Nutrient Requirement for Natural Rubber

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The need to improve fertilizer application within the mature rubber plantations of Tripura, India is apparent given the importance of the crop and the poor fertility soils upon which it is grown. Field study suggests an application of 60 kg N and 60 kg P_2O_5/ha along with an insurance application of K increased rubber yield significantly. Fertilizer response curves and soil test-based fertilizer application rates suggest a general fertilizer recommendation of 45 kg N, 45 kg P_2O_5 and 40 kg K_2O/ha for mature rubber plantations.

Rubber is a crop of primary importance for Tripura, which has about 67,700 ha under cultivation. It is the second largest rubber-producing state after Kerala. Rubber yield is higher in Kerala, but quality is comparable between the two state's plantations. Tripura's production is challenged in the face of poor soil fertility status. The rubber-growing soils of these northeastern (NE) states of India are highly weathered, and the essential cations have been leached out of the soil profile due to high rainfall. A highly acidic soil environment with poor plant-available nutrient status prevails (Mandal et al., 2013). A majority of the plantations in Tripura are affected from past shifting cultivation practices where slash and burn techniques removed much of the organic residue and thus created low organic matter soil.

Studies highlight that rubber trees respond well to fertilizer, particularly in challenging scenarios where soils are nutrient poor (Singh et al., 2005). Balanced fertilizer recommendations during immature and mature periods of rubber tree production have been considered an important management option for optimal plantation growth and yield. Such recommendations were formulated by the Rubber Research Institute of India (RRII) based on various field experiments carried out in Kerala and other traditional rubber-growing tracts. However, there is a need to modify these recommendations for northeastern India, as the nutrient requirement for rubber is likely to be higher due to poorer soil fertility.

This article describes the fertility status of rubber soils of Tripura and common fertilizer recommendations prescribed to growers. Data on crop response to NPK combinations has led to a proposed revision to fertilizer use in mature rubber plantations of the region.

Table 1. Soil fertility status (0 to 30 cm depth) in rubber fields (n = 2,102) of Tripura.

Organic C (OC)					
Soil status	OC content in soil, %	No of samples	% Samples	Fertilizer N recommendation	Common application, kg N/ha
Low	0.5 to 0.75	726	35	Raise by 15 to 20%	42 to 45
Medium	0.75 to 1.5	1,284	61	Raise by 0 to 5%	35 to 38
High	>1.5	92	4	Lower by 5 to 10%	30 to 32
Available P (Bray-P2 extractable)					
Soil status	Avail. P, mg/100g	No of samples	% Samples	Fertilizer P recommendation	Common application, kg P_2O_5/ha
Low	<1	2,040	97	Raise by 15 to 20%	42 to 45
Medium	1 to 2.5	44	2.2	Raise by 0 to 5%	35 to 38
High	>2.5	18	0.8	Lower by 5 to 10%	30 to 32
Available K (Sodium acetate extractable)					
Soil status	Avail. K, mg/100g	No of samples	% Samples	Fertilizer K recommendation	Common application, kg K_2O/ha
Low	<5	1,150	55	Raise by 15 to 20%	40 to 45
Medium	5 to 12.5	876	42	Raise by 0 to 5%	35 to 38
High	>12.5	76	3	Lower by 5 to 10%	30 to 32

Soil Fertility Status

Historical soil sampling by RRII Tripura between 2003 and 2010 has collected about 2,100 samples from grower's fields across the state. Data from samples collected at 0 to 30-cm depth are provided in (**Table 1**).

Soil pH is predominantly acidic with values commonly varying from 3.9 to 5.9. About 35% of sampled soils had organic carbon (OC) values below critical values (<0.75%) and 61% of soils have medium status (0.75 to 1.5%). Soil organic carbon is a significant determinant for N recommendations and critical low OC values stress a need of maintaining N application rates at adequate levels.

In case of available P, 97% of soils are well below critical values. Available P varied from 0.01 to 5.2 mg/100 g, and the majority of soils fall under the very low-to-low category.

Available K concentrations range from 1.5 to 60 mg/100g. About 55% of the soils are low in available K and 42% show medium values. The soils of northeast India also contain relatively high amounts of exchangeable Mg, which can compete with plant K uptake (Singh et al., 2005). Moreover, K plays a significant role in rubber latex flow from the tree. Given this, optimum K application is especially important to consider.

Rubber Responses to Fertilizer

Two long-term field studies are used to illustrate the response of Tripura's rubber plantations to fertilization. The first study is an RRII experimental farm in Taranagar, with RRIM 600 clone trees established in 1980. Three levels of N (0, 30, 60 kg/ha), three levels of P_2O_5 (0, 30, 60 kg/ha), and three levels of K_2O (0, 20, 40 kg/ha) were used within 6 m x 6 m plots (**Table 2**). The plants were opened for tapping in 1988 when 70% of plants attained a mean trunk girth of 50 cm at 150-cm height. Yield of individual trees from the sixteen inner plants/plot were recorded, and the annual mean yield (gram/tree/tap) was calculated between 1991 and 2002. Fertilizer and yield response curves for N and P are provided in **Figures 1 and 2**.

Abbreviations and notes: N = nitrogen; P = phosphorus; K = potassium; Mg = magnesium; g/t/t = grams/tree/tapping; LSD = least significant difference.

