K NUTRITION OF PLANTATION CROPS— A REVIEW OF WORK DONE IN INDIA

E.V. NELLIAT

Central Plantation Crops Research Institute, Kasaragod 670124, Kerala:

ABSTRACT

Potash is the nutrient element most consumed by plantation crops. Although response to K differs widely among crops, it generally improves the yield and quality of the products.

Potash deficiency symptoms in various plantation crops are reviewed. In coconut, potassium deficiency leads to chlorosis, leaf scorch and development of poor crown with short fronds. In arecanut, the deficiency symptoms consist of dead tissues around the leaf margin and between the veins of leaves. In cardamom, potassium deficiency results in the browning of leaves and reducing sucker production. In rubber, the characteristic symptom is the development of marginal and tip chlorosis in leaves. In tea, K deficiency leads to defoliation and debility. In coffee, a striking leaf tip and leaf edge blackening develops.

The requirements of coconut, tea, coffee and rubber for potassium range from 220 to 300 kg K_2O per hectare. In coconut adequate K nutrition reduces the pre-bearing age and increase the fruit set, husk weight and nut size. Copra out-turn per palm increases by over 20%. Potash fertilization to cashew and arecanut enhances the fruit set and nut weight. In coffee and tea, K nutrition helps in the development of a strong frame. Little information is available on plantation crops other than coconut, rubber, tea and coffee.

INTRODUCTION

Plantation crops are a group of commercial crops of perennial nature.

They are cultivated extensively in the tropics and the sub-tropics and demand employment of labour throughout the year. The produce of these crops had entered the international trade long before the food grains. Although area under these crops is a mere fraction of the world's cultivated area, their impact on the economy of the concerned region or the country is immense. In India, plantation crops occupy less than 2% of the cultivated area but account for 75% of our export earnings from agricultural commodities and 25% of our earnings from all exports[1]. The statistics on area, production, export and import of the major plantation crops are given in Table 1.

A plantation crop occupies the land for decades. Balanced fertilisation commensurate with the crop need and the soil's capacity to supply nutrients, is essential for maintaining a high level of production. It should fully meet the twin requirements viz., replenish the amount of nutrients removed in crop harvests from time to time, and supply enough for the normal growth and physiological functions of the plant. An imbalance in the nutritional status of the crop may be disastrous.

The plantation crops, in general, are heavy potassium feeders and potassium nutrition is a major limiting factor in their produotivity. Accordingly, fertiliser recommendations for many of these crops have N : K ratio of 1 : 2. Sufficient information on the economic optima of their nutritional requirements is, however, not available for different agro-climatic regions. The available literature and experimental data on the response of major plantation crops to potassium are reviewed and assessed in this paper.

COCONUT (COCOS NUCIFERA)

Coconut is grown on soil types ranging from littoral sand to heavy clay and pH ranging from 3.5 to 8.9[2]. Most of these soils are low in available nutrients. Coconut is known to be a potash loving plant on account of the abundance of potassium in all parts of the palm, especially the growing portion[3]. The critical levels of N and K, on dry matter basis, in the standard coconut leaf are 1.8—2.0% and 0.8—1.0% respectively. The nutrient content of the leaves of young coconut palms under NPK fertiliser experiment at CPCRI Kasaragod[4] are presented in Table 2.

The potassium deficiency symptoms in the initial stages of crop growth are drying up of the leaf tips and development of scattered olive green spots, starting from leaf tips. The spots increase in size and later turn

