

NUTRIENT UPTAKE PATTERN IN COCOA

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Introduction

Cocoa, being an introduced crop into the subcontinent, received an appreciable attention from both research and farming community due to its compatibility as an intercrop in arecanut and coconut gardens. Cocoa is grown under wide climatic and soil conditions. Sustainability of the crop depends upon the nutrient uptake and utilization in the growing environment.

Climate

Majority of the cocoa area is in the humid tropics where the climate shows relatively little variation throughout the year, especially in terms of temperature, solar radiation and day length. In India the climatic conditions suited for cocoa cultivation were found to be under palms in Southern India (Lass and Wood, 1971; Shama Bhat and Bavappa, 1972). The climatic conditions are different in these regions, with well-distributed rainfall in Southern Kerala compared with long dry spells during summer months in Northern Kerala and coastal Karnataka. The drought intensity is more pronounced in northern regions of Kerala and coastal Karnataka extending upto 5-6 months subjecting plants to severe stress especially when they are grown as intercrop in rainfed coconut gardens. However, the situation is slightly better in arecanut gardens, which are irrigated. But non-availability of water towards end of summer exposes the plants to stress. Two dissimilar crop patterns are observed under rainfed and irrigated conditions (Alvim, 1976).

Soil

Soil is the storehouse of nutrients to grow any crop. It supports the plants and provides water, air and nutrients to the plants. It is essential that the soil should be suitable for the crop being grown on that (Smyth, 1975). A study of soil factors in adjacent high-yielding (990 kg/ha) and low-yielding (335 kg/ha) areas showed that conditions known to affect root development, such as soil resistance (shear strength) and clay content (reduced aeration), were the most important factors limiting yield in areas of lower productivity (Cadima and Alvim, 1973). The high clay content reduces the suitability of soil. The slope did not affect soil suitability but steeper the slope lower was the efficiency of N and K fertilization and higher the possibility of erosion (Hardjono, 1986). The ideal soil for cocoa should have a depth-1.5 m, organic matter-3.5%, C/N ratio->9, Base exchange capacity->12 me/100g soil, base saturation->35%.

Biomass production and nutrient content in different parts

Cocoa is a tropical tree and it produces leaves throughout the year. The biomass production varies with age and growing conditions. Cocoa normally produces 14 kg leaf (including pruned biomass), 4 kg pod husk and 2 kg beans per year on dry weight basis. This comes to about 9.1 t leaf, 2.6 t pod husk and 1.3 t beans per hectare. The nutrient analyses of different parts of cocoa plants have shown that leaf and bean have higher N percentage compared to pod husk (Table 1). However, the pod husk has higher K content compared to leaf and bean.

Table 1. Nutrient content in different parts of cocoa

Parts	N (%)	P(%)	K(%)
Leaf	2.73	0.10	1.70
Pod husk	1.09	0.09	4.11
Bean	2.66	0.39	1.34

Nutrition

Nutrient requirement of cocoa depends upon the type of soil it is being grown and the cultivation practices being followed. So the nutrient application varies with different cocoa growing countries. The nutrient management is different in different countries. In general, the nutrient application is made based on analysis of soil or plant or both. In Malaysia, the fertilizer requirement of cocoa was found to be 200 kg N, 25 kg P, 300 kg K and 140 kg Ca per one ha (Thong and Ng, 1978). The results of the fertilizer experiments conducted in Nigeria revealed that the annual fertilizer rates for cocoa are 120-204 kg/ha N, 30-60 kg/ha P, 67 kg/ha K and 6 g B/tree (Ojeniyi, 1982). In Southern Bahia, Brazil the cocoa yield was highest with N, P₂O₅ and K₂O, at 90:90:90 kg/ha (Cabala *et al.*, 1982), whereas on soils of Amazonia, (Yellow Latosols) annual application of 60 kg/ha of N, P₂O₅ and K₂O was found optimum (Morais, 1988). The fertilizer dose for cocoa based on trials conducted in different countries is summarized in Table 2.

Table 2. Fertilizer recommendation for cocoa during bearing stage

Country	Fertilizer				Dosage	References
	N	P ₂ O ₅	K ₂ O	Mg O		
Sarawak	27.3	27.3	38.5	4.5	g/tree	Ebon <i>et al.</i> , 1978
Nigeria	120-204	30-60	67	-	kg/ha	Ojeniyi, 1982
Brazil	50-100	25	85	15	kg/ha	Hardy, 1960
Malaysia	200	25	300	70	kg/ha	Thong and Ng, 1978
India	100	40	140	-	g/tree	Shama Bhat, 1988

The nutrient removal by the crop also makes the basis of fertilizer application to cocoa. Nutrient removal by cocoa in different countries is given in Table 3. In India, the quantities of N, P and K removed by cocoa pods per kg of dry beans was 48.4, 5.7 and 95.6 g, respectively. For a crop yielding about 2 kg of dry beans per plant (about 60 pods) per year, the average crop removal by pods would be around 96.8, 11.4 and 191.2 g each of N, P₂O₅ and K₂O. One cocoa tree removes 479 g N, 36 g P and 429 g K per year which includes nutrients removed through leaves, pod husk and beans (Table 4).

Table 3. Nutrients (kg) removed in a crop of 1000 kg dry beans

Country	Type of cocoa	N	P	K	Ca	Mg
Nigeria	Amazon	39.8	6.3	85.6	-	-
Nigeria	Amelonado	38.3	5.7	76.9	-	-
Cameroon	Trinitario	34.2	6.3	72.6	8.2	6.8
W. Malaysia	Amazon	31.0	4.9	53.8	4.9	5.2

Table 4. Nutrient removal from cocoa

Nutrient	Nutrient exported through 1000 kg dry beans	Nutrient removal at yield level of 2 kg dry beans/tree	
		per tree	per hectare (650 trees)
N	48.4 kg	479 g	311 kg
P	5.7 kg	36 g	23.4 kg
K	95.6 kg	429 g	279 kg

Conclusion

Cocoa extracts large quantity of nutrients from soil. The application of nutrients should match the removal for optimum yields. The present application rate might not be sufficient in long run.

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