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# EFFECT OF PHOSPHORUS ON THE GROWTH AND NUTRITIONAL STATUS OF THREE LEGUMINOUS COVER CROPS IN RUBBER PLANTATIONS

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The dry matter production and uptake of nutrients in three leguminous cover crops viz. *Pueraria phaseoloides*, *Mucuna bracteata* and *Calapogonium caeruleum* were studied in a pot culture experiment using graded doses of rockphosphate. The cover crops responded to phosphorus application irrespective of the species. Among these species, varied responses were noted by the application of graded doses of phosphorus. Six months after planting, *Pueraria* showed superiority over other two species while *Mucuna* and *Calapogonium* were found to be on par in both dry matter production and uptake of nutrients. Dry matter production under both 30 and 45 kg $P_2O_5$ per ha application was on par.

Key words: Cover crop, Dry matter production, *Hevea brasiliensis*, Nutrient uptake, Rock phosphate.

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## INTRODUCTION

Establishment of leguminous cover crops during the immature phase of rubber contribute much to the nitrogen requirement of rubber plants (Shorrocks, 1965). These leguminous cover crops return to the soil a large amount of litter and thereby increase the organic matter and mineral nutrient status. *Pueraria phaseoloides* and *Mucuna bracteata* are the two widely cultivated leguminous cover crops in rubber plantations in India. *Calapogonium caeruleum*, indigenous to Central America, is reported as a shade tolerant, drought resistant leguminous cover crop suitable for cultivation in association with rubber (Tan *et al.*, 1976). These leguminous covers vary in their ability to improve the fertility of the soil, depending on the amount of dry matter produced and on the chemical composition of the different plants.

Manuring of leguminous ground cover has been found to be beneficial for quick establishment and easy maintenance. Phosphorus plays an important role in legume nutrition and symbiotic nitrogen fixation. Beneficial effect of phosphorus application to cover crops has been reported by Mathew *et al.* (1978). Mussoorie rock phosphate is reported as a suitable phosphatic fertilizer for leguminous cover crops (Karthikakuttyamma *et al.*, 1984). To compare the growth and uptake of nutrients by the three species of cover crops viz. *Pueraria phaseoloides, Mucuna bracteata* and *Calapogonium caeruleum* a pot culture study was undertaken using graded doses of rock phosphate.

## MATERIALS AND METHODS

Two sets of pot culture experiments in completely randomized design were conducted in the glasshouse of the Rubber Research Institute of India. The treatments included three species of cover crops *viz. Pueraria phaseoloides* (T1, T2, T3), *Mucuna bracteata* (T4, T5, T6) and *Calapogonium caeruleum* (T7, T8, T9) and three levels of phosphate viz. 0, 30 and 45 kg $P_2O_5$ per ha applied in the form of Mussorie rockphosphate (MRP).

Clay loam soil was collected from the experiment station of Rubber Research Institute of India. The soil was deficient in available phosphorus and was acidic (pH of 5.0) in nature. Glazed porcelain pots of 30 cm diameter and 30 cm height were used for the experiment. Each pot was filled with 17.5 kg of the soil. Seeds of *P. phaseoloides, M. bracteata* and *C. caeruleum* were subjected to hot water, abrasion and acid treatment respectively as per the recommendations of Rubber Research Institute of India (Potty *et al.*, 1980). Five pretreated seeds were sown per pot and were regularly watered. One month after sowing, the seedlings were thinned down to three per pot and rock phosphate was applied as per the treatment schedule. A common dose of 30 kg $K_2O$/ha as Muriate of potash was also applied uniformly to all the pots. Each experimental set comprised of 27 pots with 3 replications per treatment.

Three months after sowing, the plants in the first set were uprooted. Shoot and root were separately collected from each pot and the oven dry (70$^0$C) weights recorded. Shoot and root samples were analysed for major nutrients (Piper, 1966) and the uptake was calculated. The second set of experimental plants were harvested six months after sowing and similar data collected as described above . The data from both sets were analysed statistically (Snedecor and Cochran, 1967).

