



Response of high yielding coconut variety and hybrids to fertilization under rainfed and irrigated conditions

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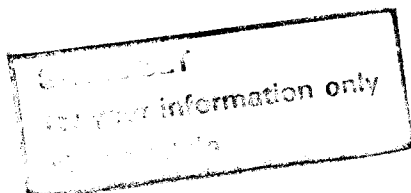
Abstract

A long-term experiment was conducted to study the differential fertilizer response of high yielding West Coast Tall variety, Chowghat Orange Dwarf (COD) × West Coast Tall (WCT) and WCT × COD hybrids of coconut for growth, nutrition, yield and economic returns under rainfed and irrigated conditions at Central Plantation Crops Research Institute, Kasaragod. The average yield for 8 years showed that the fertilizer treatment 1000 g N: 437g P: 1667g K palm⁻¹ yr⁻¹ (M₂) recorded significantly higher nut yield (136 nuts palm⁻¹ yr⁻¹) than M₁ treatment (500 g N: 218 g P: 833 g K palm⁻¹ yr⁻¹) and no fertilizer application (M₀). Amongst the variety/hybrids, the hybrid COD × WCT (128 nuts palm⁻¹ yr⁻¹) out yielded its reciprocal cross (114 nuts palm⁻¹ yr⁻¹) and WCT variety (115 nuts palm⁻¹ yr⁻¹). The growth parameters recorded did not show any significant difference in tree height and girth at base among the variety/hybrids. However, fertilizer application significantly increased the trunk height and girth at base. Annual application of fertilizers for a period of 32 years to coconut resulted in a marked increase in available phosphorus and potassium status in soil, but a marginal change in soil available nitrogen status was observed. Foliar contents of N remained below the critical levels of 1.8–2.0%. Phosphorus buildup in the soil due to fertilizers, did not reflect in the P contents of diagnostic leaf under both rainfed and irrigated conditions. Application of K fertilizer at M₁ level maintained K content of leaves at 1.07% i.e. just above the critical level (0.8–1.0%), whereas application of K fertilizers at M₂ level raised the leaf K content to 1.20%. The leaf nutrient contents did not vary much among variety/hybrids due to fertilizer application. The cost-benefit ratio was most favourable under fertilizer treatment M₁. For every rupee (Rs) invested on manuring, the total net return was Rs 2.80 under M₁ level and Rs 2.85 under M₂ level of fertilizers.

Introduction

Coconut palm produces fronds and nuts throughout the year and hence, demands continuous supply of nutrients from the soil (Khan, 1993). The annual nutrient export by various parts of the palm viz. nuts, fronds, trunk, bunch and spathe reported by different workers vary from 20 to 174 kg N, 2.5 to 20 kg P and 35 to 249 kg K ha⁻¹ (Ouverier & Ochs, 1978; Pillai, 1919; Pillai & Davis, 1963; Ramadasan & Lal, 1966), but there appears to be a general agreement on the ratio of N and K removed by the palms (1:1.44–1.75). Coconut varieties give differential yield response to

fertilizer application (John & Jacob, 1959) and that hybrid vigour observed in other crops is often associated with higher fertilizer requirements for realising increased yields. Hybrid palms (PB-121) require more N and P compared to West Coast tall (WCT) and utilise higher proportion of absorbed N (62%) and P (75%) for the production of more nuts (Khan, 1993). In WCT, N and P nutrients are utilized more or less equally in the production of nuts and growth. For both cultivars, the K removal through bunches is 78% of K uptake (Ouverier & Ochs, 1978; Pillai & Davis, 1963). An adult palm (West Coast Tall) producing 40 nuts and 12–13 fronds yr⁻¹ absorbed 321 g N, 69 g P and 406 g