TABLE 1: **Plantation Crops in India—Area, production, exports and imports**

Crop	Area ('000ha)	Production ('000 tonnes)	Average yield (kg/ha)	Export (Million Rs.)	Import	Leading states and their share in area	India (%) of
Tea	361·4	487·4	1360	1530·9	Nil	Assam	51·8
						West Bengal	24·4
						Kerala	10·1
Coffee	156·1	92·5	590	584·0	Nil	Karnataka	59·2
						Kerala	23·6
						Tamil Nadu	16·2
Rubber	225·0	138·0	760	Nil	Nil	Kerala	86·2
						Tamil Nadu	5·0
						Karnataka	2·6
Coconut	1115·5	5961·3 (million nuts)	5344 (Nuts/ha)	177·1	2·7	Kerala	62·4
						Tamil Nadu	16·6
						Karnataka	12·7
Arecanut	187·4	169·4	904	5·3	Nil	Karnataka	42·44
						Kerala	33·8
						Assam	18·9
Cashewnut	418·1	184·7	442	1196·2	366·0	Kerala	63·8
						Karnataka	18·1
						Andhra Pradesh	6·9
Cacao	3·6	—	—	4·6	3·8	Kerala	54·1
						Karnataka	37·5
						Tamil Nadu	7·0
Cardamom	91·5	1·9	32	133·2	Nil	Kerala	70·7
						Karnataka	19·0
						Tamil Nadu	10·3
Pepper	121·7	28·2	231	344·8	Nil	Kerala	96·5

Source: K.V.A. Bavappa[1].

TABLE 2: Nutrient content of the leaves of young coconut palms under NPK fertiliser experiment at CPCRI, Kasaragod

N		P_2O_5		K_2O	
Treatment	% Content	Treatment	% Content	Treatment	% Content
500 g	1·60	500 g	0·10	750	0·55
750 g	1·70	1000 g	0·11	1500	0·80
1000 g	1·80	1500 g	0·13	2250	0·90

Source: CPCRI, Kasaragod[4].

reddish brown. In a case of acute deficiency, the entire leaf turns orange yellow in colour and the leaflets start drying up from the tip. The frond size gets reduced.

Pillai and Davis[5] estimated the annual removal of nutrients by middle aged bearing palms of low yield group (25 nuts/palm) at 55 kg N, 27 kg P and 84 kg K/ha. The nutrient removal by palms yielding around 60 nuts works out to 720g N, 330 g P_2O_5 and 1080 g K_2O/palm/year.

Seedlings, produced from seednuts collected from palms manured with K, displayed better vigour and growth than those obtained from unmanured palms[6]. It has been reported that in the palms well supplied with K, the first fruits were observed 5 years after planting, while it took 8 years to fruit for the palms that did not receive K[7]. In the NPK factorial experiment on the Tall variety, in sandy loam soil at CPCRI, Kasaragod, the palms to flower first were those that received 1 kg N and 1.5 kg K_2O/palm/year. Palms which suffered from K deficiency during the prebearing period remained on an average 15% less productive than those that never suffered.

In the fertiliser demonstration trials, conducted all over the west coast of India, John and Jacob[8] observed that an application of 0.34 kg N+0.34 kg P_2O_5+0.68 kg K_2O/palm/year resulted in an increase of 35% in nut production and 44% in copra production over the cultivators' practice. Where they failed to obtain response to this application, significant yield increase was recorded when the amount of K_2O was raised to 0.90 kg/palm. Muliyar and Nelliat[9] observed yield response to potassium applica-

tion from the fifth year onwards in a 3^3NPK experiment conducted at CPCRI, Kasaragod on middle aged palms in a sandy loam soil. They also found that for palms yielding less than 60 nuts annually, the optimum amount of N application ranged between 0.40 and 0.65 kg and that of potassium ranged between 0.89 and 1.21 kg/year/palm. From the results of a field experiment, with two amounts each of N, P and K, Marar and Pandalai[10] concluded that the responses to N and K were equal and additive.

Muliyar and Nelliat[9] reported that nitrogen adversely affected the nut characters, viz., weight and volume of nut and copra weight per nut and that these characters were markedly improved by K nutrition. Although N application increased nut production by 16% the copra out-turn per palm increased only by 6%, because of the adverse effects. Potassium application increased nut production by 12% and copra out-turn per palm by 22%.

The amount of fertilisers recommended for the ordinary tall variety of coconut is 500 g N+320 g P_2O_5 +1200 g K_2O and that for high yielding genotypes 1000 g N+500 g P_2O_5 +1500 g K_2O/palm/year. This works out to 210 kg and 262 kg K_2O/ha/year.

