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# COMPARATIVE EVALUATION OF DRY MATTER PRODUCTION AND NUTRIENT ACCUMULATION IN THE SHOOTS OF *PUERARIA PHASEOLOIDES* BENTH AND *MUCUNA BRACTEATA* D.C. GROWN AS COVER CROPS IN AN IMMATURE RUBBER (*HEVEA BRASILIENSIS*) PLANTATION

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In a comparative study it was observed that the dry matter production of one year old *Pueraria phaseoloides* Benth was higher than that of *Mucuna bracteata* D.C. of the same age. From the second year onwards the dry matter production was higher for *M. bracteata*. Dry matter production was the maximum in the second year for both *P. phaseoloides* (5.46 t/ha) and *M. bracteata* (7.62 t/ha). The N, P, K, Ca and Mg contents of *P. phaseoloides* was 174.17, 13.08, 103.84, 65.35 and 18.03 kg/ha respectively while it was 236.21, 15.21, 79.08, 55.71 and 14.57 kg/ha respectively for *M. bracteata*.

Key words: Biomass, Cover crop, *Hevea brasiliensis, Mucuna bracteata*, Nutrient, *Pueraria phaseoloides.*

The beneficial effects of leguminous covers on growth and yield of rubber (*Hevea brasiliensis*) have been well documented (Watson, 1961, 1963; Watson *et al.*, 1964; Mathew *et al.*, 1989; Punnoose *et al.*, 1994). Cover crops help to improve physico-chemical properties of soil, resulting in a more favourable soil environment for root growth and proliferation (Watson, 1957; Soong and Yap, 1976). They also add a large quantity of litter to the soil, which on biological degradation and mineralisation forms humus. The nature, quantity and chemical composition of the dry matter produced varies with the cover crops and it influences the soil fertility (Jeevaratnam, 1961). *P. phaseoloides* and *M. bracteata* are the more popular cover crops grown in rubber plantations in India. The growth characters, nodulation and nitrogen fixation of *M. bracteata* have been studied (Kothandaraman *et al.*, 1987). The comparative efficiency of *M. bracteata* and *P. phaseoloides* on soil nutrient enrichment, building up of microbial population and on soil moisture status have also been reported (Kothandaraman *et al.*, 1989). However, their efficiency in dry matter production and nutrient accumulation over years has not been established. Hence a study was taken up for quantifying the dry matter production and nutrient accumulation by *P. phaseoloides* and *M. bracteata* from the first to the fifth year of growth.

Immature rubber fields, with *P.*

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*phaseoloides* and *M. bracteata* ranging in age from one to five years as cover crops were identified in the Travancore Rubbers and Tea Company Estates at Mundakayam, in Kottayam District of Kerala State in India. *P. phaseoloides* was established by planting the pretreated seeds in beds and *M. bracteata* by planting cuttings in beds. Eight micro plots each (1 x 1m size) were demarcated at random in the respective leguminous cover crop fields within each age group. The fresh weight of the shoot portions and litter in the micro plots were recorded. The samples were then oven dried at 70°C and their dry weight recorded and the dry matter production estimated. The nutrient contents were analysed as per standard procedures (Piper, 1950). The data were subjected to ANOVA and ANACOVA analyses. In order to account for the soil heterogenity, covariance analysis was done using soil properties as the covariant for the comparison of cover crops at different ages.

A comparison of the dry matter production by *P. phaseoloides* and *M. bracteata* of the same age is presented in Table 1. The data indicated that dry matter production of one year old *P. phaseoloides* was higher than that of *M. bracteata*. However, from the second year onwards the dry matter production was more for *M. bracteata* and was significantly higher during the third and fourth years.

Covariance analysis of the dry matter production at different ages (Table 2) indicated that two year old *P. phaseoloides* and *M. bracteata* recorded the highest dry matter accumulation (5.46 and 7.62 t/ha respectively). Thereafter a declining trend was noticed which could be due to the shade effect of the growing rubber trees.