K (Pillai & Davis, 1963). The general recommendation from Central Plantation Crops Research Institute for fertilizing the matured bearing palms is 500 g N, 140 g P and 1000 g K palm⁻¹ yr⁻¹, to be applied in two split doses viz. one-third in May–June and two-thirds in September–October (Nelliat, 1973). Murray & Smith (1952) reported from Trinidad that the response to nitrogen was inversely proportional to the pre-treatment bearing level of the palm i.e. the poor bearers show greater response to the application of nitrogen. Muliyar & Nelliat (1971) also found similar results. Application of NPK fertilizers to young hybrid palms of Chowghat Orange Dwarf (COD) × West Coast Tall (WCT) and its reciprocal cross and high yielding tall resulted in a significant increase in growth characters such as tree height, girth and annual leaf production and resulted in early flowering (Nelliat & Muliyar, 1971), and also significantly increased the leaf N and K contents from 1.40 and 0.46% of dry matter in the no fertilizer plot to 1.55 and 0.92% respectively in plots receiving the highest amount of fertilizers (1000 g N, 437 g P and 1667 g K palm⁻¹ yr⁻¹). However, leaf P content did not increase significantly (Kamladevi et al., 1974). Later, Khan et al. (1986) observed that high yielding WCT palms responded to high levels of fertilization (1000 g N + 437 g P + 1667 g K palm⁻¹ yr⁻¹), whereas only marginal yield improvement was observed in the hybrids, COD × WCT and its reciprocal cross. The aim of the study was to examine the effect of annual fertilizer application over longer periods on high yielding West Coast Tall variety, COD × WCT and WCT × COD hybrids of coconut growth, nutrition, yield and economic returns under rainfed and irrigated conditions.

Materials and methods

The field experiment was laid out in the year 1965 in a strip plot design (Gomez & Gomez, 1984) with three replications in the Research Farm of Central Plantation Crops Research Institute at Kasaragod. High yielding coconut variety viz. West Coast Tall (WCT) and hybrids viz. Chowghat Orange Dwarf × West Coast Tall (COD × WCT) and its reciprocal cross (WCT × COD) received three levels of fertilizers, M₀:No fertilizer; M₁: 500 g:218 g:833 g N, P and K palm⁻¹ yr⁻¹ and M₂: 1000 g:437 g:1667 g N, P and K palm⁻¹ yr⁻¹. The palms were planted at a distance of 7.5 M × 7.5 M in a square system. Each treatment consisted of a plot

size of six palms (337.5 m²), replicated thrice. The response of the palms to various fertilizer levels under rainfed conditions were studied from 1965 to 1984 and the results of which have been reported by Khan et al. (1986). In 1984–85, each treatment plot (six palms) was subdivided into rainfed and irrigated plots (three palms each) and response of the palms to these conditions was studied. The experimental site is located at about sea level and receives an annual rainfall of 3500 Mm. The soil is deep red sandy loam (*Arenic Paleustults*). The soil had pH 5.3, clay 22% and CEC 4.7 C molc kg⁻¹ soil. It contained 90, 5.2 and 41.5 Mg kg⁻¹ soil of available N, P and K, respectively, at 0–50 cm soil depth (Nelliat et al. 1978).

The N, P and K were applied in the form of urea, Mussoorie-phos and muriate of potash, respectively, in two splits viz. one-third (33%) in May–June (beginning of monsoon) and two-thirds (66%) in September–October (receding monsoon). Fertilizers were applied by being broadcast in circular basins of 1.8 M around the palm. In the irrigation treatment, palms were irrigated at 100% open pan evaporation (EO) through perfo-irrigation system upto 1990. From 1990 onwards, the palms were irrigated under a drip system with 32 lit palm⁻¹ d⁻¹ from November to May.

The yield data was recorded every month from all the palms and annual yield palm⁻¹ was computed. The yield from 1990–1991 after introduction of irrigation has been included in this paper. The growth observations such as height of trunk, girth of trunk at bottom, number of leaves on crown, leaf length, number of leaflets leaf⁻¹ and petiole length were recorded from two palms plot⁻¹ in 1997.

