

## RESPONSE OF *MEDICAGO SATIVA* TO INOCULATION WITH VESICULAR ARBUSCULAR MYCORRHIZAE (VAM) UNDER VARYING LEVELS OF PHOSPHORUS

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A pot experiment was conducted with sterilized soil to study the effect of  $P_2O_5$  and mycorrhizal fungus on growth of *Medicago sativa*. Inoculation with *Gigaspora rosea* had no significant effect on plant growth over the respective/uninoculated controls, while with dual inoculation, (*Glomus etunicatum* + *Glomus intraradices*) the increase was significantly higher both in the presence or absence of phosphorus. The maximum shoot dry weight with dual inoculation was 12.57g at 0 kg  $P_2O_5$  ha<sup>-1</sup> and 12.01 g at 25 kg  $P_2O_5$  ha<sup>-1</sup>, while root dry weight was 3.68 g at 0 kg  $P_2O_5$  ha<sup>-1</sup> and 3.52 g at 25 kg  $P_2O_5$  ha<sup>-1</sup>.

**Keywords:** *Medicago sativa*, VAM, phosphorus, inoculation.

### INTRODUCTION

The rangelands of Pakistan are deficient in P, as soils are calcareous and alkaline, and dominated by mica mineralogy. Phosphorus deficiency has been observed in 90% of the soils of the Pakistan (Rashid and Qayyum, 1990; Memon *et al.*, 1992). Phosphorus use efficiency, therefore, is very low in rangelands and it needs to be increased to a considerable extent for boosting forage production.

Vesicular arbuscular mycorrhizae occur widely under various environmental conditions and are found in association with a number of leguminous crops (Islam and Ayanaba, 1981). Inoculation enhanced the growth, 7-8 times as compared to no inoculated system for flat pad crown vetch ad lotus (Lambert *et al.*, 1980). The beneficial effects of mycorrhizae on alfalfa production are associated with a better nutrient balance (Hamel *et al.*, 1992).

The colonization of arbuscular mycorrhizae increased the dry matter production and number of nodules in soybean crop (Fonseca *et al.*, 1993). Improvement in dry matter production and grain yield of clusterbean by inoculation with VAM fungi has been reported by Rao and Tarafdar (1993). A study to investigate the association between American ginseng grown in monoculture and vesicular arbuscular mycorrhizae conducted by Hovius (1997) revealed that plant growth did not always follow the same pattern of development except for root to shoot ratios which increase over the entire season. The effects of arbuscular mycorrhizae fungi on the growth and reproduction of *Kummerowia striata*, a common annual legume of river flood plains of Japan, were examined by Nakatsubo (1997) in culture experiment by growing the plant and seeds in pots with nutrient poor soil collected from fluvial bar.

Utilization of organic P is enhanced by VAM and this enhancement effect could be due to both increase in surface area and phosphate activity of the extra radical hyphen (Li *et al.*, 1991a). The beneficial responses from mycorrhizal inoculation at moderate fertility were reported by Bethlenfalvay *et al.* (1983) who found that in general the application of 30 kg  $P_2O_5$  ha<sup>-1</sup> was the best in increasing dry matter production of roots, shoots and grains. Subterranean clover inoculation stimulated growth only when insufficient phosphorus was applied (Robson *et al.*, 1981).

The present study deals with the result of a pot experiment to assess the effect of inoculation of seeds of *Medicago sativa* with a VAM fungus in the absence and presence of 25 kg  $P_2O_5$  ha<sup>-1</sup> on the yield dry matter production by plants under sterile soil conditions.

### MATERIALS AND METHODS

Pot experiments were conducted during 1996-1998 at Quaid-i-Azam University, Islamabad and University of Arid Agriculture, Rawalpindi, Pakistan. Inoculation of *Gigaspora rosea*, *Glomus intraradices* + *Gigaspora rosea*; *Glomus etunicatum* + *Glomus intraradices* and one control were used to conduct the following experiment in order to study the effect of mycorrhizae inoculation and  $P_2O_5$  on growth of *Medicago sativa*. Autoclaved and analyzed soil with the following composition was used in 16 cm diameter earthen pots, moisture 32%, total organic carbon 0.6%, total nitrogen 16 mg kg<sup>-1</sup>, phosphorus 5.3 mg kg<sup>-1</sup>, potassium 140 mg kg<sup>-1</sup> and pH 7.4.

The seeds of *Medicago sativa* were obtained from the National Agricultural Research Centre, Islamabad. Both experiments were arranged in open air under natural field conditions using Completely Randomized Design.

