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Research Article

Effect of different levels of phosphate fertilizer on foxtail millet (*Setaria italica* (L.) Beauv) VAR-SIA-326 inoculated with VA Mycorrhiza (*Glomus fasciculatum*).

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Abstract

Phosphorus is a major and essential nutrient for plant growth and it is sparingly soluble in nature. About 98 per cent of the Indian soil has inadequate supply of phosphorous. It plays a vital role in the process of photosynthesis and energy transformation and is the second major plant nutrient after nitrogen in terms of quantitative requirements for plants. Most of the Indian tropical soil lack required quantity of phosphorus for the growth of plants. The seed of Foxtail Millet SiA-326 variety were sown in earthen pots (15 cm in diameter) containing 3kg of sterilized soil. The soil was mixed in the ratio of 1:1 (One part of garden soil + one part of pure sand). 15 g of VAM (*Glomus fasciculum*) inoculum, 10 ml of half strength phosphorus less Hoagland solution was given per pot with the seedlings, at the interval of 15 days. The study showed that different levels of superphosphate with mycorrhiza enhanced the plant height and 'P' uptake. It is concluded that, inoculum of the respective efficient AM fungi in Foxtail Millet SiA-326 variety supplemented with 75% is recommended 'P' fertilizer would save 25% of 'P' fertilizer.

Keywords: Phosphorus, Photosynthesis, VAM, Sterilized Soil, Foxtail Millet

INTRODUCTION

Phosphorus is a major and essential nutrient for plant growth and it is sparingly soluble in nature. About 98 per cent of the Indian soil has inadequate supply of phosphorous. It plays a vital role in the process of photosynthesis and energy transformation and is the second major plant nutrient after nitrogen in terms of quantitative requirements for plants. Most of the Indian tropical soil lack required quantity of phosphorus for the growth of plants (Donahude, 1965).

The deficiency of phosphorus effects carbohydrate and protein metabolism in plants. Thus 'P' has a significant role in sustaining and building soil fertility and productivity, particularly under present day intensive system of agriculture. 'P' has been referred as the master key element in crop production. Most of the 'P' supplied in the form of fertilizer is unavailable to plants. Use of VAM fungi plays an important role in uptake and translocation of diffusion limited nutrients mainly 'P' and they promote the growth of plant. The beneficial effect of VAM has special importance for those plants having a course of poorly branched root systems. Thus absorption of phosphate ions could be possible through some beneficial microsymbionts that are associated with rhizospheric zones of numerous plants. VAM fungi have been associated symbiotically with most of the terrestrial plants. When nutrients are exhausted from the soil, a balanced fertilizer is necessary in order to maintain nutrient balance in given soil. It is reported that, 'P' is absorbed in the form of ortho-phosphate and transported through much branched hyphae as phosphate. The major transfer of 'P' from the VAM to the plants occurs through arbuscules. VAM inoculation increases the recovery of phosphate fertilization from the soil.

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Research on VAM dependence of many plants has clearly demonstrated that tropical crop will not grow well in low 'P' soils without mycorrhizal association. Since mycotropic plants depend on VAM colonization when grown under low external 'P' conditions, increasing efficiency of VAM fungi, by inoculation of more efficient fungal strains can enhance their yield. Hence present study was undertaken by using different levels of 'P' (superphosphate) inoculated with *Glomus fasciculatum* on Foxtail Millet SiA-326 variety.

REVIEW OF LITERATURE

VAM improves plant growth in 'P' deficient soils by uptake of 'P' and in return obtains carbon from the host plants (Pearson & Jakobsen, 1993). Mycorrhizal fungi help in the utilization of 'P' from organic form and enter into plants through roots (Joner & Jakobsen, 1995). Pandey and Mishra (1975) observed higher 'P', 'N', 'K', concentration, increased growth and yield of *Litchi chinensis* by inoculating the soil with an endomycorrhizal fungus. Daft and El-Giahgmi, (1976) have demonstrated that 'P' uptake was significant in infected plants than control and vigorous growth was observed in colonized cowpea, tomato maize. Iqbal and Qureshi (1977) reported remarkable increase in growth and 'P' uptake in sunflower when colonized with VAM.