Soil and leaf samples were collected from two palms in each plot during May, 1996 prior to fertilizer application. Soil samples were taken from two opposite sides of the palm, from the circular basin at 1.0 M distance away from the bole, at two depths viz. 0–25 cm and 25–50 cm using a tube augur. The soil samples were air dried in the shade, ground to pass through a 2 Mm sieve and analysed for available nitrogen, phosphorus and potassium status. Available nitrogen in the soil was determined by alkaline permanganate method (Subbiah & Asija, 1956). The available phosphorus was estimated (Bray - 1) following the procedure outlined by Bray & Kurtz (1945) and Jackson (1973), and available potassium was determined in the 1N NH₄OAC (Hanway & Heidel, 1952) flame photometrically. The leaf samples were collected from index leaf (14th leaf) of the palm by using a specially designed knife, by cutting 4–5 leaflets from

Table 1. Growth parameters of various coconut cultivars and for fertilizer levels during 1998

Treatments	Height (m)	Girth* (cm)	No. of leaves on	Length of leaf (cm)	No of leaflets/leaf	Petiole length (cm)
Cultivars						
WCT	10.46	89.1	37	516.0	243	124.7
COD × WCT	9.73	86.0	38	515.9	234	122.2
WCT × COD	10.74	94.4	33	518.8	243	123.6
C.D at 5%	NS	NS	2.9	NS	NS	NS
Fertilizers						
M ₀	9.36	81.0	37	528.1	242	129.9
M ₁	10.77	97.1	35	509.6	236	121.6
M ₂	10.80	91.4	36	513.1	242	118.9
C.D at 5%	0.97	7.6	NS	NS	NS	NS

M₀ – No fertilizer.

M₁ – 500 g N + 218 g P + 833 g K.

M₂ – 1000 g N + 437 g P + 1667 g K.

* Girth was measured just above the ground level.

the middle of the frond on both the sides (Chapman, 1964). The leaf samples were washed with distilled water, oven dried at 65 °C for 72 h and powdered using a Tecator Cyclotec sample mill. The powdered fraction (0.5 Mm) of leaf sample was digested in HNO₃: HClO₄ (3:1) and analysed for phosphorus and potassium content (Jackson, 1973). The nitrogen content in the plant sample was estimated according to the modified Kjeldahl procedure as described by Jackson (1973) using Tecator Kjeltec Auto Analyser.

Results and discussion

Growth parameters

The data on growth parameters recorded during 1998 are presented in Table 1. Among the variety/hybrids, no significant differences were observed on height of the palm after 32 years. The hybrid, COD × WCT possessed 38 leaves on the crown compared to 37 (WCT) and 33 (WCT × COD hybrid). The other growth parameters such as girth at base, length of leaf, petiole length and number of leaflets leaf⁻¹ did not vary significantly among the variety/hybrids.

The application of fertilizers at M₁ level led to a significantly higher trunk height (10.8 M) and girth at base (97.1 cm) than control, M₀ (9.4 M height and 81.0 cm girth). However, at the M₂ level of fertilizers, no further increase in trunk height (10.8 M) and girth (91.4 cm) was observed. The other growth parameters of palm, such as number of leaves on crown, leaflets

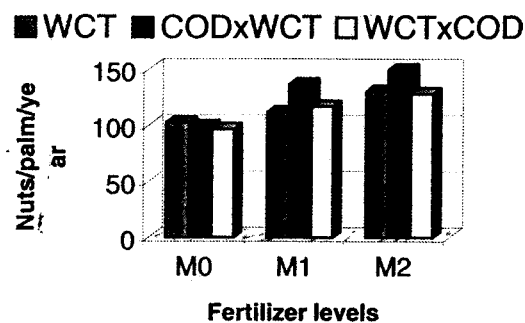


Figure 1. Mean coconut yield of eight years (nuts palm⁻¹ yr⁻¹) as influenced by fertilizer levels in variety/hybrids. (M₀: No fertilizer; M₁: 500 g N:218 g P:833 g K and M₂: 1000 g N:437 g P:1667 g K palm⁻¹ yr⁻¹) (n= 18, S.E.m ± 4.09, C.D (p=0.05) =12.27).

