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NITROGEN AND P UPTAKE IMPROVEMENT OF FORAGE LEGUMES BY ROCK PHOSPHATE FERTILIZATION AND VAM INOCULATION

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ABSTRACT

This experiment was conducted to determine the effect of rock phosphate fertilization and vesicular-arbuscular mycorrhiza (VAM) inoculation of *Glomus* sp on nitrogen (N) and phosphorus (P) uptake of *Flemingia congesta* (flemingia), *Pueraria phaseoloides* (puero), and *Stylosanthes guianensis* (stylo) on the Latosolic soil sterilized by gamma irradiation. Flemingia, puero, and stylo were fertilized by rock phosphate (0, 100, 200, and 300 kg P_2O_5/ha or 0, 0.8, 1.6, and 2.4 g rock phosphate/pot) and were inoculated by Glomus sp. (control, 50 spores/pot). Legumes were cut twice at 3 month and 2 month, respectively. N and P uptake of flemingia and puero were increased (P<.05) by VAM inoculation. N and P uptake of puero were higher (P<.05) than flemingia and stylo with VAM inoculation for both the first and second cutting. However, N and P uptake of mycorrhizal puero were decreased (P<.05) on the second cutting. N and P uptake of stylo with and without VAM inoculation were not significantly different (P>.05) on the first and second cutting. P uptake of legumes was increased (P<.05) by rock phosphate 300 kg P_2O_5/ha.

Key words: Mycorrhiza, Rock phosphate, *Flemingia congesta*, *Pueraria phaseoloides*, *Stylosanthes guianensis*

INTRODUCTION

Flemingia (*Flemingia congesta*), puero (*Pueraria phaseoloides*), and stylo (*Stylosanthes guianensis*) are important forage legumes as protein and mineral sources for ruminant livestock in the tropics (Lukiwati *et al.*, 1995). Most of the lands which are used for forage production belong to the non productive lands characterized by lack of P content and low soil pH. Legumes are very sensitive to P deficiency because their efficiency of P absorption is very low (Jones, 1990). This is due to its magnolioid roots system (Mosse, 1981). The combination of persistent legumes and superphosphate fertilization have been used widely to improve the pasture development. However, the high cost of superphosphate fertilizer to be a limiting factor for pasture development. Rock phosphate fertilization and VAM inoculation maybe a promising technique to overcome these problems.

Rock phosphate as one of the phosphorus sources, its price relatively cheaper than superphosphate and its available in fast amount in Indonesia. However, rock phosphate belongs to slow available source of phosphorus. VAM fungi is one of the endomycorrhiza which plays an important role to increase nutrient uptake (Marshner and Dell, 1994). Legumes are suitable host plants for VAM culture (Lukiwati and Supriyanto, 1995) and they are persistent in poorly productive soils (Lukiwati *et al.*, 1994). Symbiotic association between VAM and legume plant was more responsive and efficient with rock phosphate than the other type of P fertilizers (Dodd *et al.*, 1990[b])

Most of research on VAM inoculation was done in forest trees and agriculture crops, but it is rarely in forage crops. The constraint of mycorrhizal technology application in

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forage crops is caused by limited information on the role of VAM fungi especially in the production and nutritive value of forage crops in Indonesia (Lukiwati *et al.*, 1997).

The objective of this study was to examine the effect of VAM inoculation and rock phosphate fertilization on N and P uptake of flemingia, puero and stylo on the Latosolic soil.

MATERIALS AND METHODS

The experiment was conducted in a greenhouse during 5 months. Sterilized soil (by gamma irradiation at 42 kGy) was used for this experiment. Each pot contain 4 kg airdry weight soil inoculated with 50 spores of Glomus sp according to the assigned treatment. Counting of the spore number for inoculation was carried out using wet seaving and decanting technique (Gerdemann and Nicolson, 1963), followed by sucrose centrifugation (Daniels and Skipper, 1982). Rock phosphate and KCl (100 kg K_2O/ha or 0.3 g KCl/pot) were applied at the time of planting. Urea was added (50 kg N/ha or 0.2 g urea/pot) at 3 weeks after planting.

Split in time in Completely Randomized Design was used in three replicates and tested using Duncan's Multiple Range Test (DMRT) by SAS program. The main plots were : 1). Legume species (flemingia, puero, stylo), 2). VAM inoculation (without or with VAM), and 3). Rock phosphate fertilization (0, 100, 200, and 300 kg P_2O_5/ha or 0, 0.8, 1.6, and 2.4 g rock phosphate/pot). The sub plot was a cutting period (twice). The first cutting period was conducted three months after planting and two months for the next cutting. Plant samples were analyzed for N and P uptake (N and P content in % x dry matter yield).