Bagyaraj and Manjunath (1980) studied the effect of *Glomus fasciculatum* on the growth and nutrient uptake of three crop plants namely cotton, cowpea and finger millet in sterile and unsterile soil, in low available phosphorus and found that VAM inoculated plant attained higher shoot and root dry weight, and higher phosphorus content when compared to un-inoculated plants.

Many workers have reported that higher 'P' doses reduce development of AM fungi. Menge et al., (1978) reported that high fertilization with 'P' significantly decreased number of chlamydospores of *Glomus fasciculatum* in *Sorghum sudanense*. The number of vesicles, arbuscules and the amount of hyphae were inversely proportional to the higher concentration of 'P' in roots. Walters and Coltman (1989) studied the mycorrhizal colonization levels in 'green emerald giant' variety of *Capsicum* with 'P' concentrations ranging from 0.01 to 1 mg per liter of nutrient medium. *Glomus aggregatum* increased 'P' uptake, growth and yield of the crop when plants supplied with nutrient medium having 'P' concentrations at 0.01-0.03 mg/lt., beyond this dose of 'P', the mycorrhizal development decreased and there was no effect of inoculation of AM endophyte on growth and yield of *Capsicum*. Babu et al., (1988) studied the response of chilli to the early inoculation of AM fungi at different levels of 'P'. Srihari et al. (1993) studied the effect of inoculation of *Glomus fasciculatum* on the growth and yield of sunflower and found that mycorrhizal inoculation increased plant dry weight, shoot 'P' concentration and grain yield significantly as compared to the uninoculated plants (control). They also reported that 25% recommended dose of phosphatic fertilizer could be saved in sunflower with *Glomus fasciculatum*. Jones (2000) demonstrated the effect of long term fertilization with organic or inorganic fertilization on mycorrhizal mediated 'P' uptake in *subterranean clover*.

MATERIALS AND METHODS

The seed of Foxtail Millet SiA-326 variety were sown in earthen pots (15 cm in diameter) containing 3kg of sterilized soil. The soil was mixed in the ratio of 1:1 (One part of garden soil + one part of pure sand). 15 g of VAM (*Glomus fasciculum*) inoculum, 10 ml of half strength phosphorus less Hoagland solution was given per pot with the seedlings, at the interval of 15 days.

Treatment

Five levels of phosphorus, in the form of single superphosphate dose were supplied. Three replicates were maintained for each treatment (Recommended Dosage (RD) of P_2O_5 for Foxtail Millet SiA 326 variety.

1. Non-mycorrizal+without phosphate (UIC) (A)
2. VAM (*Glomus fasciculatum*)+ zero level phosphate (B)
3. VAM (*Glomus fasciculatum*)+ 25%level phosphate (8.75 mg/pot) (C)
4. VAM (*Glomus fasciculatum*)+ 50%level phosphate (17.5 mg/pot) (D)
5. VAM (*Glomus fasciculatum*)+ 75% level phosphate (26.25 mg /pot) (E)
6. VAM (*Glomus fasciculatum*)+ 100%level phosphate (35 mg/pot) (F)

(Fertilizers are applied on weight basis considering the weight of top 6 inch soil 2.5×10^6 kg).

The pots were kept in a green house. The triplicate sets of pots were maintained with proper controls. To maintain the moisture, the experimental pots were watered on alternate days. Periodical data were recorded for three harvests at every 20 days intervals. The plant parameters such as plant height, root length, number of rootlets, number of leaves, per cent root colonization, spore number per 50 g soil; shoot-root dry weight and 'P' uptake were recorded. The per cent uptake of "P" in shoots was determined according to Jackson (1973).

RESULTS AND OBSERVATIONS

Different levels of recommended doses (25%, 50%, 75% and 100%) were given to the selected Foxtail Millet SiA-326 variety inoculated with VAM (*Glomus fasciculatum*). The details of the parameters are given in **Table 1**.

