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EFFECT OF ORGANIC MANURE ON GROWTH OF IMMATURE RUBBER

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In a field experiment to evaluate the effect of farmyard manure application on soil nutrient status and growth of immature rubber in a field where *Mucuna bracteata* was maintained as cover crop, it was observed that the application of organic manure through farmyard manure did not improve the growth of plants or chemical properties of the soil.

Key words: Growth, Immature rubber, *Mucuna bracteata*, Organic manure, Soil nutrient status.

INTRODUCTION

Rubber cultivation necessitates intense management of nutrients with every cycle of replanting. Judicious application of inorganic fertilizers and organic manures is needed to sustain high crop yields and maintain an optimum balance of nutrients. Rubber plantations present a closed ecosystem with a constant cycle of uptake and return of nutrients from and to the soil (Watson, 1989). Annual defoliation of rubber trees results in the addition of about six tonnes of leaf litter per hectare every year in a rubber plantation (Krishnakumar and Potty, 1992). Moreover, leguminous cover crops established in the immature phase of rubber add about six tonnes of organic matter and 230-350 kg of fixed nitrogen per hectare (Watson, 1957). Proper cover crop management and litter fall would result in an appreciable enrichment of soil which could, in turn, reduce the requirement of fertilizers in the rubber plantations. In general, soils under *Hevea* have been found to be rich in organic matter.

Although applying organic manure at agronomic rates for plant nutrient supply is a traditional agricultural practice, the high cost and difficulty in transport has very much restricted its use. Recently, there has been a renewed interest in the application of organic manures to sustain soil productivity and quality. However, no reports are available on the effect of nutrient supply through organic manure in rubber plantations. This study was initiated to find out whether the application of farmyard manure may have any additional benefit on soil chemical properties and growth of plants.

MATERIALS AND METHODS

This study was conducted at

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Shaliacary estate, Punalur, Kerala, India. The design of the experiment was split plot with two main plot treatments and ten sub plot treatments replicated four times. The main plot treatments included plots with farmyard manure (FYM) and without FYM. The quantity of FYM was 3 tonnes/ha/year. The sub plot treatments consisted of nine factorial combinations of three levels each of N and P_2O_5 at 0, 25 and 50 kg/ha and a control (S10) without any fertilizer. Potassium was applied at uniform rate for all the plots except control S10 at recommended rates.

Polybag plants of clone RRII 105 were planted during 1994 at a spacing of 6.75 x 3.35 m with a gross and net plot size of 30 and 8 plants respectively. Fertilizer applications were made in two equal splits during April-May and September-October every year. Urea, rock phosphate and muriate of potash were used as the sources of N, P_2O_5 and K_2O. The entire quantity of farmyard manure was applied as a single dose before the onset of South West monsoon. Leguminous cover crop *Mucuna bracteata* was maintained in all plots. Other cultural operations were carried out as per the recommendations of the Rubber Board. Girth was recorded annually at 150 cm height.

Soil samples were collected (0-30 cm depth) and analysed for available nutrients before the commencement of the experiment. The soil was medium in organic carbon (0.94%), low in available P (0.5 mg/100 g soil), available K (3.04 mg/100 g soil) and available Mg (0.95 mg/100 g soil) and the pH was 4.85. Soil samples were collected from individual plots during 1996 and 1998 and analysed for OC, available P, K, Mg and pH. OC was determined by Walkley and Black's method as described by Jackson (1973). Available P, K and Mg were estimated using Bray II (Bray and Kurtz, 1945), Morgan's reagent (Morgan, 1941) and colorimetric method (Vogel, 1969) respectively. Leaf samples were collected during 1998 and analysed for total nutrients (Piper, 1966).

RESULTS AND DISCUSSION

Growth of plants

The girth data indicated that the growth of plants was not significantly influenced by organic manure, levels of inorganic fertilizers and their interactions (Table 1). Among the various levels of N and P, there was no significant difference in girth of plants. During the eighth year of planting, the plots receiving phosphorus alone at the rate of 50 kg P_2O_5/ha attained the highest girth of 51.27 cm. This might be due to adequate N availability in the experimental area due to the presence of cover crop. Phosphorus application at higher level might be beneficial for growth (girth) in low P soils. The role of P in enhancing the growth of rubber is well documented (Potty *et al.*, 1976; Pushparaj *et al.*, 1983).

The coefficient of variation (CV) of growth was only 9.5% (Table 1) indicating that experimental error was under control.