The economic product of rubber is latex. Latex is collected by controlled wounding (tapping) of bark of the trees. The tree trunk shown, was divided into two panels and one part of the tree was tapped once in three days for five years, and then switch over to other panel. This type of tapping system is termed as the half spiral once in three days (notation is 1/2Sd/3). The mean annual tapping days is 70.

The second study was started in 1986 at Tulakona, Agartala with the RRIM 600 clone and six treatments (**Table 3**). The plants were opened for tapping during 1994 using a 1/2Sd/3 tapping system. Mean annual tapping days obtained from this trial was 68 and tree stand per ha was 400. Yield was recorded from individual trees between 1995 and 2000.

At Taranagar, a significant yield increase was attributable to N and P, but not to K (**Table 2**). Application of 60 kg N resulted in a significant increase to 41.2 g/t/t. Similarly, application of 60 kg P_2O_5 produced a significant increase to 38.7 g/t/t. Fertilizer response curves suggest a maximum of 47 kg N/ha and 53 kg P_2O_5/ha (**Figures 1 and 2**). A mean annual yield of 46.7 to 47.2 g/t/t, or 1,307 to 1,321 kg/ha (400 trees/ha x 70 tapping days), was obtained between 1991 and 2002. In comparison, average rubber yields in Tripura are 10 to 11% less (Anon, 2013).

At Tulakona, trees also responded to higher rates of fertilizer application (**Table 3**). Application of 30-30-30 kg N-P_2O_5-K_2O/ha produced a yield of 36.7 g/t/t; while 60-60-60 and 90-90-90 produced equally as high yields near 45 g/t/t. Rubber is a deciduous tree that can add 6 to 8 t/ha of leaf material annually to the soil floor, which upon decomposition releases about 94 to 120 kg N, 5 to 7 kg P, and 20 to 25 kg K for plant uptake (Varghese et al., 2001). This recycled source of nutrients remains an important factor to consider in the overall nutrient management plan of rubber plantations.

Table 2. Effect of NPK on latex yield, Taranagar, Tripura (1991-2002).

Treatment[1], kg/ha	Yield, grams/tree/tap
0 N	32.6
30 N	35.8
60 N	41.2
0 P_2O_5	31.6
30 P_2O_5	35.3
60 P_2O_5	38.7
0 K_2O	34.6
20 K_2O	36.2
40 K_2O	36.9
LSD (p = 0.05)	2.98

[1]Grand mean of the nine possible combinations.

Table 3. Effect of NPK on latex yield, Tulakona, Tripura (1995-2000).

Treatment, kg N-P_2O_5-K_2O/ha	Yield, grams/tree/tap
30-30-30	36.7
60-60-60	44.8
90-90-90	45.3
LSD (p = 0.05)	4.7

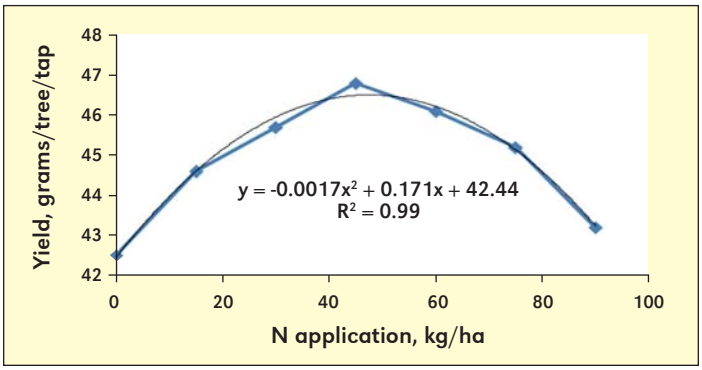

Figure 1. Fertilizer N response curve for rubber, Tripura.

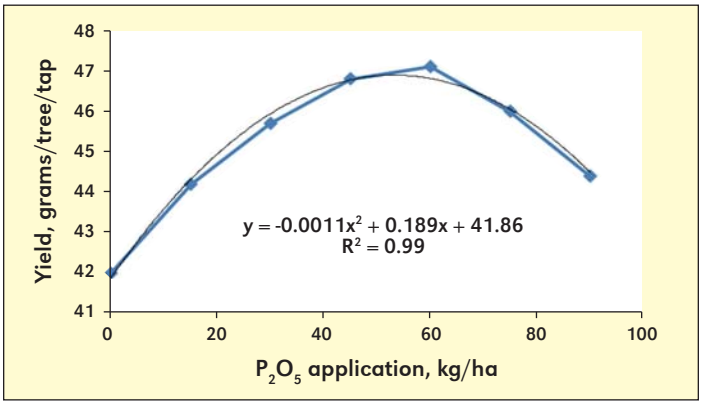

Figure 2. Fertilizer P response curve for rubber, Tripura.

Summary

Evidence suggests a need to modify the present recommendations of N, P and K for the mature rubber plantations of Tripura. The majority of soils fall within the low-to-medium fertility range for N, P and K. It is recognized that recommendations for these responsive soils should be raised by 15 to 20% for low testing soils and by 5% for medium testing soils. Considering the poor nutrient status of soils in this region, fertilizer-yield response studies, and common fertilizer recommendations, a generalized balanced fertilizer application of 45-45-40 kg N-P_2O_5-K_2O/ha would create significant benefit to Tripura's rubber growers. BC

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