EFFECT OF CONTROLLED RELEASE FERTILIZERS ON GROWTH AND LEAF NITROGEN STATUS OF IMMATURE RUBBER

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The growth and leaf nitrogen status of immature rubber (*Hevea brasiliensis*) trees (clone RRII 105) which received 50 or 75 per cent of the recommended dose of N as NPK Mg tablets or 75 per cent as neem extract coated or neem cake mixed urea were comparable to those which received the full dose as prilled urea in two field experiments conducted in the central region of the traditional rubber growing tract of India, during 1994 to 1998. Single low dose of N applied as NPK Mg tablets was comparable to split doses of other fertilizers in terms of growth (girth) of the plants.

Key words: Controlled release fertilizers, Growth, *Hevea brasiliensis*, Leaf nitrogen, Immature rubber.

INTRODUCTION

Urea, the cheapest source of nitrogen fertilizer is highly soluble and often subjected to substantial loss through leaching and volatilisation. These losses contribute to the low efficiency of the fertilizer use by crops (Soong, 1973; Bronson and Mosier, 1991) and the contamination of ground water (Adetunji, 1994). The use of controlled release fertilizers is reported to reduce the loss of nutrients through leaching and run off, which helps to maintain the nutrients in the soil for a prolonged period (de Silva *et al.*, 1996). These features of controlled release fertilizers would thus lead to reduced frequency and lower rates of application with substantial savings in labour and time. Response to the application of controlled release fertilizers for rubber *(Hevea brasiliensis)* have been reported (Yusof *et al.*, 1995). Among the sources of N, urea form was the best to support the growth and development of young rubber plants in pot culture (Karthikakuttyamma *et al.*, 1994). However, information on the effect of controlled release fertilizers on the field performance of immature rubber in India is limited. The objective of the present work was to study the effects of different controlled release fertilizers in comparison to conventional fertilizers on the growth and leaf nitrogen status of immature rubber trees.

MATERIALS AND METHODS

Two field experiments were laid out, one (Experiment 1) at the Central Experiment Station of the Rubber Research Institute of India at Chethackal, Pathanamthitta District, Kerala (longitude 9° 22'N, latitude 76° 50'E, 100 m above MSL) and the other

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(Experiment 2) in a smallholding at Kuzhimattom, Kottayam District, Kerala (longitude 9° 32'N, latitude 76° 36'E, 100 m above MSL), both in the central region of the traditional rubber cultivated tract of India, to evaluate the effect of different controlled release fertilizers on growth and leaf N status of immature rubber. The experiments were laid out in fields replanted with clone RRII 105 during 1993. The soils of both the experimental sites were acidic (pH 5.3 and 4.7 respectively) sandy loam. The soil of the experimental site at Chethackal was high in organic carbon (2.4%), low in available P (0.38 mg/100 g) and medium in available K (6.08 mg/00 g). The soil at Kuzhimattom was medium in organic carbon (1.38%) and available P (1.29 mg/100 g) and low in available K (2.46 mg/100 g). The experiment was started in 1993 at Chethackal and in 1994 at Kuzhimattom. Experiment 1 comprised of seven treatments and Experiment 2 comprised of ten treatments as detailed in Table 1. Prilled urea and NPK Mg tablets were supplied by FACT, Cochin. Neem extract coated urea was prepared by mixing Nimin (neam extract) supplied by M/s. Godrej Agrovet Pvt. Ltd. with urea (100 ml to 5 kg). Powdered neem cake (200 g) was mixed per kg of urea to get neem cake mixed urea (Karthikakuttyamma *et al.*, 1994). In Experiment 1, all the fertilizers were applied in two splits. In Experiment 2, the fertilizers were applied either in a single dose or in two splits as indicated in Table 1. Phosphorus, K and Mg were applied uniformly following standard recommendations except in treatments with NPK Mg tablets

