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BANANA GROWN AS AN INTERCROP IN RUBBER PLANTATION REQUIRES LESS FERTILIZER

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An experiment was conducted to study the effect of sequential reduction of fertilizer doses for banana when grown as an intercrop with rubber in Assam. Rubber was manured as per the standard recommendation for the region throughout the experiment period. All banana plants received uniform recommended dose of fertilizers during first year. From second year onwards, different doses of fertilizers *i.e.* 0, 25, 50 and 100 per cent were applied to banana. Observations on growth of rubber, yield of banana, soil and leaf nutrient status were recorded. Intercropping with banana, irrespective of its fertilizer doses significantly improved the growth of rubber. Yield of banana was comparable in the treatments which received 100 per cent fertilizers throughout, 100 per cent fertilizer during first year, 50 per cent during second and third year and 100 per cent during first year, 50 per cent during second year and 25 per cent during third year. There were no significant differences in organic matter content and pH of soil, however, significant reduction in available phosphorus and potassium contents were observed in treatments which received lower dose of fertilizers. The study shows that the fertilizer dose for the second crop of banana can be reduced when cultivated as an intercrop in young rubber plantation, without adversely affecting the growth of rubber.

Keywords: Banana intercropping, BCR, North East India, Rubber, Soil and leaf nutrients

INTRODUCTION

Rubber (*Hevea brasiliensis*) is a perennial tree, latex of which is processed to produce the strategically important natural rubber. Of late, rubber cultivation in the North East India has become very popular. Rubber plants require approximately 7 to 8 years to attain maturity (Sethuraj *et al.*, 1989; Vinod *et al.*, 1996), and the comparatively long gestation period is one of the constraints for expansion of rubber cultivation in North East India. It is possible to effectively utilize the inter- row spaces in the rubber plantations for growing intercrops (Jessy *et al.*, 1998; Roy *et al.*, 2001). Banana is a very popular fruit crop in North East India and was found to be suitable as an intercrop in the region. When banana is cultivated as an intercrop, substantial quantities of nutrients are recycled through crop residues (Jessy *et al.*, 1998), which will be available for the subsequent crops. This

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study was carried out to find out the fertilizer requirement of banana when grown as an intercrop in young rubber plantation.

MATERIALS AND METHODS

The experiment was conducted during the period from April 2005 to March 2008 at Rubber Research and Training Centre, Hahara, Kamrup district of Assam which is about 32 km away from Guwahati towards the eastern side. The experiment was laid out in randomised block design with eight treatments (Table 1) and three replications.

The clone RRIM 600 was planted during July 2005 at a spacing of 6.7 x 3.4 m. Sword suckers of local banana variety Malbhog of medium height and sweet taste were planted as a single row in the middle of two inter-rows of rubber at a spacing of 2 m between plants during July 2005. Cultural operations for rubber were followed as per the recommendations of Rubber Board (Rubber Board, 2004). Cultural operations recommended for the state were followed for banana. The quantities of fertilizers for rubber and banana are given in Table 2.

Soil samples were collected before the commencement of the experiment (March 2005) and four years after planting (March 2008). The soil samples were analysed for organic carbon, available phosphorus (P) and potassium (K) and pH as per the method outlined by Jackson (1973). Leaf samples were collected from rubber and banana during September 2007 for the analysis of nutrient content. Leaf nitrogen content was determined by Kjeldahl method. The

Table 1. **Treatment details**

Treatment	Crop	Fertilizer dose for banana		
		First year (2005)	Second year (2006)	Third year (2007)
T1	Rubber + Banana	RDF* for banana	RDF for banana	RDF for banana
T2	Rubber + Banana	RDF for banana	50% of RDF for banana	50% of RDF for banana
T3	Rubber + Banana	RDF for banana	50% of RDF for banana	25% of RDF for banana
T4	Rubber + Banana	RDF for banana	50% of RDF for banana	No fertilizer for banana
T5	Rubber + Banana	RDF for banana	25% of RDF for banana	25% of RDF for banana
T6	Rubber + Banana	RDF for banana	25% of RDF for banana	No fertilizer for banana
T7	Rubber + Banana	RDF for banana	No fertilizer for banana	No fertilizer for banana
T8	Rubber alone	RDF for rubber	RDF for rubber	RDF for rubber

*RDF: Recommended doses of fertilizers

Table 2. **Recommended doses of fertilizers for rubber and banana**

Crop		Fertilizer dose			
		Urea	SSP	RP	MOP
Banana (g plant^{-1})		240	210	-	550
Rubber (g plant^{-1})	1st year	130	165	188	50
	2nd year	260	330	376	100
	3rd year	290	-	900	120

samples were ashed at 600 °C for 18 hours and the ash was dissolved in hydrochloric acid. The solution was used for determination of P content by UV spectrophotometer and K by flame photometer.