leaf⁻¹, leaf length and petiole length, did not differ significantly on fertilization. Nelliät & Muliyar (1971) found that application of NPK fertilizers at highest level (1000 g:437 g:1667 g N, P and K palm⁻¹ yr⁻¹) significantly increased girth, annual leaf production and height of 6 year old young palms of high yielding variety and hybrids. But in the present study, the response of adult palms was noticed only on the height of tree and girth at base in M₁ level. This is mainly due to the fact that the M₁ level of NPK fertilizers adopted in this study (500 g:218 g:833 g N, P and K palm⁻¹ yr⁻¹) is comparable to the N, P and K dose suggested for the optimum growth of palms (Nelliät, 1973). Thus, the growth response of the additional dose of NPK fertilizers (M₂) was not noticed. Though fertilizer application has resulted in improved growth

parameters and precocity in flowering (Nelliath & Muliyaar, 1971) and improved carbohydrate reserves and precocity in flowering in young palms (Ramadasan & Mathew, 1977), the yield response observed due to differential fertilizer treatments did not give a good correlations with growth parameters in the later years.

Nut yield of palms

The yield of palms as influenced by variety, fertilizer levels and rainfed/irrigation are presented in Figures 1 and 2. The yield of palms for M₁ treatment was significantly higher than the M₀ treatment in all the years except during 1997–98. In the M₀ treatment, the nut yield ranged between 82 and 118 nuts palm⁻¹ yr⁻¹ for all the three cultivars, whereas with the application of fertilizers (M₁), it ranged from 112 to 152 nuts palm⁻¹ yr⁻¹. In two consecutive years, 1996–97 and 1997–98, the yield recorded in M₂ treatment was significantly higher (145 and 133 nuts palm⁻¹ yr⁻¹, respectively) than M₁ (122 and 114 nuts palm⁻¹ yr⁻¹, respectively) and M₀ (103 and 106 nuts palm⁻¹ yr⁻¹, respectively) treatments. The average nut yield for eight years (1990–91 to 1997–98) was significantly higher in M₂ (136 nuts palm⁻¹ yr⁻¹) than M₁ (122 nuts palm⁻¹ yr⁻¹) and M₀ (99 nuts palm⁻¹ yr⁻¹).

The hybrid COD × WCT significantly out yielded its reciprocal cross, WCT × COD and the variety WCT during 1992–93, 1993–94, 1995–96 and also when average of 8 years was considered. WCT performed better in this experiment even without fertilizer application (102 nuts palm⁻¹ yr⁻¹), while heterosis vigour in yield expression was apparent with hybrids with improved nutrition (Figure 1). The previous results (Khan et al., 1986) from the same experiment (1972–83) revealed that M₁ dose of fertilizer doubled the yields of COD × WCT palms and increased the yield of WCT × COD hybrid three times over M₀. However, in M₂ treatment, the coconut hybrids did not respond favourably (Khan et al., 1986).

The response of hybrid palms to applied nutrients was high with irrigation. In 1996–97, COD × WCT (182 nuts palm⁻¹ yr⁻¹) and WCT × COD (158 nuts palm⁻¹ yr⁻¹) gave significantly higher yield with M₂ under irrigation than other treatments. Similarly, the average yield for 8 years was highest in COD × WCT hybrid (158 nuts palm⁻¹ yr⁻¹) at M₂ under irrigation (Figure 2), followed by WCT × COD (146 nuts palm⁻¹ yr⁻¹). However, yield difference between irrigation and rainfed treatments in WCT variety was small (125–135 nuts palm⁻¹ yr⁻¹). The mean nut

yield of cultivars and fertilizer levels under irrigation was 127 nuts palm⁻¹ yr⁻¹ as compared to 110 nuts palm⁻¹ yr⁻¹ under rainfed condition indicating the advantages of fertilizer application to palms. The palms gave 28% increase in nut yield on irrigation over the average nut yield obtained for 8 years under rainfed with no fertilizer (110 nuts palm⁻¹ yr⁻¹). Under irrigation, 6% (7 nuts palm⁻¹ yr⁻¹) and 17% (21 nuts palm⁻¹ yr⁻¹) increase in nut yield was observed over rainfed at M₁ and M₂ fertilizer levels, respectively.

