Effects of P on Vigna unguiculata cv. 305 and Stylosanthes hamata cv. Verano in rubber plantation.

K. Sungthongwises*, R. Poss*, and J.J. Drevon*

Department of Plant Science and Agricultural Resources, Faculty of Agriculture, Khon Kaen University, Muang, Khon Kaen, 40002, Thailand.

* INRA, UMR EcoylsysteM, Montpellier, France.

ABSTRACT

The objective was to assess the effects of P and N additions on nodulation and N₂ fixation of Vigna unguiculata cv. 305 (cowpea) and Stylosanthes hamata cv. Verano associations with hevea brasiliensis in NE Thailand. The results show that P additions increased above-ground biomass, nodulation and N₂ fixation of V. unguiculata and S. hamata. With P applications, N₂ fixation represented between 30% and 58% of total plant N. Without fertilization, the nodule dry weight for V. unguiculata increased strongly with the soil organic carbon, and was positively correlated with plant N content.

INTRODUCTION

The sandy soils of NE Thailand are P deficient (Suriya-Arunroj et al., 2000). P deficiency is more likely to affect N₂-dependent legumes than other species because symbiotic nitrogen fixation is an energetic process which requires more inorganic P than mineral nitrogen assimilation (Ribet and Drevon, 1995). The objectives of this study were i) to characterize the effects of soil P on the growth and nodulation of V. unguiculata cv. 305 (cowpea) and S. hamata cv. Verano, ii) to test the use of the weight of the nodules to estimate N fixation.

MATERIALS AND METHODS

1. Experimental design

Seeds of V. unguiculata cv. 305 (crop 1) and Stylosanthes hamata cv. Verano (crop 2) were sampled to measure their average weight and to determine their N and P content before the start of the experiment. The seeds were then inoculated with Bradyrhizobium sp. (V. unguiculata) strain TAL 169 + NC 92. Potassium nitrate and Triple super phosphate (TSP) were applied at emergence. For the NP treatment urea was applied as follows: 20 kg N ha⁻¹ at emergence, 50 kg N ha⁻¹ at the beginning of flowering and 50 kg N ha⁻¹ as urea at grain filling. PK treatment was a bare plot with 30 kg N ha⁻¹ as potassium nitrate and 90 kg P ha⁻¹ triple super phosphate (TSP) at emergence.

2. Biomass measurements

At flowering for V. unguiculata cv. 305, 10 plants per plot were randomly selected in the control and the P treatment. For each plot the above-ground part was cut and the roots were carefully removed from the soil. For each cut for S. hamata cv. Verano a pit was dug to 30 cm to collect the roots. The number of nodules was counted.

3. Nitrogen measurements

For each sample of above-ground biomass N content was measured by micro-Kjeldahl with indophenol blue. For the control and the P treatment, the grains and the rest of the plant were analyzed to determine N and P content.

RESULTS

1. Effect of P fertilization on the growth

P addition resulted in a significantly better shoot growth of V. unguiculata cv. 305 at flowering. N and P addition (NP) resulted in a significant increase in growth compared to the control but did not significantly improve any biomass parameter compared to P addition. The differences in growth between crop 1 and crop 2 was due to water saturation of the soil during the rainy season. S. hamata cv. Verano also had significantly higher values after 158 DAS (Figure 1).

2. Effect of P fertilization on nodulation

For V. unguiculata cv. 305, P addition resulted in a significant increase in nodule weight for all the stages of the two crops and significantly higher nodule weight only at 158 DAS for S. hamata cv. Verano. This higher weight was the result of an increase in the number of nodules rather than an increase in the average weight of the nodules (Figure 2).

3. Effect of P fertilization on plant N and P content and relation with nodulation

For V. unguiculata cv. 305 and S. hamata cv. Verano, P addition increased consistently total N (Figure 3 and 4) and P (Figure 5 and 6) in the plant. N fixation can be estimated from the correlation between total plant N and nodule weight. Figure 7 shows the addition of P increased significantly total plant N for V. unguiculata cv. 305 at flowering and harvest stage in crop 2 and for S. hamata cv. Verano at 183 DAS.

CONCLUSION

P addition increased the above-ground biomass, the nodulation, the overall dry weight of nodules and N₂ fixation of V. unguiculata cv. 305 and S. hamata cv. Verano. The addition of nitrogen fertilizer had a negative effect on nodulation. N fixation was therefore increased by P applications and provided between 50 and 58% of total plant N. The correlation between total plant N and nodule dry weight seems thus a promising method to estimate N fixation.

ACKNOWLEDGEMENTS

This work was supported by collaboration between IRD, INRA and Khon Kaen University with the kind support of the Franco-Thai Cooperation Program in Research. We would like to thank heartfully the farmer partners in the project.

REFERENCES