The macronutrient contents of the shoot portions of the two legume covers in the same age groups are presented in Table 3. The nitrogen content of the two cover

Table 2. **Covariance analysis of the adjusted mean dry matter production (t/ha) of *P. phaseoloides* and *M. bracteata* at different ages**

| Age (year) | *P. phaseoloides* | *M. bracteata* |
|---|---|---|
| 1 | 3.34 | 2.63 |
| 2 | 5.46 | 7.62 |
| 3 | 3.43 | 5.41 |
| 4 | 2.60 | 3.92 |
| 5 | 2.45 | 3.32 |
| SE | 0.51 | 0.82 |
| CD ($P \leq 0.05$) | 1.03 | 1.66 |

crops was not significantly different in the different years, though it was marginally higher in *M. bracteata* in the second and third years. The potassium, calcium and magnesium contents were significantly higher in *P. phaseoloides* than in *M. bracteata* in the first three years. In the fourth year, no significant difference was noticed between the species in these nutrient levels. In the

Table 1. **Dry matter production (t/ha) of *P. phaseoloides* and *M. bracteata***

| Species | Age (year) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| *P. phaseoloides* | 3.25 | 5.56 | 3.46 | 2.56 | 2.47 |
| *M. bracteata* | 2.75 | 7.53 | 5.35 | 4.01 | 3.28 |
| SE | 0.33 | 0.66 | 0.56 | 0.34 | 0.39 |
| CD ($P \leq 0.05$) | NS | NS | 1.71 | 1.03 | NS |

Table 3. **Macronutrient content (%) in shoots of cover crops of the same age groups**

| | Age (year) | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| N | *P. phaseoloides* | 3.47 | 3.20 | 3.12 | 3.74 | 3.29 |
| | *M. bracteata* | 3.27 | 3.52 | 3.69 | 3.87 | 3.57 |
| | SE | 0.07 | 0.08 | 0.08 | 0.10 | 0.11 |
| | CD (P≤0.05) | NS | 0.23 | 0.23 | NS | NS |
| P | *P. phaseoloides* | 0.30 | 0.26 | 0.23 | 0.26 | 0.22 |
| | *M. bracteata* | 0.21 | 0.26 | 0.20 | 0.27 | 0.22 |
| | SE | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| | CD (P≤0.05) | 0.03 | NS | NS | NS | NS |
| K | *P. phaseoloides* | 2.70 | 2.31 | 2.28 | 2.06 | 2.23 |
| | *M. bracteata* | 1.34 | 1.71 | 1.62 | 2.00 | 1.66 |
| | SE | 0.11 | 0.09 | 0.08 | 0.10 | 0.07 |
| | CD (P≤0.05) | 0.32 | 0.27 | 0.23 | NS | 0.20 |
| Ca | *P. phaseoloides* | 0.85 | 1.04 | 0.81 | 0.93 | 0.92 |
| | *M. bracteata* | 0.69 | 0.59 | 0.55 | 0.85 | 0.60 |
| | SE | 0.05 | 0.04 | 0.05 | 0.04 | 0.04 |
| | CD (P≤0.05) | 0.14 | 0.12 | 0.16 | NS | 0.11 |
| Mg | *P. phaseoloides* | 0.42 | 0.34 | 0.24 | 0.36 | 0.27 |
| | *M. bracteata* | 0.27 | 0.14 | 0.16 | 0.31 | 0.27 |
| | SE | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 |
| | CD (P≤0.05) | 0.04 | 0.04 | 0.04 | NS | NS |

case of phosphorus, one year old *P. phaseoloides* registered a significantly higher content than *M. bracteata* of the same age, probably due to the rock phosphate application in their planting strips. During the remaining periods the values were comparable for both the species. Similar results were reported by Mathews and Thim (2000).

The macronutrient contents in the shoot portions of *P. phaseoloides* and *M. bracteata* at different ages are given in Table 4. In the case of *P. phaseoloides*, the N content was the highest in the fourth year, while P, K and Mg contents were the highest in the first year. In the case of *M. bracteata* all the macronutrients were the highest in the fourth year of growth.

The micronutrient contents of the shoots of the two legume covers of the same

Table 4. **Covariance analysis of adjusted means of macronutrient content (%) in *P. phaseoloides* and *M. bracteata* at different ages**

| Age (year) | N | P | K | Ca | Mg |
|---|---|---|---|---|---|
| | | | *P. phaseoloides* | | |
| 1 | 3.52 | 0.31 | 2.71 | 0.86 | 0.42 |
| 2 | 3.16 | 0.25 | 2.29 | 1.02 | 0.33 |
| 3 | 3.10 | 0.23 | 2.27 | 0.80 | 0.24 |
| 4 | 3.77 | 0.26 | 2.11 | 0.94 | 0.36 |
| 5 | 3.28 | 0.22 | 2.22 | 0.91 | 0.27 |
| SE | 0.11 | 0.014 | 0.15 | 0.07 | 0.024 |
| CD (P≤0.05) | 0.22 | 0.02 | 0.30 | 0.14 | 0.04 |
| | | | *M. bracteata* | | |
| 1 | 3.27 | 0.21 | 1.35 | 0.71 | 0.27 |
| 2 | 3.51 | 0.26 | 1.73 | 0.63 | 0.14 |
| 3 | 3.69 | 0.20 | 1.62 | 0.55 | 0.16 |
| 4 | 3.88 | 0.27 | 1.98 | 0.81 | 0.31 |
| 5 | 3.57 | 0.22 | 1.65 | 0.58 | 0.26 |
| SE | 0.13 | 0.012 | 0.10 | 0.04 | 0.014 |
| CD (P≤0.05) | 0.26 | 0.024 | 0.20 | 0.08 | 0.028 |

