4

CROP MANAGEMENT

A. SOILS AND MANURES

A. R. MOHAPATRA and N. T. BHAT
Central Plantation Crops Research Institute,
Regional Station, Vittal 574 243, Karnataka

I. Soils

In India arecanut is mostly grown in high rainfall regions of Kerala, Karnataka, Assam, West Bengal, Tamil Nadu and Maharashtra. Andamans is also considered as an ideal area for arecanut cultivation (Nambiar, 1954). The largest area under the crop is found in gravelly laterite soils of red clay type of southern Kerala and coastal Karnataka (Nambiar, 1949). In the plain region or the *Maidan* part of Karnataka, arecanut is planted in fertile clay loam soils (Naidu, 1962). These soils may have at places a large admixture of tank silt particularly in places where tank irrigation is practised. Of all the soils, the deep black fertile clay loams in the tank irrigated areas supported luxuriant tree growth. Sticky clay, sandy, alluvial, brackish and calcareous soils are not favourable 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).

1. Fertility status of soils

Though a comprehensive survey of fertility constituents of soils of arecanut growing areas has not been carried out, some information on the native fertility status of soils has been gathered from the Arecanut Research Stations situated in various states of the country (Anonymous, 1973; Mohapatra, 1977). In general, the organic carbon content of the soil is high. Available P in the soils of Peechi (Kerala), Mohitnagar (West Bengal) and Kahikuchi (Assam) is medium, whereas it is low in the soils of Vittal, Hirehalli (Karnataka) and Palode (Kerala). Soils from all the stations except that at Mohitnagar are found to be medium to high in available K status. The pH of the soils is acidic to neutral in all the stations except that at Hirehalli, where it is neutral to alkaline. The total CaO and MgO contents of soils from Vittal and Palode are lower than those of others. The Al_2O_3 content is more

than that of Fe_2O_3 in all the soils (Table 4A.1). 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).

Iyengar (1954) reported that the total N content of the soils varied from 0.03–0.22% in some of the arecanut gardens in Karnataka.

Khadilkar, Badhe and Pandya (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 and low in bases, P and K. The alluvial soils from the coastal region are found to be neutral, base saturated and rich in organic matter.

II. Manures

1. Phosphorus and its mobility

The movement of PO_4 ion in the soil profile when applied at the rate of 50, 100 and 200 kg of P_2O_5 per ha as superphosphate was studied in a field experiment at Vittal and the results showed that after 24 hr of application of superphosphate, available P_2O_5 in surface soil (0-5 cm depth) increased by 23, 31 and 38 folds over initial level with increase in dosage of application. It decreased with increase in depth and time of sampling. The increase in available P_2O_5 and movement of PO_4 ion in the profile were found to be associated with the level of application. It was also observed that the difference between available P_2O_5 at the initial stage and 120 days after application was negligible (Table 4A.2) (Anonymous, 1970).

Another field experiment was conducted with different sources of phosphorus *viz.*, superphosphate, (0:16:0), Suphala (20:20:0), Factamfos (20:20:0) and Thermophosphate (0:17.5:0) at 40 kg and 60 kg P_2O_5 and Ultraphos (0:33:0) at 80 kg and 120 kg P_2O_5 per 500 palms for three years to assess the release of P from these fertilisers in soil. Soil and leaf sample were collected in March, June and September and analysed for their P content (Table 4A.3) (Anonymous, 1974). Thermophosphate and Suphala applied at 60 kg P_2O_5 per 500 palms were superior with respect to soil available P_2O_5. Except for Ultraphos, all the carriers at 60 kg P_2O_5 per 500 palms gave significantly more soil available P_2O_5 than the 40 kg P_2O_5 dose. There was also a significant reduction of available phosphorus (Bray-I) in soil from March to September. When adjudged by the standard of 25 ppm of P_2O_5 as the level of sufficiency in soil, all the five phosphatic fertilisers applied at their higher

Table 4A.1. *Nutrient status of soils (0–25 cm depth) of experimental stations under arecanut*