## RESULTS AND DISCUSSION

Data on dry matter production at the two stages namely 3 months and 6 months after planting are presented in Table 1. Application of rockphosphate generally improved the dry matter production of cover crops. The data indicate that for first sampling overall average performance did not show any significant difference but the interaction was significant. There was no response to P application in *P. phaseoloides*. In the case of *M. bracteata*, application of P at the rate of 30 kg $P_2O_5$ per ha gave highest dry matter production which was significantly higher than both control and application at the rate of 45 kg. For *C. caeruleum*, application of 45 kg $P_2O_5$ per ha showed superiority over other two treatments. The differential response in the dry matter production in the three cover crop species may be due to the difference in their nutrient uptake pattern as illustrated by

Table 1. **Dry matter production ( g/pot )**

| $P_2O_5$ (kg/ha) | *P. phaseoloides* | *M. bracteata* | *C. caeruleum* | Mean |
|---|---|---|---|---|
| **3 months** | | | | |
| 00 | 7.06 | 7.17 | 6.01 | 6.74 |
| 30 | 9.58 | 12.22 | 8.96 | 10.25 |
| 45 | 9.00 | 8.36 | 13.57 | 10.31 |
| Mean | 8.54 | 9.25 | 9.51 | |
| **6 months** | | | | |
| 00 | 34.56 | 23.58 | 20.50 | 26.21 |
| 30 | 42.96 | 26.38 | 26.11 | 31.81 |
| 45 | 39.18 | 25.45 | 27.29 | 30.64 |
| Mean | 38.90 | 25.13 | 24.63 | |

| Factor | 3 months | | | | 6 months | | | |
|---|---|---|---|---|---|---|---|---|
| | crop | level | crop x level | one way (9 treatments ) | crop | level | crop x level | one way (9 treatments ) |
| CD (P = 0.05) | NS | 1.61 | 2.79 | 3.07 | 1.83 | 1.83 | NS | 3.69 |

Marwaha *et al.* (1981). In the second sampling, crop x P interaction was not significant. Among the three species, *P. phaseoloides* was found to be superior in which the biomass was about 50% higher than the other two species. *M. bracteata* and *C. caeruleum* were on par in dry matter production. Among the different levels of P application, both the 30 kg and 45 kg levels were at par in terms of dry matter production. The above results show the beneficial effect of rock phosphate application to cover crops. Similar results on the response of cover crop to rock phosphate application was reported by Watson *et al.* (1963). The increased dry matter production in leguminous species due to rock phosphate application may be due to the beneficial effect of phosphate on N fixation which in turn help to improve the dry matter production (Subharao, 1988; Sprent, 1979).

The data on the content of nutrients N, P, K, Ca and Mg in the three cover crops at the two stages of the experiments are summarised in Table 2. Significant difference in content of nutrients was noted only for phosphorus during the first sampling. For *P. phaseoloides* no difference in P content was noted by the differential application of graded doses of P while application of 30 kg $P_2O_5$ per ha for *M. bracteata* and 45 kg $P_2O_5$ per ha for *C. caeruleum* gave significantly lower P content. This difference in P status may be due to dilution effect as a result of higher dry matter production in those treatments. In the case of second sampling i.e. 6 months after planting this difference in P status was not apparent. Significant difference was noted only for K and Mg status. Application of 30 kg $P_2O_5$ per ha level for *P. phaseoloides* alone gave significantly higher K and Mg status, while all other treatments were found to be on par.

Application of rock phosphate improved the uptake of nutrients N, P, K, Ca and Mg

Table 2. **Nutrient content (%) of whole plant**

| Treatment | N | | P | | K | | Ca | | Mg | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Months | | Months | | Months | | Months | | Months | |
| | 3 | 6 | 3 | 6 | 3 | 6 | 3 | 6 | 3 | 6 |
| *P. phaseoloides* + $P_0$ | 2.79 | 2.39 | 0.21 | 0.16 | 2.66 | 2.26 | 1.47 | 1.25 | 0.37 | 0.26 |
| *P. phaseoloides* + $P_{30}$ | 2.65 | 2.45 | 0.21 | 0.19 | 2.59 | 3.29 | 1.74 | 1.34 | 0.45 | 0.31 |
| *P. phaseoloides* + $P_{45}$ | 2.83 | 2.64 | 0.22 | 0.16 | 2.68 | 2.55 | 1.65 | 1.29 | 0.40 | 0.26 |
| *M. bracteata* + $P_0$ | 2.77 | 2.92 | 0.18 | 0.15 | 2.58 | 2.59 | 1.57 | 1.33 | 0.33 | 0.20 |
| *M. bracteata* + $P_{30}$ | 3.14 | 2.84 | 0.14 | 0.15 | 2.53 | 2.32 | 1.84 | 1.40 | 0.33 | 0.22 |
| *M. bracteata* + $P_{45}$ | 2.81 | 2.75 | 0.19 | 0.16 | 2.49 | 2.54 | 1.79 | 1.32 | 0.39 | 0.22 |
| *C. caeruleum* + $P_0$ | 2.69 | 2.72 | 0.19 | 0.16 | 2.43 | 2.37 | 1.50 | 1.35 | 0.33 | 0.22 |
| *C. caeruleum* +$P_{30}$ | 2.54 | 2.55 | 0.18 | 0.17 | 2.33 | 2.29 | 1.55 | 1.29 | 0.39 | 0.18 |
| *C. caeruleum* +$P_{45}$ | 3.07 | 2.37 | 0.15 | 0.17 | 2.21 | 2.56 | 1.37 | 1.16 | 0.34 | 0.18 |
| SE | 0.21 | 0.14 | 0.01 | 0.01 | 0.13 | 0.19 | 0.10 | 0.09 | 0.04 | 0.02 |
| CD (0.05) | NS | NS | 0.03 | NS | NS | 0.58 | NS | NS | NS | 0.05 |