RESULTS AND DISCUSSION

Growth of rubber

Significant difference in growth of rubber was not observed between treatments in eight months after planting. During 2007 (20 months after planting), growth of rubber in the treatments T1 and T4 was significantly superior to that of rubber alone treatment (Table 3). During March 2008, all intercropped treatments except T5 were significantly superior to the treatmental, rubber alone. However, there was no significant difference between intercropped treatments. Different doses of fertilizers applied to banana did not influence the growth of rubber. Under a given climatic condition, early growth of rubber is mostly dependent on the initial plant vigour and soil fertility status. Limiting root system during the initial years of growth of rubber do not exploit the nutrients from the soil in the inter-row spaces. Moreover, rubber was separately and adequately manured. Hence, variations in the quantity of fertilizers applied for banana did not have any significant effect on growth of rubber. The overall superiority in growth of rubber intercropped with banana compared to monocrop of rubber might be due to better micro-climate inside the intercropping system and other favourable interactions. Significant improvement in growth of rubber due to intercropping with banana was reported in several earlier studies (Jessy *et al.*, 1998; Roy *et al.*, 2001; George *et al.*, 2010).

Table 3. **Influence of varying doses of fertilizers for banana on girth (cm) of rubber**

Treatment	Girth of plants		
	2006 (March)	2007 (March)	2008 (March)
T1	6.35	14.70	24.85
T2	5.92	12.91	22.62
T3	6.18	13.44	23.63
T4	6.05	14.18	23.44
T5	5.87	12.93	21.61
T6	5.98	14.05	21.93
T7	6.14	13.70	22.88
T8	5.84	10.66	17.75
CD ($P = 0.05$)	NS	3.46	4.12

Yield of banana

There was no significant difference between treatments with respect to yield attributes and yield of banana during 2006. During 2007, highest yield was recorded in T1 which received full dose of fertilizers throughout. It was comparable with T2 and T3, which received 50 per cent fertilizers during second and third year and 50 per cent during second year and 25 per cent during third year (Table 4). Hands per bunch also followed the same trend. Drastic reduction in yield of banana was observed in plots (T6 and T7) receiving only 25 per cent of the RDF or no fertilizers from the second year onwards. Reduction in fruit size during the second harvest season was observed as reflected by the reduced weight of unit bunch. Residual effect of fertilizers applied during the previous years and the nutrients released from crop residues might have reduced the fertilizer requirement of banana during the second cropping season. Jessy *et al.* (1998) reported considerable recycling of nutrients through banana residues and also a positive balance of nutrients after intercropping with banana.

Table 4. **Yield of banana as influenced by fertilizer doses**

Treatment	Hands per bunch		Fingers per hand		kg per bunch	
	2006	2007	2006	2007	2006	2007
T1	8.2	8.4	14.3	14.8	10.8	11.3
T2	7.7	7.3	13.6	13.2	9.5	9.2
T3	7.9	7.1	13.8	12.6	9.8	8.9
T4	7.7	6.4	13.2	11.4	9.6	6.3
T5	7.2	5.9	13.0	10.6	8.7	5.7
T6	7.0	5.1	11.6	10.2	8.3	5.1
T7	7.0	4.6	11.3	9.7	8.0	4.2
CD (P = 0.05)	NS	1.8	NS	NS	NS	2.6

* Yield recorded till the end of December during 2006 and 2007

Soil nutrient status

Analysis of soil samples collected during March 2008 showed an overall reduction in organic carbon content under all treatments compared to the pre-treatment values (Table 5). The difference in organic carbon content among the treatment was not significant.

Intercropping of rubber with banana showed a reduction of available phosphorus, whereas it increased in the plot with rubber alone, compared to pre-treatment value. For banana, single super phosphate (SSP) was the source of P and it has less residual effect compared to rock phosphate, which is the source of P for rubber. Hence continuous application of rock phosphate might have increased available P content of soil in plots with rubber alone. In the case of banana, application of SSP and uptake by plants might have resulted in lower P status in soil after intercropping. Contrary to this observation, in traditional rubber growing tract, intercropping with banana enhanced soil available P status and this might be due to the addition of rock phosphate as the source of P in this experiment (Jessy *et al.*, 1998).