Stations	pH	Organic carbon (%)	Total N (%)	Available		CaO (%)	MgO (%)	Fe_2O_3 (%)	Al_2O_3 (%)
				P_2O_5 (ppm)	K_2O (ppm)				
Vittal (Karnataka)	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 (Karnataka)	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
Peechi (Kerala)	5.1–5.6	1.0–2.0	0.06–0.16	50–81.0	115–130	0.53	1.7–2.3	8.0–11.2	17.1–24.6
Palode (Kerala)	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
Mohitnagar (West Bengal)	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
Kahikuchi (Assam)	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

Table 4A.2. *Available P_2O_5 (ppm) in soil profile*

Sampling intervals in days	0 kg P_2O_5/ha					50 kg P_2O_5/ha					100 kg P_2O_5/ha					200 kg P_2O_5/ha				
	Depth of soil sampling in cm					Depth of soil sampling in cm					Depth of soil sampling in cm					Depth of soil sampling in cm				
	0–5	5–10	10–15	15–20	20–30	0–5	5–10	10–15	15–20	20–30	0–5	5–10	10–15	15–20	20–30	0–5	5–10	10–15	15–20	20–30
Initial	5.2	5.7	4.8	3.4	2.8	5.0	5.9	4.5	2.4	2.7	4.9	4.9	3.9	2.2	2.6	5.5	5.5	4.5	3.3	2.9
1	5.2	5.2	3.8	2.4	2.8	111.4	25.6	11.1	5.5	4.0	154.1	78.7	33.3	12 0	4.9	240.3	127.8	37.0	22.0	9.4
15	5.7	6.6	4.3	2.5	2.7	34.0	16.4	5.6	3.8	3.4	71.6	33.7	11.0	8.7	3.7	117.9	54.4	27.0	16.4	9.1
30	6.2	6.9	5.6	3.5	3.2	22.5	9.5	5.2	3.1	3.0	40.9	16.5	9.4	7.4	3.9	88.6	28.5	17.0	12.4	7.1
60	6.0	6.2	3.9	2.8	2.2	12.6	5.2	3.8	2.0	2.4	18.0	11.0	6.0	3.9	3.2	52.1	17.8	10.7	7.3	3.0
120	6.0	6.2	4.0	2.0	2.2	10.8	5.0	3.8	2.3	2.3	12.5	8.0	4.0	3.9	3.0	22.9	10.2	8.7	5.3	3.4
180	5.8	5.5	4.0	2.1	2.2	7.5	5.5	4.0	2.4	2.7	9.2	6.2	3.9	4.1	2.9	12.6	9.2	5.0	4.3	3.1

dose were equally good from the point of view of meeting P requirement of arecanut. The results also showed that there was no difference in yield due to the sources tried. Eventhough differences in soil available P was observed, leaf P levels did not show any difference due to treatments (Anonymous, 1974).

Table 4A.3. *Release of available phosphorus from different phosphatic carriers in soil (mean values of P_2O_5 in ppm)*

Treatments (kg P_2O_5/500 palms)	Months			Mean
	March	June	September	
Superphosphate 40 kg	35.20	19.95	15.30	23.50
Superphosphate 60 kg	79.86	59.09	26.20	55.10
Factamfos 40 kg	27.60	17.07	11.00	18.60
Factamfos 60 kg	76.66	43.19	17.20	45.70
Suphala 40 kg	36.93	50.98	14.83	34.30
Suphala 60 kg	101.86	110.88	26.60	79.80
Thermophosphate 40 kg	69.60	63.69	24.71	52.70
Thermophosphate 60 kg	120.00	107.65	36.53	88.10
Ultrafos 80 kg	25.00	12.91	9.60	15.60
Ultrafos 120 kg	29.20	32.65	15.26	25.70
Mean	60.20	51.80	19.70	

LSD (for months at 1% level) = 6.50 LSD (for fertilisers at 1% level) = 19.90

2. Green manuring

Green leaf manuring is an accepted practice in arecanut garden (John, 1952; Bhat, 1955). *Crotalaria anagyroides* and *C. striata* are recommended as good green manure crops in the areca gardens of *Malnad* areas of Karnataka (Krishnappa, 1962). Incorporation of *Stylosanthes gracilis* increased organic carbon and nitrogen contents of soil (Anonymous, 1969).