Soil nutrient status

Organic Carbon (OC)

Significant differences were not observed between treatments with respect to OC content of the soil (Table 2). However, there was an increase in OC over the years (1.06 during 1996 and 1.88 during 1998). Addition of organic matter through cover crop litter might have contributed to the OC content. Because of the narrow C:N ratio of leguminous cover crop, rapid mineralization

Table 1. **Girth of rubber plants (cm)**

Main treatment	1997			2001 (7th year)			2002 (8th year)		
	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean
Sub treatment									
S1 - N0P0	12.95	14.42	13.68	44.72	45.62	45.17	47.59	48.70	48.14
S2 - N0P25	13.77	13.90	13.83	44.70	45.85	45.27	47.76	50.42	49.09
S3 - N0P50	12.87	14.25	13.56	44.85	43.47	44.16	55.62	46.93	51.27
S4 - N25P0	10.77	12.80	11.78	45.37	45.20	45.28	48.02	48.10	48.06
S5 - N25P25	14.17	14.80	14.48	47.10	47.42	47.26	50.59	49.38	49.98
S6 - N25P50	13.85	13.62	13.73	44.65	45.12	44.88	47.80	47.58	47.69
S7 - N50P0	13.57	14.80	14.18	46.42	45.57	46.00	49.36	48.62	48.99
S8 - N50P25	14.82	14.10	14.46	45.55	43.85	44.70	48.38	46.43	47.41
S9 - N50P50	12.55	14.72	13.63	43.02	45.37	44.20	48.16	48.44	48.30
S10 - Control	13.00	13.85	13.42	45.17	45.07	45.12	47.93	48.55	48.24
Mean	13.23	14.12		45.15	45.30		49.12	48.31	
Main plot SE			0.27			0.27			0.67
CD (P≤0.05)			NS			NS			NS
CV (%)			12.60			3.3			6.18
Sub plot SE			0.76			0.77			1.93
CD (P≤0.05)			NS			NS			NS
CV (%)			15.8			4.7			7.93
Interaction SE			1.07			1.09			2.73
CD (P≤0.05)			NS			NS			NS

takes place which raises the organic matter content of the soil (Lock, 1977).

Levels of inorganic fertilizers and their interactions had no significant influence on OC of the soil as reported earlier (Jessy *et al.*, 1996).

Available Phosphorus

Analysis of the soil samples before the commencement of the experiment indicated an available P content of 0.5 mg/100 g of soil which increased further to 0.84 in 1996 and then to 1.50 mg in 1998 (Table 3). It shows that application of organic manure, inorganic fertilizers and their interactions did not significantly influence the available P status of the soil. The increase in soil P status was noticed even in the plots which did not receive phosphatic fertilizers. The addition of organic matter through cover crop litter and FYM might have contributed to the P in soil. Organic materials generally contain P, which is mineralized during decomposition and a large proportion is released into the soil solution (Haynes and Mokolobate, 2001).

Available Potassium

All treatments except control plots received same quantity of K. The effect of organic manure, inorganic fertilizers and their interactions could not find any significant increase in the available K content of the soil. However, K status of the soil in all the plots showed a slight increase. The control plots also showed an increase in K

Table 2. **Organic carbon content (%) of the soil (0-30 cm)**

Sub treatment	1996 M1 (without FYM)	1996 M2 (with FYM)	1996 Mean	1998 M1 (without FYM)	1998 M2 (with FYM)	1998 Mean
S1 - N0P0	1.00	1.02	1.01	1.91	1.83	1.87
S2 - N0P25	1.11	0.86	0.98	1.89	1.83	1.86
S3 - N0P50	1.03	1.13	1.08	1.80	1.81	1.80
S4 - N25P0	1.10	1.07	1.09	1.84	1.86	1.85
S5 - N25P25	1.12	1.11	1.11	1.78	1.79	1.78
S6 - N25P50	1.07	1.10	1.08	2.10	2.13	2.11
S7 - N50P0	1.07	1.10	1.09	1.91	2.12	2.01
S8 - N50P25	1.20	0.88	1.04	1.62	1.91	1.76
S9 - N50P50	1.13	0.95	1.04	1.85	1.69	1.77
S10 - Control	1.05	1.02	1.03	1.91	1.98	1.95
Mean	1.09	1.02	1.06	1.86	1.89	1.88
Main plot SE			0.05			0.14
CD (P≤0.05)			NS			NS
Sub plot SE			0.07			0.16
CD (P≤0.05)			NS			NS
Interaction SE			0.10			0.22
CD (P≤0.05)			NS			NS

status of soil. During 1996 and 1998 the K content was slightly higher in the plots which received FYM.