ARECANUT (ARECA CATECHU)

Arecanuts grow well on laterite soils of west coast, red loams of Mettupalayam (Tamil Nadu) and alluvial soils of West Bengal and Assam. The laterite soils which have the largest area under the crop, are slightly acidic and low in general fertility[11]. The soils are low to medium in K.

Deficiency of K causes the leaves to become rough and puckered[12]. The leaf margins curl downwards. Dead tissues occurring around the margins and between leaf veins are a sure indication of K deficiency.

It is estimated that bearing arecanut palms remove 67-90 kg N, 22-34 kg P_2O_5 and 67 to 90 kg K_2O/ha/year[13].

Lakshmanachar *et al*[14] reported the results of simple manurial trials conducted in cultivators' gardens. The fertiliser amounts were 57 and 113 kg N, 45 and 91 kg P_2O_5 and 85 and 170 kg K_2O/ha/year. The treatments found economical were 170 kg K_2O/ha for the sub-montane areas and 85.0 kg K_2O/ha for the coastal regions with 57 kg N + 45 kg P_2O_5 for both regions. A 3^4 factorial experiment to determine the fertiliser requirement of

arecanut is in progress at 5 centres under the CPCRI. The amounts of potassium being tried are 0, 140 and 280 g/palm/year. The results show that application of potash significantly reduces leaf fall and increases the weight of nuts[15].

The amounts of fertilisers recommended for arecanut are 100 g N, 40 g P_2O_5 and 140 g K_2O/palm/year. This works out to 175 kg K_2O/ha.

RUBBER (HEVEA BRASILIENSIS)

Rubber thrives in well-drained fertile loamy soils. A tonne of dry latex removes 6-8.7 kg N, 1.7-2.7 kg P_2O_5 and 5.7 to 8.4 kg K_2O from the soil.

The first symptom of K deficiency in rubber plant is the mild diffused marginal paleness of the lamina. Subsequently, the marginal border becomes yellower and the mottled areas coalesce and become necrotic, at first near the tip of the leaf. In the young trees the symptoms occur in the lower canopy, while in the older trees these are observed in the upper canopy. Reduction in leaf size and bark thickness follow.

The critical level of K in the leaves ranges between 1.0 and 1.5% on drymatter basis, the leaves exposed to the sun have lower K content than that in the leaves under shade. Potassium has a marked antagonistic effect on Ca and Mg; excess K in the soil causes Mg deficiency.

Application of potassium in amounts of 50 and 100 kg/ha increases the latex yield. The increase is more marked with the larger amount and is more persistent. In a long term experiment, du Plessix *et al*[16] found that trees grown without potash fertilisation took 4 and 7 years to attain critical level of leaf K when fertilised at the rate of 300 and 150 g K_2O/tree/year respectively. They also found that the K fertilised trees yielded 19 and 18% more latex than those not receiving K fertiliser.

The use of stimulants like ethrel necessitates the application of adequate quantities of potash to ensure sustained and satisfactory flow of latex. This is because of the higher nutrient content in the latex under stimulation (Table 3). The response to stimulants was absent when K fertilisation was not practised[16]. The latex flow increased with increasing amounts of Potash and the latex flow reduced drastically after 3 years of stopping K fertilisation.

TABLE 3: Nutrient removal by the rubber latex with and without stimulation

Treatment	Yield	Nutrient removal		
		N	P_2O_5	K_2O
			(kg/ha)	
No stimulation	1390	9·4	5·3	10·0
Ethrel	2570	23·9	16·5	26·8

Potty *et al.*[17] found that the optimum requirement of NPK for seedling nursery was 500, 250 and 100 kg/ha N, P_2O_5 and K_2O respectively for obtaining maximum number of vigorous, healthy and buddable seedlings. On the basis of various field experiments they suggested a fertiliser schedule of 40 kg N, 40 kg P_2O_5 and 16 kg K_2O/ha for immature rubber and 30 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha for mature rubber.

TEA (THEA SINENSIS)

Tea grows on a wide variety of soils, ranging from the river alluvium of the Brahmaputra valley to the Bheel soils of the Kangra Valley and the laterite loams of South India. Although tea is known as calcifuge, it grows well on soils with pH ranging from 4 to 6.