Table 1. **Treatment details**

Treatment*	Source of N	Rate of application**
Experiment 1		
NFC	No fertilizer control	-
CF 100	Prilled urea	100
TAB 100	NPK Mg tablets	100
TAB 75	NPK Mg tablets	75
NCU 100	Neem extract coated urea	100
NCU 75	Neem extract coated urea	75
NCMU 75	Neem cake mixed urea	75
Experiment 2		
NFC	No fertilizer control	-
CF 100 TS	Prilled urea	100
TAB 75 SA	NPK Mg tablets	75
TAB 75 TS	NPK Mg tablets	75
TAB 50 SA	NPK Mg tablets	50
TAB 50 TS	NPK Mg tablets	50
NCU 100 TS	Neem extract coated urea	100
NCU 75 TS	Neem extract coated urea	75
NCMU 100 TS	Neem cake mixed urea	100
NCMU 75 TS	Neem cake mixed urea	75

* Experiment 1 All treatments in two splits
Experiment 2 SA: Single application
TS: Two splits

** % of recommended dose (kg/ha)
(Recommended dose of NPK and Mg)
First year : 20:20:8:3; Second year : 40:40:16:6;
Third year: 50:50:20:6.5; Fourth year : 40:40:16:6;
Fifth year : 30:30:30:0.

where all the nutrients were applied at 50, 75 and 100 per cent level as per the treatments. The fertilizers were applied during June-July for single application and in two equal splits during June-July and September-October in the case of split application. Small channels having a depth of 15 cm were taken at 30 cm radius around the base of the plant and NPK Mg tablets were placed equidinstantly in the channel and covered with soil during the first year. The distance

from the base of the tree was gradually increased from year to year to 1.5 m during the fifth year keeping the depth of placement as 15 cm itself. Other fertilizers were broadcasted in circular bands around each plant and slightly forked in. The experiments were laid out in RBD and replicated thrice. The plot sizes were 6.7 x 23.3 m and 6.7 x 33.4 m having 7 and 10 plants each for experiment 1 and 2 respectively at a spacing of 6.7 x 3.34 m.

Growth was monitored annually by recording the girth of the trees at a height of 150 cm from the base. Leaf samples were collected during the month of August in 1997 and 1998 from Experiments 2 and 1 respectively (Karthikakuttyamma *et al.*, 2000) and were analysed according to the standard procedure (Piper, 1966).

RESULTS AND DISCUSSION

Growth of trees

There were significant differences between the treatments for mean girth of the plants in Experiment 1 from 1995 onwards (Table 2). During 1995, two years after the commencement of the experiment, significantly higher growth was observed only for the NPK Mg tablets (TAB 75 and TAB 100) treated plots. From 1996 onwards, all the controlled release fertilizers irrespective of the source and rate of application, recorded significantly higher girth than the control. No statistical difference in the growth of the plants between conventional and controlled release fertilizer was observed throughout the experimental period except during 1998, where NPK Mg tablet (TAB 75) treated plot exhibited a slight superiority. Five years after the commencement of the experiment (1998) the mean girth of the plants ranged from 34.0 cm in the control to 39.7 cm with the maximum in NPK Mg tablet treated plots (TAB 75).

The cumulative girth increment for a period of three years (1995-1998) is shown in Fig. 1. The results manifested a similar trend as in the case of girth. All the fertilized treatments recorded significantly higher girth increments than the no fertilizer control. There was no statistical difference be-

Table 2 **Effect of controlled release fertilizers on growth of rubber in different years (Experiment 1)**

Treatment	Girth (cm)			
	1995	1996	1997	1998
NFC	13.89	17.06	25.55	33.97
CF 100	14.14	19.16	28.20	36.31
TAB 100	15.55	20.52	29.23	38.74
TAB 75	17.42	21.37	30.70	39.71
NCU 100	14.61	19.89	28.73	37.42
NCU 75	14.90	19.38	28.37	37.20
NCMU 75	14.93	19.79	29.49	37.47
SE	0.53	0.62	0.91	0.96
CD (P=0.05)	1.63	1.91	2.80	2.96

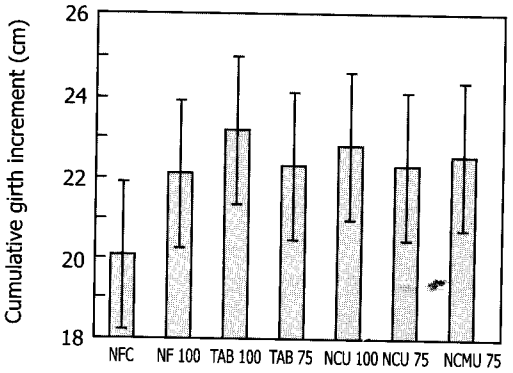

Fig. 1. Effect of controlled released fertilizers on cumulative girth increment for three years (Experiment 1)

tween the cumulative girth increment of trees which received controlled release fertilizers (at both the levels of applied N) and the conventional fertilizer indicating the sufficiency of the former.