age groups are given in Table 5. *P. phaseoloides* contained more Fe than *M. bracteata* at all the years except at the fourth year. The Mn content was significantly higher in *P. phaseoloides* than in *M. bracteata* at the second, third and fifth years of growth. Zn content in the two species was on par in all the years.

Nutrient content of the *P. phaseoloides* and *M. bracteata* litters are presented in Table 6. Litter of *M. bracteata* was richer than that of *P. phaseoloides* in N content and it was the highest in the litter of the two year old cover crop. *P. phaseoloides* litter was richer than that of *M. bracteata* in P, K, Mg and Zn contents. Calcium content was higher in the *P. phaseoloides* litter than that of *M. bracteata* at all ages except in the third

Table 5. **Micronutrient content (ppm) in cover crops of the same age groups**

| | Species | Age (year) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Fe | *P. phaseoloides* | 660.00 | 726.38 | 484.50 | 402.88 | 621.25 |
| | *M. bracteata* | 329.25 | 298.50 | 379.00 | 680.00 | 445.88 |
| | SE | 45.14 | 31.62 | 48.65 | 37.49 | 40.52 |
| | CD ($P \leq 0.05$) | 136.92 | 95.90 | NS | 113.71 | 122.91 |
| Mn | *P. phaseoloides* | 211.88 | 193.00 | 125.12 | 169.62 | 202.88 |
| | *M. bracteata* | 225.62 | 77.88 | 86.38 | 176.25 | 121.75 |
| | SE | 12.35 | 13.64 | 10.32 | 8.13 | 11.99 |
| | CD ($P \leq 0.05$) | NS | 41.37 | 30.39 | NS | 36.37 |
| Zn | *P. phaseoloides* | 42.00 | 41.00 | 30.00 | 40.75 | 36.12 |
| | *M. bracteata* | 41.62 | 39.38 | 25.88 | 43.12 | 37.75 |
| | SE | 1.38 | 2.11 | 1.64 | 1.26 | 1.77 |
| | CD ($P \leq 0.05$) | NS | NS | NS | NS | NS |

Table 6. **Nutrient content in the litter of *P. phaseoloides* (P) and *M. bracteata* (M)**

| | Species | Age (year) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| N (%) | P | 2.18 | 3.12 | 2.12 | 2.77 | 2.80 |
| | M | 2.52 | 3.16 | 2.79 | 2.87 | 2.86 |
| P (%) | P | 0.15 | 0.16 | 0.15 | 0.14 | 0.15 |
| | M | 0.12 | 0.15 | 0.16 | 0.12 | 0.12 |
| K (%) | P | 0.40 | 0.38 | 0.48 | 0.44 | 0.30 |
| | M | 0.40 | 0.32 | 0.32 | 0.36 | 0.32 |
| Ca (%) | P | 1.47 | 1.20 | 1.00 | 1.20 | 1.42 |
| | M | 1.06 | 1.15 | 1.31 | 1.00 | 0.87 |
| Mg (%) | P | 0.36 | 0.28 | 0.26 | 0.33 | 0.29 |
| | M | 0.28 | 0.29 | 0.27 | 0.25 | 0.30 |
| Mn (ppm) | P | 574 | 329 | 256 | 378 | 493 |
| | M | 386 | 334 | 292 | 358 | 511 |
| Zn (ppm) | P | 53 | 74 | 51 | 52 | 53 |
| | M | 49 | 60 | 50 | 52 | 61 |