Trials at Vittal, Hirehalli and Mohitnagar showed that *Pueraria javanica* and *Mimosa invisa* are good green manures and cover crops in arecanut gardens from point of view of their green matter yield and nutrient addition capacity (Table 4A.4) (Anonymous, 1974).

3. Organic matter and nitrogen

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 at 100 kg N per ha was estimated from an experiment at Vittal. The mineralisation of these substances was found to be complete in four months (Table 4A.5) and thereafter, the rate was very slow. It is evident that easily

Table 4A.4. *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_2O_5	K_2O
Calopogonium mucconoides	7.14	78.37	2.63	0.23	2.80	40.50	7.92	51.91
Pueraria javanica	14.35	79.01	3.30	0.24	1.63	99.33	16.54	59.06
Stylosanthes gracilis	12.81	79.40	2.42	0.23	1.63	63.64	13.54	51.61
Mimosa invisa	12.62	77.63	3.96	0.34	2.00	111.67	21.62	67.90
Sesbania speciosa	5.18	77.50	2.70	0.17	1.12	31.32	4.51	15.64
Centrocema pubescens	6.90	75.20	2.54	0.24	1.75	43.43	9.21	36.02
Crotalaria anagyroides	3.39	78.30	2.81	0.27	2.12	20.51	4.51	18.62

Table 4A.5. *Ammoniacal nitrogen in soil samples incorporated with different organic manures*

Sampling intervals (months)	Ammoniacal nitrogen (ppm)						Mean
	Glyricidia	*Mimosa*	Forest leaf	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	0.17	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

decomposible material gets oxidised in the course of about four months. The fish manure contributed more to the NH_4–N content and also increased soil acidity. Lime reduced the contents of NH_4–N and available K. Forest leaf and cattle manure increased organic matter content of soil (Table 4A.6) (Anonymous, 1972). The study indicated that skipping of annual application of organic manure (as practised by some farmers) in arecanut gardens is not a desirable practice.

4. Organic manures and inorganic fertilisers in arecanut cultivation

An experiment to study the long term effect of supplying nutrients as organic, inorganic, a combination of both and with and 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 100g N, 40g P_2O_5 and 140g K_2O per palm per year in the form of organics and inorganics.

Table 4A.6. *Organic carbon in soil samples incorporated with different organic manures at different periods after incorporation*

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

Application of organic manures significantly increased organic matter in soil to a higher degree than inorganic fertilisers. The plant nutrients in the soil were found to build up as a result of fertiliser application. Both organic manures and inorganic fertilisers were equally effective in building up soil available plant nutrients (Table 4A.7). Eventhough there was increase in organic carbon, available P_2O_5, K_2O and exchangeable calcium due to different treatments, in the absence of significant yield differences and also the soil nutrient levels being much higher than what is normally required for the crop, it is safe to assume that application of nutrients in the form of organic or inorganic sources, meets the needs of the crop (Anonymous, 1981).

Table 4A.7. *Changes in soil fertility parameters as a result of treatments (pre-treatment samples compared with post-treatment samples, 0–50 cm depth)*

Treatments	Soil constituents									
	pH		Organic carbon (%)		Available P_2O_5 (ppm)		Available K_2O (ppm)		Exchangeable Ca (ppm)	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Organic manures	6.08	6.75	0.62	1.29	3.0	37.0	105	144	390	1115
Inorganic fertilisers	6.08	5.49	0.61	0.81	5.0	65.0	121	134	388	406
Organic manures + inorganic fertilisers	5.95	6.73	0.67	1.28	7.0	78.0	144	154	365	1166
Organic manures + inorganic fertilisers + cultivation	6.03	6.45	0.68	0.90	6.5	44.0	132	131	350	700
Organic manures + cultivation	6.13	7.25	0.64	1.60	4.8	96.0	115	235	353	1306
Inorganic fertilisers + cultivation	6.13	5.49	0.57	0.80	5.5	37.5	106	140	315	368

The rhizosphere of palms in treatments receiving organic manures had also higher microbial population (Table 4A.8) (Bopaiah and Bhat, 1981).