Tea being a leaf crop, initially only N was felt necessary. However, the tea flush contains 4-5% N and 1.5 to 2.0% K. For every 1000 kg of processed tea, 160-200 kg N and 60-80 kg K_2O are removed from the soil. The estimated quantity of nutrients removed by an average tea crop is 91 kg N, 9 kg P_2O_5 and 40 kg K_2O/ha/year.

Potassium is now considered necessary to obtain sustained yield and preserve the health and vigour of the bush. It is the limiting element in the sustained productivity of tea bushes, especially under Indian conditions. Deficiency causes defoliation and debilitation of bushes. It helps to build up resistance to a number of fungal diseases. Potassium also enhances the flavour and taste of tea.

In the long term fertilizer experiments at Toklai Experimental Station, the tea yield started declining after 20-25 years[18]. The yield from plots receiving 135 kg N continuously for 30 years was lower by 268 kg/ha than

that from plots receiving 45 kg N. In the initial stages of the experiment 135 kg N/ha gave higher yields. When K fertilisation was super-imposed, the yield went up in proportion to the K applied. An application of 67 kg K_2O/ha restored the yield level in 135 kg N/ha plots to the same level as in 45 kg N/ha continuous applications plots.

Heavy use of N, which is essential for tea cultivation, and the low pH of soil result in the depletion of K[19]. The effect of K nutrition becomes dominant as the age of bushes advance. Ranganathan[20] estimated that the average N and K requirement of tea is 170-190 kg N and 100 kg K_2O/ha. He felt that there was a definite response to increasing amounts of K application in heavy rainfall areas up to 200 kg K_2O/ha.

COFFEE (COFFEA ARABICA)

Coffee prefers deep well drained soils, slightly acidic in reaction and rich in organic matter. The striking potash deficiency symptom is the blackening of the leaf tip and leaf edges. It also causes die back and often the whole branch dries up. The berries also develop brown colour.

Coffee, being a perennial crop, continuously produces berries and fresh wood for the succeeding crop. The crop requirement of K is high during the development of coffee berries and is maximum during their ripening. The nutrient removal by the berries in the two important cultivated varieties of coffee has been estimated at 34 kg N, 5 kg P_2O_5 and 45 kg K_2O/ha in arabica and 35 kg N, 7 kg P_2O_5 and 89 kg K_2O/ha in robusta. The nutrients required for building up of the framework are twice the quantity of nutrients removed by the berries. Iyengar and Awatramani[21] found that a mature coffee plant had 2.5% N, 0.25% P and 3% K on dry matter basis.

Mathew *et al.*[22] suggested that the most efficient proportion of N : K in terms of added fertilisers is 1 : 1 excepting in cases where the amount of available potash in the soil was low. The fertiliser recommendations for coffee are 160, 120, and 160 kg NPK/ha for arabica and 120, 90 and 120 kg NPK/ha for robusta.

CASHEW (ANACARDIUM OCCIDENTALE LINN.)

Cashew can grow on sandy soils, laterites and red loams but not on heavy clay soils. Its cultivation is generally confined to inferior land unsuitable for other more remunerative crops.

A cashew tree which yields 25 kg nuts, removes about 2.1 kg N, 0.6 kg P_2O_5 and 1.0 kg K_2O/year[4].

Manurial experiments carried out and in progress at the research centres have shown that bearing cashew trees in laterites and sanday soils respond significantly to balanced NPK fertilisation over a basal dressing of compost/ cattle manure[23]. NPK fertilisation increased the yield from 0.5 kg/tree to 4 kg/tree in 4 years in an established stand[24]. In a new plantation, application of 660 g N, 266 g P_2O_5 and 533 g K_2O/tree/year from the year of planting reduced the prebearing period and resulted in the sixth year in a mean yield of 5.68 kg nuts/tree. The mean dry weight per nut increased by 8 and 7 per cent by the application of N (600 g) and P (480 g) respectively, while potassium application @ 580 g K_2O/tree/year increased the weight per nut by 42%.

The amount of fertilisers generally recommended is 250 g N, 120 g P_2O_5 and 120 g K_2O/tree/year.