Table 5. **Soil nutrient status under different treatments (March 2008)**

Treatment	Organic carbon (%)	Available P (mg 100 g^{-1})	Available K (mg 100 g^{-1})	pH
Pre-treatment	1.27	1.04	7.12	5.01
T1	1.25	1.01	6.87	4.70
T2	1.30	0.87	5.81	4.93
T3	0.97	0.90	5.21	5.05
T4	1.17	0.70	4.76	5.12
T5	0.92	0.84	5.12	4.87
T6	1.06	0.74	4.07	5.25
T7	0.85	0.59	3.62	5.10
T8	1.12	1.40	7.25	4.98
CD (0.05)	NS	0.21	1.27	NS

Banana is a heavy feeder of potassium (Jessy *et al.*, 1998). Soil available K status was comparable in the treatments which received full dose of fertilizers throughout and which received full dose during first year and 50 per cent during second and third year. There was a significant reduction in available potassium status in the other intercropped plots. No significant difference in soil pH was observed among the treatments.

The nutrient requirement of banana is comparatively high and it is mainly due to their rapid and vigorous growth and high

Table 6. **Leaf nutrient content (%) of rubber and banana (September 2007)**

Treatment	Rubber			Banana		
	N	P	K	N	P	K
T1	3.05	0.21	1.24	3.22	0.28	3.16
T2	3.26	0.20	1.28	3.04	0.24	2.96
T3	2.89	0.18	1.30	3.16	0.18	2.89
T4	2.76	0.22	1.16	2.87	0.19	2.76
T5	3.14	0.19	1.07	3.01	0.21	2.78
T6	2.90	0.20	1.14	2.72	0.16	2.18
T7	2.85	0.18	1.25	2.35	0.11	2.04
T8	3.28	0.22	1.18	-	-	-
CD (P = 0.05)	NS	NS	NS	NS	0.06	0.32

fruit yield. It mainly exploits surface soil due to shallow root system of the crop (Chadha and Bhargava, 1997). The results indicated the need for careful monitoring of soil nutrient status after intercropping and the necessity for the adoption of discriminatory fertilizer application for rubber based on soil and leaf nutrient status.

Leaf nutrient status

Leaf nutrient status of rubber was not influenced by reducing the fertilizer dose to banana indicating lack of competition between banana and rubber for nutrients (Table 6). This might be the reason for the lack of influence of treatments on growth of rubber. Contrary to this, Jessy *et al.* (2005) observed significantly low status of K in rubber leaves during the active growth period of banana in traditional rubber growing tract. Critical values of leaf nutrient content for banana are N- 2.6 (range 2.3-3.8), P_2O_5- 0.45 (range 0.53-0.81) and K_2O- 3.3 (range 2.0-5.3) expressed as per cent of dry weight.

Though no deficiency symptom was observed, leaf P content was below the critical range for banana. Leaf N and K contents were within the critical range. No significant difference in leaf N content was observed among the treatments. However, there were significant differences in P and K contents of leaves of banana. Leaf P status in plots receiving full dose of fertilizers throughout was comparable with the plots receiving, 50 per cent of fertilizer during second and third year and was significantly higher than all other treatments. Leaf K status was comparable in T1,T2 and T3, where the treatments receiving full dose throughout, full dose during first year and 50 per cent during second and third year and full dose during first year, 50 per cent during second year and 25 per cent during third year.

Economics of crop production

The economics of various treatments have been presented in Table 7. A perusal of the data on total income and expenditure in different treatments revealed that T1 yielded maximum net income per hectare. However, the highest return (2.66) per rupee invested was observed with T3. The net return and return per rupee invested were found to be the lowest with T7. Except fertilizer, the cost of labour and other inputs are same for all the treatments with banana as the intercrop

Table 7. **Benefit:Cost ratio of different treatment combinations**

Treatment	Cost of cultivation per ha (Rs.)	Gross Return per ha (Rs.)	Net return per ha (Rs.)	B:C Ratio
T1	52452	183435	130983	2.50
T2	44867	152216	107349	2.39
T3	42359	155030	112671	2.66
T4	40298	131973	91675	2.27
T5	40287	119529	79242	1.97
T6	38149	111224	73075	1.92
T7	36062	101261	65199	1.81

and that is the reason why T3 showed higher benefit cost ratio (BCR) than T1.

CONCLUSION

The study indicated the possibility of reducing the fertilizer dose for the second crop of banana when cultivated as an intercrop in young rubber plantation, without adversely affecting the growth of rubber. However, soil nutrient dynamics after the intercropping period needs careful monitoring and discriminatory fertilizer recommendation should be followed for rubber after the intercropping period.

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