Table 4A.8. *Microbial population in rhizosphere of areca palms (0–30 cm)*

Treatments	Soil pH	Soil organic carbon (%)	Bacteria 10^4	Fungi 10^3	Actino-mycetes 10^3
Organic manures	7.38	2.23	129.0	29.0	10.5
Inorganic fertilisers	5.78	1.62	18.0	22.0	5.0
Organic manures + inorganic fertilisers	6.87	2.41	47.0	18.5	11.5
Organic manures + inorganic fertilisers + 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 fertilisers + cultivation	5.52	1.09	51.0	17.5	9.0

The soils of arecanut gardens are slightly acidic and low in general fertility. Fertilisers which increase acidity in soil could be avoided, wherever organic manures are abundantly available. Acidity adversely affects physical, chemical and biological properties of soil. Liberal application of organic matter buffers soil reaction. Lime could be added to soils, whose pH is below 5.0 to correct acidity.

The micronutrients do not have a pronounced effect on the growth and yield of arecanut (Mohapatra, 1977).

LITERATURE CITED

AIYER, A. K. Y. N. 1966. *Field Crops of India.* 6th ed. Bangalore Printing and Publishing Co. Ltd., Bangalore. pp. 564.

ANONYMOUS, 1969. Annual Report for 1965–'66. Central and Regional Arecanut Research Stations, Vittal, India. pp. 70.

ANONYMOUS, 1970. Annual Report for 1968. Central and Regional Arecanut Research Stations, Vittal, India. pp. 69.

ANONYMOUS, 1972. Annual Report for 1971. Central Plantation Crops Research Institute, Kasaragod, India. pp. 212.

ANONYMOUS, 1973. Annual Report for 1972. Central Plantation Crops Research Institute, Kasaragod, India. pp. 178.

ANONYMOUS, 1974. Annual Report for 1973. Central Plantation Crops Research Institute, Kasaragod, India. pp. 183.

ANONYMOUS, 1981. Annual Report for 1978. Central Plantation Crops Research Institute, Kasaragod, India. pp. 248.

BHAT, K. S. 1955. Why not areca growers also grow green manure? *Arecanut Bulletin.* 6: 196–197.

BOPAIAH, B. M. and BHAT, N. T. 1981. Effect of continuous application of manures and fertilisers on rhizosphere microflora in arecanut palm. *Plant and Soil.* 63: 497–499.

IYENGER, B. N. 1954. Manuring of the areca palm. *Arecanut Bulletin.* 5: 162–166.

JOHN, T. J. 1952. Green manure for arecanut plantation. *ICAC Monthly Bulletin.* 3: 1–4.

KHADILKAR, V. B., BADHE, N. N. and PANDYA, H. A. 1964. Physico-chemical studies in the coastal and hilly soils under arecanut palm of the Bombay–Deccan. *Arecanut J.* 15: 7–13.

KRISHNAPPA, K. T. 1962. Growing green manure and cover crops in arecanut gardens in the *Malnad* tract. *Arecanut J.* **13**: 129–131.

MOHAPATRA, A. R. 1977. Soil fertility research in arecanut: A review. *J. Plant. Crops.* **5**: 114–120.

NAIDU, G. V. B. 1962. Arecanut in Mysore. pp. 14–24. Information Series No. 7, Dept. Agric., Government of Mysore.

NAMBIAR, K. K. 1949. *A Survey of Arecanut Crop in Indian Union.* Indian Central Arecanut Committee, Calicut. pp. 74.

NAMBIAR, K. K. 1954. Possibilities of arecanut cultivation in the Andamans. *Arecanut Bulletin.* **5**: 65–67.