RESULT AND DISCUSSION

The result showed that N and P uptake was significantly influenced by interaction between cutting period, legume species and VAM inoculation (Table 1, Table 2). Rock phosphate fertilization was significantly increased P uptake of legumes (Table 3).

Nitrogen and P uptake of flemingia and puero with VAM were higher than that without VAM at the first and second cutting (Table 1, Table 2). Meanwhile it is not significant in stylo. In terms of N and P uptake of puero was highest one followed by flemingia and stylo.

Plant growth and root geometry (root number and distribution in the soil) vary between plant species, as well as their response to VAM inoculation (Kerridge and Ratcliff, 1982; Lukiwati *et al.*, 1994).

The increase of N and P uptake of each legume species with VAM at the first cutting was 31 times, 84 times for flemingia, and 9 times, 18 times for puero, respectively compared to non-mycorrhizal one. Micro-organisms are eliminated when soils are exposed to gamma irradiation at 25-60 kGy (Alexander, 1964).

Table 1. Nitrogen uptake of mycorrhizal legumes on two cutting period

Legume Species	Cutting Period I VAM-	Cutting Period I VAM+	Cutting Period II VAM-	Cutting Period II VAM+
	.... mg/pot			
Flemingia	2.30d	71.67bc	3.44d	72.87bc*
Puero	22.66d	209.93a	25.94cd	99.83b
Stylo	2.31d	30.16cd	2.44d	17.18d

*) Significantly different at 5% level (DMRT)

Table 2. Phosphorus uptake of mycorrhizal legumes on two cutting period

	Cutting Period			
	I		II	
Legume Species	VAM-	VAM+	VAM-	VAM+
	.... mg/pot			
Flemingia	0.05c	4.20b	0.20c	4.32b*
Puero	0.60c	10.94a	0.60c	5.61b
Stylo	0.03c	1.91c	0.09c	1.10c

*) Significantly different at 5% level (DMRT)

Legume belongs to the magnolioid roots plant. Therefore, their association with mycorrhizal fungi will improved the growth and development of legume plant (Mosse, 1981). VAM inoculation improved the plant growth possibly because of enhancing nutrient uptake (Marschner and Dell, 1994). Nutrient uptake en hancement in mycorrhizal legumes is most likely due to the external fungal hyphae acting as an extension of the rooting system. External hyphae length prolong up to 7-10 m/g soil (Allen *et al.*, 1992). Accordingly, the mycorrhizal legumes will absorb the nutrient from the soil and will translocate the nutrient to the host root more efficient (more extensive and better distributed) than the nonmycorrhizal legume (Linderman, 1992).

Nitrogen and P uptake of mycorrhizal puero were de creased at the second cutting period (Table 1, Table 2). Regrowth of forage legumes in the pot culture are slower than in the field (Lukiwati, 1996). Under these condition there is probably competition between the plant and the VAM fungi in photosynthate utilization for host plant regrowth and VAM fungi development. The development of VAM fungi may normally be controlled by photosynthate supply from host plant (Azcon-Aguilar and Bago, 1994). Thereby, dry matter production of the second cutting became lower than the first cutting period which in turn decreased N and P uptake.

Phosphorus uptake of legumes was increased by rock phosphate fertilization (Table 3). Rock phosphate fertilization (300 kg P_2O_5/ha) significantly increased the P uptake of legumes compared to control (without rock phosphate). Rock phosphate fertilization could increased P uptake, especially if the phosphorus nutrient is a major limiting factor to plant growth (Dodd *et al.*, 1990[a]; Jones, 1990).

CONCLUSION

Vesicular-arbuscular mycorrhiza (VAM) fungi inoculation increased nitrogen

Table 3. Effect of rock phosphate fertilization on P uptake of legumes

Rock Phosphate (kg P_2O_5/ha)	P Uptake (mg/pot)
0	1.37b*
100	2.13ab
200	2.94ab
300	3.51a

*) Significantly different at 5 % level (DMRT)

and P uptake of forage legumes. Nitrogen and P uptake of mycorrhizal puero were higher than those of flemingia and stylo. Rock phosphate fertilization increased P uptake of forage legumes.

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