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## Response of Oat (*Avena sativa*) to Inoculation with Vesicular Arbuscular Mycorrhizae (VAM) in the Presence of Phosphorus

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**Abstract:** A pot experiment was conducted with sterilized soil to study the effect of P<sub>2</sub>O<sub>5</sub> and mycorrhizal fungus on growth of *Avena sativa*. Single inoculation with *Gigaspora rosea* had no significant effect on plant growth over the corresponding controls while with dual inoculation the increase was significantly higher, both in the presence or absence of phosphorus. The maximum shoot dry weight with dual inoculation (*Glomus etunicatum* + *Glomus intraradices*) was 38.45 g at 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and 45.22 g at 25 kg P<sub>2</sub>O ha<sup>-1</sup>, while root dry weight was 19.13 g at 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and 22.50 g at 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>.

**Key words:** Ota, 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 need to be increased to a considerable extent for boosting forage production.

Vesicular arbuscular mycorrhizae (VAM) occur widely under various environmental conditions and are found in associations of forage crops. The beneficial effect of mycorrhizal fungi in phosphate nutrition of crop plants in soils low in phosphorus have been reported by different workers (Mackay and Barber, 1985a, 1985b).

Due to the presence of native endophytes and other soil microorganisms, mycorrhizal inoculation has proved better and beneficial in some unsterile soils than in sterile soils (Manjunath *et al.*, 1983; Mosse, 1981). In addition, plant hormones which are produced by soil bacteria have been reported to stimulate mycorrhizal formation (Azcon *et al.*, 1978).

The present report deals with the results of pot experiments to assess the effects of inoculation of seed of *Avena sativa* with a VAM fungus in the absence and presence of 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> on yield, dry mater production by plants under sterile soil conditions.

- Effect of mycorrhizal inoculation on growth of plants.
- Effect of fertilizer application especially that of phosphorus on growth of plants with and without mycorrhizal inoculation.

### Materials and Methods

Pots 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 etunicatums* + *Glomus intraradices* and one control were used to conduct the following experiment in order to study the effect of mycorrhizae inoculation and P<sub>2</sub>O<sub>5</sub> on growth of *Avena 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 (mg kg<sup>-1</sup>) 16, phosphorus (mg kg<sup>-1</sup>) 5.3, potassium (mg kg<sup>-1</sup>) 140 and pH 7.4.

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

### First experiment

*Avena 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

Additional twelve pots of *Avena 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 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 under control without mycorrhizae at 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> was 27.38 g whereas shoot dry weight increased from 29.50 to 33.35 g and 38.45 g in plant inoculated by *Gigaspora rosea*, *Glomus intraradices* + *Gigaspora* and *Glomus etunicatum* + *Glomus intraradices*, respectively. As compared to 31.11 g shoot dry weight under control without inoculation at 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, the shoot dry weight increased from 37.14 g to 42.18 g and 45.22 g at 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> in plants inoculated by *Gigaspora rosea*, *Glomus intraradices* + *Gigaspora* and *Glomus etunicatum* + *Glomus intraradices*, respectively.

This may be noted that shoot dry weight in the last two figures 33.35, 38.45 g at 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and 42.18, 45.22 g at 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, were particularly higher due to co-inoculations. These results are supported by Bagyaraj and Manjunath (1980). They reported that the crop benefited due to inoculation of *Glomus fasciculatum* alone, even in the presence of additional phosphorus at the rate of 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. The results also highlighted due to the dual inoculation of VAM fungi with *Azospirillum brasilense* in increasing the yield of different genotypes of wheat. Bethlenfalvai (1983) reported that in general the application of 30 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> was found to be the best in increasing dry matter production of root, shoot and grain yield. This may be because of the beneficial response from mycorrhizal inoculation at moderate fertility.

The root dry weight (Table 2) under control without mycorrhizae at 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> was 13.61 g whereas root weight increased from 14.75 to 16.84 to 19.13 g in plant inoculated by *Gigaspora rosea*, *Glomus intraradices* + *Gigaspora* and *Glomus etunicatum* + *Glomus intraradices*. As compared to 15.45 g root dry weight under control, without inoculation at 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, the root weight increased 18.69 to 21.09 to 22.50 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* and *Glomus etunicatum* + *Glomus intraradices*, respectively. This may be noted again that root dry weight in the last two figures 16.84, 19.13 g at 0 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> and 21.09 to 22.50 g at 25 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>, were particularly higher due to dual inoculation. This estimate compares favourable with similar data reported by Singh and Subba Rao (1987) who reported that *Glomus fasciculatum* inoculation significantly increased the yield of root and shoot of wheat crop. Such increases were pronounced due to

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 *Avena sativa*

Treatments	Shoot dry weight (g)	
	0 kg 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	27.38 h	31.11 f
<i>Gigaspora rosea</i>	29.50 g	37.14 d
<i>G. intraradices</i> + <i>Gigaspora</i>	33.35 e	42.18 b
<i>Glomus etunicatum</i> + <i>G. intraradices</i>	38.45 c	45.22 a

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 *Avena sativa*

Treatments	Root dry weight (g)	
	0 kg 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	13.61 h	15.45 f
<i>Gigaspora rosea</i>	14.75 g	18.69 d
<i>G. intraradices</i> + <i>Gigaspora</i>	16.84 e	21.09 b
<i>Glomus etunicatum</i> + <i>G. intraradices</i>	19.13 c	22.50 a

inoculation *G. fasciculatum*, both in absence and presence of different level of phosphorus (0, 60 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>), respectively. Fay *et al.* (1996) investigated the effects of arbuscular mycorrhizal infection by *Glomus mosseae* on growth and photosynthesis of barley (*Hordeum vulgare* L. cv. Manitou) in sand culture at 5 levels of calcium phosphate. Mycorrhizal infection was low and varied with P supply. It was at the lowest P supply that VAM plants had higher rates of photosynthesis and greater P and N efficiency.

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