CARDAMOM (ELETTARIA CARDAMOM)

Cardamom, known as the "Queen of Spices", is grown on the Western ghats at elevations of 900 m above MSL. These soils are normally rich in organic matter and available K and Mg, but low to medium in available P. According to Aiyar[25], the pH of these soils ranges between 4.5-5.5 and the available K is about 12.5 mg/100 g of soil. The potash deficiency causes poor root and shoot growth and the production of suckers is adversely affected. Browning of leaf tip takes place and extends downwards. In acute cases, the whole leaf turns dark brown[26]. Since the production of new suckers ceases, the plant dies in about 6 to 8 weeks.

The nutrient removal by cardamom has been worked out to be 26 kg N, 4 kg P_2O_5 and 52 kg K_2O/year from a hectare of cardamom plantation. It has also been found that 1 kg cardamom capsules remove 122 g N, 14 g P_2O_5 and 200 g K_2O. The data clearly indicate that K requirement of cardamom is twice that of nitrogen.

Since cardamom produces suckers throughout the year and initiation of panicles and development of capsules continue for a period of 8-9 months, there is a steady utilisation of plant nutrients by the crop. Not much information is, however, available on the nutritional requirement of cardamom in general and potash in particular. Based on the information available thus far from the field experiments conducted at various centres,

the recommended dose of fertilisers is 30 g N, 10 g P_2O_5 and 60 g K_2O per clump per year. Considering the factors affecting the availability of nutrients in the soil, the Cardamom Research Station, Mudigere recommended a fertiliser dose of 75 kg N, 75 kg P_2O_5 and 150 kg K_2O/ha for a plantation yielding 100 kg dry capsules[27].

OIL PALM (EALIES GUINENSIS)

Oil palm is generally grown on well drained deep loamy soil, rich in humus. Potash deficiency causes development of orange spots on the pinnae of older leaves which later turn purple in colour. The pinnae become narrow with marginal and tip scorching. The dessicated and dried old leaves are retained erect on the crown.

The fertiliser recommendation is 1400 g K_2O/palm/year, the N:K ratio being 1:2. The critical concentration of K in the leaf tissue is 1.0-1.2 per cent on dry matter basis.

PEPPER (PIPER NIGRUM)

Pepper, the king of spices, thrives best in virgin humus rich soils. It is cultivated widely on red loams and sandy loams on the hill slopes of west coast. The recommended amount of fertilisers for the perennial vine is 200 g N and 60 g K_2O per standard.

EVALUATION

Although the need to apply balanced fertilisers to maintain optimum nutrient status of the soil and to obtain sustained high productivity in plantation crops is established, the acceptance by the farmers depends on the profitability of the practice. Available experimental evidences suggest N:K ratios ranging from 0.5 to 1.0. It is also known that the damages done to these perennial crops during the pre-productive stage by K deficiency may not be fully repaired by subsequent supply of adequate quantities of fertilisers[28]. There is a long time lag between the application of inputs and the receipt of returns through increased yields. For a fair evaluation of a practice and its economics the mean response of four years or more has to be considered because of the possible variation in response caused by seasonal conditions.

The distribution and consumption of K fertilisers in the different states during the past two years indicates an awareness among the farmers

about the importance of potassium nutrition of plantation crops. Whereas the statewise consumption ratio of N to K is 5.1 in the South Zone, it is 13.5 in the North and 11.0 in the Central Zone. Kerala which has the largest area under plantation crops with only 1.8 per cent of the country's cropped area, consumed in 1976-77, 1.4 per cent of the nitrogenous fertilisers and 6.3 per cent of the potash fertilisers on all-India basis. However, majority of the farmers still do not adopt the recommended fertiliser practices.

FUTURE LINE OF WORK

The exact role of potassium in the nutrition of plantation crops with a view to determine the economic optimum N:K ratio in different soils has to be studied in depth. Since plantation crops grow on a wide range of soil types, the mobility, fixation, losses and availability of potassium should be examined for different soils and climatic situations.

ACKNOWLEDGEMENT

Thanks are due to Dr. N.M. Nayar, Director, Central Plantation Crops Research Institute, Kasaragod for help and encouragement in preparation of the manuscript.

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