Available Magnesium

The initial Mg status of the soil indicated that the soil of the experimental area was low in available Mg. Addition of FYM and organic matter improved the Mg content of the soil during 1996 (Table 3). However, there was no significant difference between the main plot treatments.

Soil pH

The soil pH was 4.85 before the commencement of the experiment. There was a reduction in the soil pH in all plots after the treatment imposition. Presence of organic matter in all plots contributed to the increase in acidity. Soils with higher content of OC may contain more of microbial population, which helped in the decomposition organic matter and resulted in the production of organic acids. Increase in soil acidity by leguminous cover crop has been reported by Horst *et al.* (2001).

Significant difference in soil pH was not observed between main plot treatments in 1996 and 1998. Reduction of soil pH was observed by the addition of FYM in both the years which may be caused by the relatively higher number of microflora in plots with FYM. Different levels of inorganic fertilizers significantly influenced the soil acidity during 1996. However, in 1998 significant variations were not observed for sub plot treatments.

Soil nutrient status over the years

Pooled analysis of the soil data in 1996 and 1998 indicated that there was an

Table 3. **Soil nutrient status**

Treatments	Organic carbon (%)			Available P (mg/100g soil)			Available K (mg/100g soil)			Available Mg (mg/100g soil)			pH		
	1996	1998	Mean	1996	1998	Mean	1996	1998	Mean	1996	1998	Mean	1996	1998	Mean
M1S1	1.00	1.91	1.45	0.57	1.66	1.11	4.02	4.37	4.02	0.80	1.80	1.30	4.88	4.13	4.51
M1S2	1.11	1.89	1.50	0.52	1.81	1.17	3.32	5.22	4.27	0.42	1.79	1.10	4.78	4.22	4.50
M1S3	1.03	1.80	1.41	0.95	1.41	1.18	3.75	4.79	4.27	1.32	1.99	1.65	4.86	4.11	4.48
M1S4	1.10	1.84	1.47	1.37	1.84	1.61	3.85	4.03	3.94	2.47	1.85	2.16	4.83	4.15	4.49
M1S5	1.12	1.78	1.45	0.42	1.52	0.97	2.77	4.31	3.54	0.77	1.95	1.36	4.81	4.25	4.53
M1S6	1.07	2.10	1.58	1.70	1.41	1.55	3.20	4.12	3.66	1.02	1.71	1.37	4.72	4.10	4.41
M1S7	1.07	1.91	1.49	0.40	1.59	0.99	2.50	5.47	3.98	1.17	3.68	2.42	4.73	4.30	4.52
M1S8	1.20	1.62	1.41	0.82	1.63	1.22	3.80	5.46	4.63	2.00	2.32	2.16	4.73	4.05	4.39
M1S9	1.13	1.85	1.49	0.47	1.67	1.07	3.00	4.84	3.92	0.90	1.72	1.31	4.75	4.08	4.41
MS10	1.05	1.91	1.48	0.52	1.24	0.88	4.75	5.50	5.12	1.27	2.11	1.69	4.80	4.08	4.44
M2S1	1.02	1.83	1.42	0.92	0.97	0.94	5.50	4.27	4.88	1.20	2.90	2.05	4.72	4.26	4.49
M2S2	0.86	1.83	1.34	0.47	1.80	1.14	3.02	5.64	4.33	1.00	2.64	1.82	4.83	4.27	4.55
M2S3	1.13	1.81	1.47	0.47	1.78	1.13	3.83	6.47	5.15	1.10	2.40	1.75	4.78	4.16	4.47
M2S4	1.07	1.86	1.46	0.90	1.08	0.99	3.80	4.39	4.09	1.00	2.04	1.52	4.76	4.13	4.44
M2S5	1.11	1.79	1.45	1.82	1.18	1.50	4.72	4.64	4.68	1.27	2.59	1.93	4.66	4.23	4.44
M2S6	1.10	2.13	1.62	0.70	1.87	1.28	4.65	5.83	5.24	1.32	2.14	1.73	4.65	3.98	4.31
M2S7	1.10	2.12	1.61	1.60	2.08	1.84	3.62	6.50	5.06	0.82	2.87	1.84	4.66	4.09	4.37
M2S8	0.88	1.91	1.39	1.02	0.82	0.92	3.92	5.22	4.58	1.30	2.07	1.68	4.80	4.20	4.50
M2S9	0.95	1.69	1.32	0.70	1.20	0.95	4.13	5.25	4.68	0.62	2.10	1.36	4.65	3.63	4.14
M2S10	1.02	1.98	1.50	0.52	1.51	1.01	4.95	5.42	5.18	0.82	3.26	2.04	4.78	4.21	4.50
Mean	1.06	1.88*		0.84	1.50*		3.85	5.09*		1.13	2.30*		4.76	4.13*	