No significant difference in plant growth due to application of fertilizers was observed in Experiment 2 during 1995, one year after the commencement of the treatments (Table 3). However, from 1996 onwards there was significant response to applied fertilizers. The difference in average girth between the no fertilizer control and the other fertilizer treatments was in the range of 1.78 to 3.78 cm, 3.69 to 5.28 cm and 5.16 to 7.08 cm during the third, fourth and fifth years of experiment respectively. Though there was significant increase in the girth of the plants in response to application of fertilizers, no statistical difference was observed between plants which received controlled release fertilizers and conventional fertilizers (Table 3). There was no significant difference in girth of plants among the rates and sources of different controlled release fertilizers tried. Similarly, single and split application of NPK Mg tablets also gave comparable growth, with the girth ranging from 36.30 cm for 50% N, single application to 38.22 cm for 75% N, split application during the fourth year.

The cumulative girth increment over a period of four years also exhibited a similar trend (Fig. 2). The no-fertilizer control was significantly inferior to all other fertilized treatments. All the controlled release fertilizers, irrespective of the source, rate and fre-

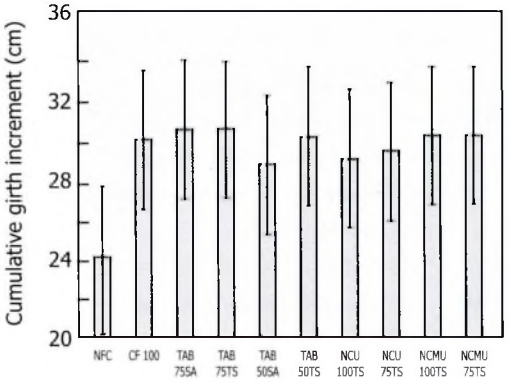

Fig. 2. Effect of controlled release fertilizers on cumulative girth increment for four years (Experiment 2)

Table 3. **Effect of controlled release fertilizers on growth of rubber in different years (Experiment 2)**

Treatment	Girth (cm)				
	1994 (pre-treatment)	1995	1996	1997	1998
NFC	6.96	10.94	17.50	25.88	31.14
CF 100	7.91	12.43	21.28	31.16	37.98
TAB 75 SA	6.80	12.28	21.13	31.05	37.37
TAB 75 TS	7.63	12.52	21.06	31.49	38.22
TAB 50 SA	7.52	12.14	20.29	29.89	36.30
TAB 50 TS	7.32	12.73	21.05	30.87	37.53
NCU 100 TS	7.21	11.53	19.28	30.01	36.33
NCU 75 TS	7.02	11.40	19.75	29.63	36.49
NCMU 100 TS	7.19	11.77	20.52	30.03	37.45
NCM 75 TS	6.88	11.59	19.95	29.57	37.45
SE	0.40	0.41	0.61	0.86	1.15
CD ($P \leq 0.05$)	NS	NS	1.81	2.50	3.41

quency of application, were comparable to the conventional fertilizer in terms of girth increment.