Soil and leaf nutrient contents

The available soil nutrient status of pre-experimental soil samples analysed contained 90 Mg N, 5.2 Mg P and 41.5 Mg K kg⁻¹ soil at 0–50 cm soil depth under rainfed condition (Nelliath et al., 1978). In the M₀ treatment, where fertilizers were not applied for 32 years, no appreciable change in available N was observed (94 Mg N kg⁻¹ soil) compared to initial values of 90 Mg N kg⁻¹ soil. However, available P values increased from 5.2 Mg P kg⁻¹ soil to 31 Mg P kg⁻¹ soil and available K from 41.5 Mg K kg⁻¹ soil to 66 Mg K kg⁻¹ soil during the period probably due to intense root activity by palms in the soil sampling zone. The number of roots on the bole of a 45 year old palm in sandy loam soil of West Coast of India has been reported to be about 6855 (Patel, 1938), whereas in the Philippines the number varied from 4000 to 7000 (Copeland, 1931). Coconut root system is adventitious and the size of roots varies from 0.8 to 1.0 cm diameter. The main roots may bear branches and both of these have numerous fine branches 1–2 mm in diameter. These branch roots are short lived and are replaced frequently (Menon and Pandalai, 1960; Patel, 1938). Thus, adding lot of root organic biomass to the soil in the basin area. On surface area basis, the area occupied by the palm is 56.25 M² (7.5 × 7.5 M); and the area of active root zone is 12.57 M² (where $r = 1.8$ m) (Nair, 1979). However, nearly 20% of coconut roots goes beyond the basin (Anil Kumar & Wahid, 1988) and scavenge in the adjoining treatment palm basins. This may lead to significant formation of soil organic matter during active root tissue without the intervention of soil microfauna, and which upon decomposition may add substantial quantity of nutrients to the soil. Secondly, when the older leaves begin to senesce, the K that is not translocated to economic produce is water-soluble and subject to elution by rainfall and this is deposited on the soil surface. In the studies by Khanna & Nair (1977) on coconut-cocoa system, 151 kg K ha⁻¹ is

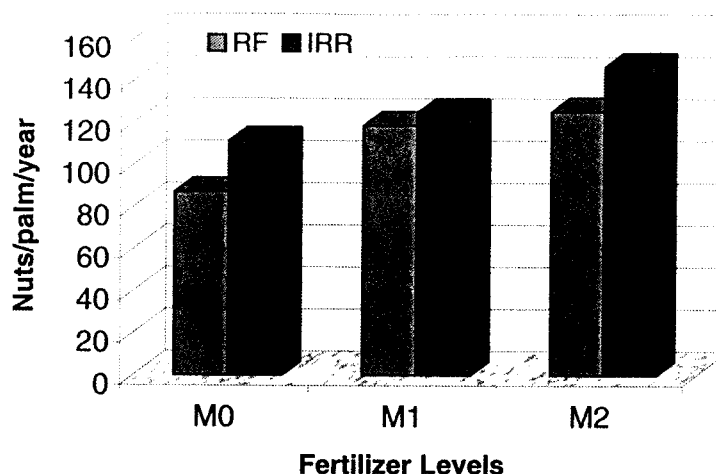


Figure 2. Mean coconut yield of 8 years (nuts palm⁻¹ yr⁻¹) as influenced by fertilizers under rainfed (RF) and irrigated (IRR) conditions (M₀: No fertilizer; M₁: 500 g N:218 g P:833 g K and M₂: 1000 g N:437 g P:1667 g K palm⁻¹ yr⁻¹) (n= 9, S.Em± 6.56, C.D (p=0.05) =NS).