* F value significant at 1% level

improvement in soil nutrient status in all treatments during the period (Table 2). In the year 1998, all treatments had a significantly higher content of soil nutrients compared to 1996. No fertilizer (control) plots also showed a marked increase in soil nutrient status. Growing of leguminous cover crops in association with rubber has been found to impart beneficial effects on soils. It provides a dense vegetative growth, covering the soil resulting in an improvement of biological, chemical and physical properties of soil. This might be the reason for the over all improvement of the soil nutrient status over the years.

However, analysis of the data indicated that continuous addition of organic matter resulted in a significant reduction in soil pH.

Economics

Economic considerations have shown that FYM manure application required an additional expenditure of Rs. 4,750 per ha per year (Table 4) being cost of FYM (Rs. 1.25 per kg) and labour wage (Rs.125 per man day). The results revealed that application of FYM had no significant effect on improving the soil chemical properties and growth of plants in a well established ground cover management system.

Table 4. **Cost of FYM**

Details	Cost Rs./ha/year
Cost of 3 tonnes of FYM at site	3750
Labour cost for application of manure (8 labour @ Rs. 125/manday)	1000
Total	**4750**

CONCLUSION

Considering the material cost and cost involved in transportation and application, addition of FYM may not be desirable in young rubber plantations where leguminous cover crops are maintained properly.

REFERENCES

Bray, R.H. and Kurtz, L.T. (1945). Determination of total, organic and available forms of phosphorus in soils. *Soil Science*, 59: 39-45.

Haynes, R.J. and Mokolobate (2001). Amelioration of Al toxicity and P deficiency in acid solids by addition of organic residues: A critical review of the phenomenon and the mechanisms involved. *Nutrient Cycling in Agro-ecosystems*, 59: 47-63.

Horst, W.J., Kamh, M., Jibrin, J.M. and Chude, V.O. (2001). Agronomic measures for increasing P availability to crops. *Plant and Soil*, 237: 211-223.

Jackson, M.L. (1973). Soil chemical analysis, Prentice Hall Inc., New York, 498p.

Jessy, M.D., Sethuraj, M.R. and Joseph, K. (1996). Physico-chemical properties of soils under rubber with different nutrient management practices: A case study. *Indian Journal of Natural Rubber Research*, 9 (2): 134-136.

Krishnakumar, A.K. and Potty, S.N. (1992). Nutrition of *Hevea*. In: *Natural Rubber: Biology, Cultivation and Technology* (Eds. M.R. Sethuraj and N.M. Mathew), Elsevier Science Publishers, Amsterdam, pp.239-281.

Lock, C.S. (1977). Leguminous cover crops for rubber smallholdings. *Paper presented at the Seminar cum Workshop on the Modernization of Rubber Smallholders*, 1977, Kuala Lumpur, Malaysia, p 83-97.

Morgan, M.F. (1941). Chemical diagnosis by the universal soil testing system. *Bulletin of the Conneticut Agricultural Experiment Station*, 450p.

Pipes, C.S. (1966). Soil and Plant analysis. Hans Publishing House, Bombay, 368 p.

Potty, S.N., Abdulkalam, M., Punnoose, K.I. and George, C.M. (1976). Response of *Hevea* to fertilizer application in relation to soil fertility characteristics. *Rubber Board Bulletin*, 13 (3): 48-54.

Pushparajah, E., Yin, C.H. and Sivanadyan, K. (1983). Recent developments for reduced fertilizer application for *Hevea*. *Proceedings of the Rubber Research Institute of Malaysia, Planter's Conference*, 1983, Kuala Lumpur, Malaysia, pp.313-327.

Vogel, A.I. (1969). A textbook of qualitative inorganic analysis including elementary instrumental analysis. The English Language Book Society and Longman, pp. 744-745.

Watson, G.A. (1975). Cover plants in rubber cultivation. *Journal of the Rubber Research Institute of Malaya*, 15 (1): 2-18.

Watson, G.A. (1989). Nutrition. In: *Rubber*. (Eds. C.C. Webster and W.J. Baulkwil). Longman Scientific and Technical Essex, pp. 291-348.