up any crust formed at the soil surface and to uproot weeds. Weeding should be done periodically to keep the garden clean. During summer, the basins should be maintained with optimum soil moisture. Arecanut is very sensitive for drought and hence timely irrigation is important.

8.5 Fertilizer Management for Cropping Systems

Considering the long prebearing age of 5-8 years, the low income in the early period of bearing and the fluctuations in the market price of arecanut from year to year, intercropping, mixed cropping and multiple cropping in arecanut garden are being recommended.

Fertilizer management for cropping system in arecanut garden is to be managed judiciously. When component crops are grown in arecanut garden, it may be ensured that all the crops get adequate nutrients. At present, the package of practices recommended for each individual crop is being followed in order to avoid the inter and intra competition between the different species as well as between the same species. While growing cocoa, banana and pepper in arecanut garden, an additional dose of 100 g N, 40 g P₂O₅ and 140 g K₂O per plant is to be applied to the above crops in order to avoid competition for nutrients between crops. While growing inter and mixed crops, all the biomass are being added to the garden for recycling the organic matter which enriches the soil fertility and builds up organic matter.

Experiments are under progress to find out the optimum fertilizer requirements for individual crops under high density cropping system.

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