Table 2. Available soil nutrient status in different depths in coconut basins as influenced by cultivars and fertilizer levels under rainfed (RF) and irrigated (IRR.) conditions during 1998

	mg N kg ⁻¹ *				mg P kg ⁻¹ *				mg K kg ⁻¹ *			
	0-25 cm		25-50 cm		0-25 cm		25-50 cm		0-25 cm		25-50 cm	
	R.F.	IRR.	R.F.	IRR.	R.F.	IRR.	R.F.	IRR.	R.F.	IRR.	R.F.	IRR.
Cultivars												
WCT	88	95	97	93	222	210	216	233	215	124	158	74
COD × WCT	88	92	89	99	218	216	194	197	195	177	144	97
WCT × COD	91	87	91	87	213	190	213	178	176	100	153	64
C.D. (p = 0.05)	NS		NS		NS		NS		NS		NS	
Fertilizer levels												
M ₀	94	96	93	97	36	31	26	20	66	79	66	38
M ₁	77	88	91	91	253	226	227	212	202	110	153	69
M ₂	95	91	93	91	363	359	370	375	318	212	235	129
Mean	89	91	92	93	217	205	208	202	195	134	151	79
C.D. (p = 0.05)	NS		NS		49.5		49.6		73.7		50.4	

* air dried soil.

washed out from the coconut canopy and adds to the soil nutrient pool.

Cumulative amount of nutrients applied during 32 years was 2832 kg N, 1235 kg P, 4719 kg K ha⁻¹ at M₁ level and 5664 kg N, 2474 kg P, 9441 kg K ha⁻¹ at M₂ level of fertilizers. Despite a marginal increase in available N in the soil due to fertilizer application (Table 2), N application nevertheless increased leaf N contents under rainfed condition (Table 3). These findings are in conformity with Kamaladevi et al. (1974) and Khan et al. (1986). Later, it was suggested by Cecil & Khan (1993) that soil available N of 80 Mg/kg

is sufficient to maintain optimum nutrition for palms in this soil type. The N content of diagnostic leaf was 1.57%, 1.60% and 1.65% in M₀, M₁ and M₂ treatments, respectively, under rainfed condition. However, under irrigation, it was 1.58%, 1.50% and 1.57% in M₀, M₁ and M₂ treatments, respectively. Interestingly, long-term application of N did not raise the foliar N content to that of critical levels of 1.8–2.0% proposed by Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement (CIRAD) (Manciot et al., 1979a). Thus, critical levels for N in

Table 3. Nutrient concentration of diagnostic leaf (frond 14) of different coconut cultivars receiving fertilizer levels (M_0 , M_1 and M_2) and under rainfed(RF) and irrigated (IRR.) conditions during 1998

Cultivars	Fert. Levels	Leaf N (%)		Leaf P (%)		Leaf K (%)	
		RF	IRR.	RF	IRR.	RF	IRR.
WCT	M_0	1.58	1.63	0.12	0.12	1.11	0.89
	M_1	1.68	1.50	0.11	0.11	1.30	1.04
	M_2	1.74	1.59	0.12	0.11	1.24	1.21
	Mean	1.67	1.57	0.12	0.11	1.22	1.05
COD × WCT	M_0	1.54	1.51	0.12	0.12	0.97	0.72
	M_1	1.51	1.51	0.11	0.11	1.07	1.00
	M_2	1.73	1.62	0.13	0.13	1.26	1.19
	Mean	1.59	1.55	0.12	0.12	1.10	0.97
WCT × COD	M_0	1.48	1.59	0.11	0.12	1.12	1.11
	M_1	1.58	1.49	0.11	0.11	1.05	1.15
	M_2	1.60	1.49	0.11	0.11	1.26	1.20
	Mean	1.55	1.52	0.11	0.11	1.14	1.15
Mean	M_0	1.57	1.58	0.12	0.12	1.07	0.90
	M_1	1.60	1.50	0.11	0.11	1.14	1.07
	M_2	1.65	1.57	0.12	0.11	1.25	1.20
	Mean	1.60	1.55	0.12	0.11	1.15	1.06
Cultivars		C.D. ($p=0.05$)		NS	NS	NS	NS
Fertilizers		C.D. ($p=0.05$)		NS	NS	0.142	
Interaction		C.D. ($p=0.05$)		NS	NS	NS	