### First experiment

*Medicago sativa* fodder seeds and three VAM species and one control were used with three replications. Twelve pots were filled with autoclaved soil. Inoculation with VAM was done by layering method (Jackson, 1972).

Pots were kept in open air under natural field conditions. Four plants were grown in each pot, plants were harvested just after seed formation.

### Second experiment

Twelve pots of *Medicago sativa* were inoculated with given mycorrhizae species at 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. The data regarding different plant characteristics (including root and shoot dry weight) under study were subjected to analysis of variance technique to determine significance of mean among the treatments by Steel and Torrie (1980) and comparisons of treatment means accomplished by least significant difference (LSD) test at 0.05 level of significance.

## RESULTS AND DISCUSSION

Table 1 shows that the shoot dry weight without mycorrhizae at 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> was 9.12g whereas shoot dry weight increased from 9.81, 10.61 and 12.57g in plants inoculated by *Gigaspora rosea*, *Glomus intraradices* + *Gigaspora rosea* and *Glomus*

*etunicatum* + *Glomus intraradices*, respectively. As compared to 9.41 g shoot dry weight without inoculation at 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, the shoot dry weight increased from 7.00, 9.93 and 12.01 g at 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> in plants inoculated with *Gigaspora rosea*, *Glomus intraradices* + *Gigaspora rosea* and *Glomus etunicatum* + *Glomus intraradices*, respectively.

It was found that shoot dry weight in the last two figures 10.61 and 12.57 g at 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, 9.93 and 12.01 g at 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, were particularly higher due to co-inoculations.

The root dry weight (Table 2) without mycorrhizae at 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> was 2.67 g whereas root weight increased from 2.88, 3.11 and 3.68 g in plants inoculated by *Gigaspora rosea*, *Glomus intraradices* + *Gigaspora rosea* and *Glomus etunicatum* + *Glomus intraradices*. As compared to 2.76 g roots dry weight under control without inoculation at 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, the roots dry weight increased from 2.05, 2.87 and 3.52 g at 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> in plant inoculated by *Gigaspora rosea*, *Glomus intraradices* + *Gigaspora rosea* and *Glomus etunicatum* + *Glomus intraradices*, respectively. It was found again that root dry weight in the last two figures 3.11 and 3.68 g at 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, 2.87 and 3.52 g at 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, were particularly higher under dual inoculations.

The data obtained are in conformity to the work of Tarafdar *et al.* (1988) who reported that many soil fungi

**Table 1. Effect of inoculation with mycorrhizae at varying level of P<sub>2</sub>O<sub>5</sub> on the shoot dry weight (g) of *Medicago sativa*.**

Treatments	Shoot dry weight (g)	
	0kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup>	25 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup>
Control	9.12 e	9.41 de
<i>Gigaspora rosea</i>	9.81 d	7.00 f
<i>G. intraradices</i> + <i>Gigaspora rosea</i>	10.61 c	9.93 d
<i>Glomus etunicatum</i> + <i>G. intraradices</i>	12.57 a	12.01 b

Any two means not sharing a letter differ significantly at 0.05 probability level.

LSD (0.05) for Shoot wt = 0.5193

**Table 2. Effect of inoculation with mycorrhizae at varying level of P<sub>2</sub>O<sub>5</sub> on the root dry weight (g) of *Medicago sativa*.**

Treatments	Root dry weight (g)	
	0kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup>	25 kg P <sub>2</sub> O <sub>5</sub> ha <sup>-1</sup>
Control	2.67 d	2.76 cd
<i>Gigaspora rosea</i>	2.88 c	2.05 e
<i>G. intraradices</i> + <i>Gigaspora rosea</i>	3.11 b	2.87 c
<i>Glomus etunicatum</i> + <i>G. intraradices</i>	3.68 a	3.52 a

Any two means not sharing a letter differ significantly at 0.05 probability level.

LSD (0.05) for Root wt = 0.1642

produce phosphatases as extra cellular enzymes and *Aspergillus fumigatus* has a particular high capacity to produces phosphatases. Enhancement effects of this fungus on growth and mineral nutrition of mung bean and clusterbean are well documented. (Tarafdar *et al.* 1992, 1995)

Mamta and Tilak (1987) studied that dry matter production of shoot and root of mungbean plant significantly increased with *Rhizobium* sp. and *Glomus versiforme*, respectively. Such increases were also pronounced when *Rhizobium* sp. was inoculated with *G. versiforme* at varying levels of phosphorus (0, 25, 50 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>).

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