(Table 3). Three months after planting significant difference between treatments was observed only for N, K and Ca uptake. No pronounced effect of rock phosphate application was noted in *P. phaseoloides* on the uptake of N, P, K and Mg three months after planting, while application of 30 kg $P_2O_5$ improved the Ca uptake. For *M. bracteata* application of 30 kg $P_2O_5$ per ha resulted in higher uptake of N, K and Ca, while for *C. caeruleum* 45 kg level gave higher uptake of N, K and Ca. Six months after planting, application of rock phosphate increased the uptake of N, P, K, Ca and Mg by the legume plants. For *P. phaseoloides* application of 30 kg $P_2O_5$ per ha gave higher uptake of N, P, K, Ca and Mg over no P control and was found to be on par with 45 kg for N and Ca uptake and higher for P, K and Mg. Response to P application in terms of P uptake was not evident in *M. bracteata* six months after planting. The lack of response to P application on uptake of nutrients in the case of *M. bracteata* may be due to the difference in

Table 3. **Nutrient uptake by whole plant (mg/pot)**

| Treatment | N | | P | | K | | Ca | | Mg | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Months | | Months | | Months | | Months | | Months | |
| | 3 | 6 | 3 | 6 | 3 | 6 | 3 | 6 | 3 | 6 |
| *P. phaseoloides* + $P_0$ | 197.00 | 829.00 | 14.71 | 57.43 | 186.67 | 785.00 | 102.67 | 430.67 | 27.67 | 88.53 |
| *P. phaseoloides* + $P_{30}$ | 255.70 | 1053.00 | 20.00 | 82.90 | 247.33 | 416.00 | 168.00 | 572.00 | 43.33 | 133.50 |
| *P. phaseoloides* + $P_{45}$ | 250.30 | 1032.67 | 19.00 | 62.43 | 236.33 | 994.67 | 148.67 | 507.33 | 38.00 | 103.20 |
| *M. bracteata* + $P_0$ | 196.70 | 689.00 | 11.70 | 35.80 | 190.67 | 608.67 | 108.33 | 310.67 | 25.00 | 48.07 |
| *M. bracteata* + $P_{30}$ | 377.30 | 752.67 | 17.00 | 39.20 | 310.67 | 615.33 | 225.33 | 372.67 | 40.67 | 57.47 |
| *M. bracteata* + $P_{45}$ | 232.30 | 702.00 | 16.50 | 40.63 | 212.00 | 644.67 | 152.30 | 338.67 | 36.67 | 55.37 |
| *C. caeruleum* + $P_0$ | 165.00 | 559.00 | 11.40 | 33.93 | 147.67 | 485.00 | 91.00 | 272.67 | 21.67 | 43.93 |
| *C. caeruleum*+$P_{30}$ | 220.70 | 665.67 | 15.40 | 45.23 | 200.33 | 601.67 | 134.67 | 341.67 | 32.33 | 47.70 |
| *C. caeruleum* +$P_{45}$ | 419.00 | 647.67 | 20.90 | 47.13 | 293.33 | 701.33 | 185.67 | 317.00 | 46.67 | 49.77 |
| SE | 31.60 | 52.28 | 2.20 | 4.14 | 28.83 | 64.71 | 18.49 | 34.05 | 5.99 | 5.33 |
| CD (P = 0.05) | 93.90 | 155.35 | NS | 12.30 | 85.66 | 192.26 | 54.90 | 101.16 | NS | 15.85 |

its rooting pattern since the roots of *M. bracteata* grow deeper and absorb nutrients from there as reported by Kothandaraman *et al.* (1984). In the case of *C. caeruleum* application of 45 kg $P_2O_5$ showed significantly higher P and K uptake than the other two treatments.

Response to rock phosphate application on P uptake was noted only after 6 months. Poor root growth during the initial period may be the reason for lack of response at the three months stage. The root growth and P uptake are correlated as suggested by Newman and Andrews (1973).

In general, the data showed that in the absence of P, the dry matter production in cover crops was significantly low. This may be due to the low availability of other major nutrients especially nitrogen under P deficient condition which limit the supply of ATP required for nodular fixation of nitrogen.

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