The results indicated that application of either 50 or 75% of the recommended dose of nitrogen through NPK Mg tablets or 75% of the recommended dose of nitrogen through neem extract coated urea or neem cake mixed urea produced the same growth as application of 100% of nitrogen through prilled urea. Single application of NPK Mg tablets as against split application of other fertilizers gave comparable growth. The uptake of nitrogen from different soluble sources may vary significantly which often results in a high concentration of N in the tissues soon after application and low availability of N for crop growth during later stages. However, controlled release fertilizers can maintain an optimum concentration of nutrients in the soil for a prolonged period and thereby minimise the nutrient loss through leaching (de Silva *et al.*, 1996). A study on the mineralisation pattern and leaching of different controlled release fertilizers revealed that NO_3- N concentration in the soil increased progressively up to 15 days for prilled urea, 30 days for neem extract coated and neem cake mixed urea and 90 days for NPK Mg tablets when the soil was supplied with the equal quantity of N through the different forms. The content of NO_3- N in the leachate was comparatively higher for prilled urea whereas it was low but consistent for NPK Mg tablets indicating their effectiveness in reducing the solubility of urea (George *et al.*, 2000). The comparable performance of controlled release fertilizers even at reduced rates and frequency of application, with that of conventional fertilizers could be due to this. Yusof *et al.* (1995) found that with the use of controlled release fertilizers, the frequency of fertilizer application for immature rubber could be greatly reduced. Karthikakuttyamma *et al.* (1994) reported that the modified forms of urea *viz.*, urea formaldehyde, neem extract coated urea and neem cake mixed urea, were effective in increasing the root and shoot growth of the plants and urea formaldehyde was the best source with respect to growth and apparent recovery of nitrogen. In NPK Mg tablets, a part of nitrogen is in the form of urea formaldehyde and thus contributes towards the controlled release. The beneficial effect of mixing neem cake with urea in terms of growth and yield was reported in coffee by Stalin *et al.* (1992). The results of the present study also confirm the efficiency of controlled release fertilizers compared to prilled urea.

Leaf nitrogen concentration

The leaf N content in different treatments in Experiment 1 during 1998 is shown in Fig. 3. Significant difference was not ob-

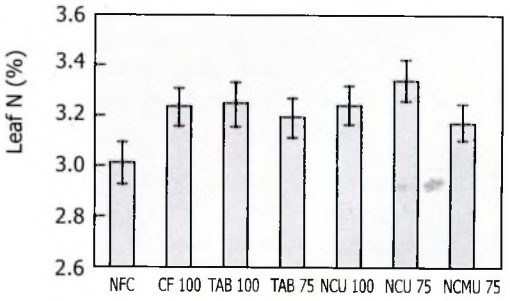

Fig. 3. Effect of controlled release fertilizers on leaf N content (Experiment 1)

served between the different treatments. The leaf N concentration varied from 3.17 to 3.34 per cent in the fertilized treatments whereas in the no fertilizer control it was 3.01 per cent, the sufficiency level being 3.0 to 3.5 per cent (Karthikakuttyamma *et al.*, 2000).

Concentration of nitrogen in the leaf of the rubber from different treatments during 1997 in Experiment 2 is shown in Fig. 4. The leaf nutrient concentration did not vary significantly between the different treatments and ranged from 3.08 to 3.41 per cent among the fertilized treatments. But in the no fertilizer control the leaf nitrogen content was below the sufficiency level (2.97%). The comparable leaf nitrogen concentration after a long period of differential fertilizer application signals that, under field conditions, low doses of fertilizers which are slowly released into the soil can supply optimal concentrations of nitrogen throughout the growing period. Similar observations

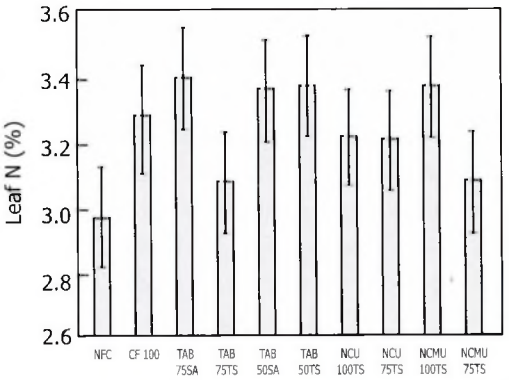

Fig. 4. Effect of controlled release fertilizers on leaf N content (Experiment 2)

were reported by Zekri and Koo (1991) for orange and by Yusof *et al.* (1995) for rubber. They found that the use of controlled release fertilizers showed no adverse effect on the leaf mineral nutrient status of the trees.

The results of the present experiment indicate that single application of low doses of nitrogen through controlled release fertilizers provide optimum N levels for the proper growth of field planted rubber.

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