Table 7. **Nutrient accumulation (kg/ha) in *P. phaseoloides* and *M. bracteata* of the same age**

| | Species | Age (year) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| N | *P. phaseoloides* | 109.23 | 176.67 | 102.22 | 88.10 | 82.08 |
| | *M. bracteata* | 86.81 | 234.30 | 168.44 | 142.14 | 97.22 |
| | SE | 11.00 | 10.89 | 11.68 | 11.13 | 6.13 |
| | CD ($P \leq 0.05$) | NS | 33.03 | 35.42 | 33.76 | NS |
| P | *P. phaseoloides* | 9.48 | 13.26 | 7.50 | 6.16 | 5.23 |
| | *M. bracteata* | 5.33 | 15.10 | 9.55 | 9.04 | 5.13 |
| | SE | 1.02 | 1.07 | 0.82 | 0.72 | 0.40 |
| | CD ($P \leq 0.05$) | 3.08 | NS | NS | 2.18 | NS |
| K | *P. phaseoloides* | 81.27 | 104.60 | 67.78 | 47.23 | 47.84 |
| | *M. bracteata* | 33.09 | 78.25 | 58.67 | 64.60 | 31.01 |
| | SE | 9.43 | 6.55 | 8.11 | 6.15 | 3.54 |
| | CD ($P \leq 0.05$) | 28.60 | 19.88 | NS | NS | 10.74 |
| Ca | *P. phaseoloides* | 30.19 | 63.19 | 31.15 | 23.22 | 24.23 |
| | *M. bracteata* | 20.66 | 55.06 | 41.27 | 35.90 | 21.30 |
| | SE | 2.57 | 4.88 | 3.50 | 2.59 | 1.46 |
| | CD ($P \leq 0.05$) | 7.80 | NS | NS | 7.86 | NS |
| Mg | *P. phaseoloides* | 13.59 | 18.38 | 8.24 | 9.41 | 7.83 |
| | *M. bracteata* | 7.53 | 14.33 | 10.54 | 12.48 | 8.27 |
| | SE | 1.38 | 1.02 | 1.04 | 1.29 | 0.76 |
| | CD ($P \leq 0.05$) | 4.20 | 3.11 | NS | NS | NS |

year. Manganese content was more in the litter of *M. bracteata* than that of *P. phaseoloides* in all years except in the first and fourth years.

Age-wise comparison of nutrient accumulation by the two cover crops is given in Table 7. *M. bracteata* accumulated significantly more nitrogen than *P. phaseoloides* in the second, third and fourth years of establishment. In the first year, *P. phaseoloides* accumulated significantly more phosphorus and calcium than *M. bracteata* but the trend was reversed in the fourth year. The potassium accumulation was significantly higher in *P. phaseoloides* than in *M. bracteata* except in the third and fourth years. The magnesium accumulated by *P. phaseoloides* was higher than that by *M. bracteata* in the ini-

Table 8. **Covariance analysis of adjusted means of nutrient accumulation (kg/ha) in the cover crops at different ages**

| Age (year) | N | P | K | Ca | Mg |
|---|---|---|---|---|---|
| | *P. phaseoloides* | | | | |
| 1 | 112.13 | 9.68 | 82.15 | 32.02 | 14.06 |
| 2 | 174.17 | 13.08 | 103.84 | 65.35 | 18.03 |
| 3 | 100.70 | 7.39 | 67.32 | 30.19 | 7.99 |
| 4 | 95.23 | 6.30 | 47.87 | 27.07 | 9.76 |
| 5 | 81.07 | 5.15 | 47.54 | 23.59 | 7.66 |
| SE | 15.21 | 1.28 | 12.63 | 7.33 | 1.93 |
| CD ($P \leq 0.05$) | 30.87 | 2.61 | 25.64 | 14.89 | 3.92 |
| | *M. bracteata* | | | | |
| 1 | 84.60 | 5.20 | 32.14 | 19.90 | 7.25 |
| 2 | 236.21 | 15.21 | 79.08 | 55.71 | 14.57 |
| 3 | 169.60 | 9.62 | 59.17 | 41.67 | 10.68 |
| 4 | 140.51 | 8.95 | 63.90 | 35.34 | 12.27 |
| 5 | 97.99 | 5.18 | 31.34 | 21.57 | 8.37 |
| SE | 15.18 | 1.13 | 6.99 | 3.21 | 1.12 |
| CD ($P \leq 0.05$) | 30.83 | 2.28 | 14.20 | 6.51 | 2.28 |

tial two years though there was no significant difference later. There was no significant difference in the content between the cover crops in the fifth year for all nutrients except K.

Nutrient accumulation by *P. phaseoloides* and *M. bracteata* at different ages is given in Table 8. The data indicated that accumulation of nutrients peaked in the second year and thereafter decreased. This may be due to the progressive decrease in dry matter production of the two cover crops from third year of establishment. The maximum quantity of nutrient accumulated in a hectare over two years were 174.17 kg N, 13.08 kg P, 103.84 kg K, 65.35 kg Ca and 18.03 kg Mg for *P. phaseoloides* and 236.21 kg N, 15.21 kg P, 79.08 kg K, 55.71 kg Ca and 14.57 kg Mg for *M. bracteata*.

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