Table 4. Additional costs and returns for the different fertilizer levels

Treatments	Additional cost over M_0 (Rs palm ⁻¹ yr ⁻¹)	Additional yield over M_0 (nuts palm ⁻¹ yr ⁻¹)	Additional net returns over M_0		Benefit:Cost ratio (Rs Rupee ⁻¹)
			(Rs palm ⁻¹ yr ⁻¹)	(Rs ha ⁻¹ year ⁻¹)	
M_1	24.2	23	67.8	11,526	1:2.8
M_2	38.4	37	109.6	18,632	1:2.85

Current price of coconut-Rs 4 nut⁻¹.

Cost of fertilizers: Urea-Rs 3.6 kg⁻¹, Musooriephos-Rs 1.925 kg⁻¹, Muriate of Potash-Rs 3.7 kg⁻¹.

Application charges-Rs 10palm⁻¹ yr⁻¹.

coconut established elsewhere (Manciot et al., 1979a) may have to be reassessed for Kerala conditions.

The available P content of the soil was significantly influenced by fertilizer application. The mean soil available P content was 36 Mg kg⁻¹ of air dry

soil in M_0 plot, 253 Mg kg⁻¹ of air dry soil in M_1 and 363 Mg kg⁻¹ of air dry soil in M_2 treatments. However, the build up of soil available P did not change foliar P levels which remained close to or below the critical levels of 0.12% proposed by Manciot et al.

(1979a). This long-term fertilizer effect for 32 years lends support to the earlier observations of Nelliath et al. (1982) and Khan et al. (1992). This suggests the need to decrease the P application rates to palms under Kerala conditions. Studies by Khan et al. (1992) had indicated that soil test values of 20 Mg kg⁻¹ of air dry soil available P is sufficient to maintain the P nutrition of coconut.

The available soil potassium content was 66 Mg kg⁻¹ of air dry soil in M₀ plot under rainfed condition, which increased, to 202 Mg kg⁻¹ of air dry soil and 318 Mg kg⁻¹ of air dry soil with M₁ and M₂ levels of fertilizer application at 0–25 cm soil depth. Under irrigation, a reduction in soil available K was observed in M₁ and M₂ plots. Application of potassic fertilizers raised the leaf K levels to 1.14% (M₁) and 1.25% (M₂) compared to 1.07% in M₀ under rainfed condition. Under irrigation, leaf K content was 1.07% under M₁ and 1.20% under M₂ compared to 0.90% under M₀. Application of K fertilizer at M₁ level was found to maintain K content of leaves above critical level (0.8–1.0%).

Available N, P and K status of the soil did not vary significantly due to variety/hybrids in both the depths. The leaf nutrient contents also did not vary much in variety or hybrid on fertilizer application (Table 3).

Economics

Application of fertilizers at M₁ (500:218:833 g NPK palm⁻¹ yr⁻¹) and M₂ (1000:437:1667 g NPK palm⁻¹ yr⁻¹) levels incurred an additional cost of Indian Rupees (Rs) 24.20 and Rs 38.40 palm⁻¹ yr⁻¹ towards the cost of fertilizers and field application charges (Table 4). The additional net return was Rs 67.8 palm⁻¹ yr⁻¹ (Rs 11,526 ha⁻¹ year⁻¹) at M₁ level and Rs 109.6 palm⁻¹ yr⁻¹ (Rs.18,632 ha⁻¹ year⁻¹) at M₂ level, which was three times the additional cost of both the levels of fertilizers. The cost-benefit ratio was most favourable for the fertilizer treatments. For every rupee invested on manuring, the total net return was Rs 2.80 in M₁ level and Rs 2.85 in M₂ level of fertilizers. This clearly indicates the economic advantage of manuring coconut at M₁ and M₂ level of fertilizer application.

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