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Table 1. Effect of VAM (*Glomus fasciculatum*) different levels of super phosphate (P_2O_5) on Shoot length , root length, no of rootlets, no of leaves,% of colonization, spore no /50 g soil, shoot dry weight, root dry weight, shoot/root ratio, P uptake of Foxtail Millet (*Setaria italic* (L.) Beauv). SiA.326 variety.

Treatment/Duration	Shoot length (cm)	Root Length (cm)	No. of Rootlets	No of Leaves	Colonization (%)	No of spores /50 g soil	Dry weight of shoot (g)	Dry weigh of root (g)	Phosphorus uptake in shoots (%)
20 Days									
UIC	16.66c	7.36c	4.00b	4.00b	0.00d	0.00c	0.0147c	0.0027d	0.07c
M+Zero level	24.33b	11.30b	5.00a	5.00a	47.76c	141.66b	0.0323b	0.0053c	0.10bc
M+ 25% RD SP	24.93ab	13.86ab	5.00a	5.00a	52.45bc	153.66ab	0.0430ab	0.0060bc	0.14bc
M +50% RD SP	25.43ab	16.06a	5.0a	5.00a	59.22ab	158.66ab	0.0483a	0.0063abc	0.16ab
M+75% RS SP	28.73a	17.14a	5.33a	5.33a	64.18a	178.33a	0.0487a	0.0083a	0.24a
M +100% RD SP	26.40ab	16.46a	5.0a	5.00a	60.18ab	166.33ab	0.0450	0.0077ab	0.19ab
40 Days									
UIC	38.16d	13.96c	7.00b	5.00b	0.00c	0.00	0.10b	0.01b	0.13c
M+Zero level	51.46c	19.46bc	12.33a	5.66b	51.01b	151.66b	0.29a	0.04ab	0.16c
M+ 25% RD SP	54.63bc	26.13ab	12.33a	5.66b	53.50b	162.00b	0.36a	0.06ab	0.23b
M +50% RD SP	58.53ab	27.93ab	13.66a	5.66b	61.38b	191.33b	0.41a	0.07a	0.28ab
M +75 % RD SP	64.03a	31.10a	16.33a	7.33a	75.69a	258a	0.42a	0.08a	0.31a
M +100% RD SP	59.53ab	29.03a	14.33a	7.00a	63.10b	235a	0.42a	0.08a	0.29a
60 Days									
UIC	57.86d	14.40d	9.33c	7.00b	0.00d	0.00d	1.08c	0.03c	0.15d
M+Zero level	63.33cd	19.53cd	11.33b	7.33ab	63.17c	192.33c	1.22c	0.06bc	0.25c
M+ 25% RD SP	68.53bc	21.66bc	12.66ab	7.66ab	69.27bc	214.33bc	1.67b	0.09ab	0.28bc
M +50% RD SP	71.90b	21.66bc	13.66a	7.66ab	70.22bc	216.33bc	1.76b	0.10ab	0.29bc
M +75 % RD SP	81.70a	28.80a	15.00a	8.00a	81.08a	286.66a	2.22a	0.12a	0.37a
M +100% RD SP	75.06b	26.06c	14.00a	7.66ab	75.90a	258.66ab	1.91b	0.12a	0.30b

UIC-Uninoculated contol, M=Mycorrhizal, RD=Recommended dose and SP= Super phosphate (P_2O_5).

*Mean values followed by the same letter within a column do not differ significantly at *P*=0.05 according to DMRT.

The 20 day plant showed significant result when supplemented with 75% (26.25 mg P_2O_5 /pot). It showed increased plant height (28.73 cm), root length (17.14 cm), number of rootlets (5.33), number of leaves (5.33), per cent root colonization (64.18%), spore number per 50 g soil (178.33 spores/50 g soil), shoot dry weight (0.047 g), root dry weight (0.0083 g) and phosphorus content in shoot (0.24%) which was dominant over the 25% (8.75 mg P_2O_5/ pot), 50% (17.5 mg P_2O_5/pot), 100% (35 mg P_2O_5/pot), only mycorrhizal (zero level) and UIC.

The 40 day plant showed significant result when supplemented with 75% (26.25 mg P_2O_5 /pot) by increased plant height (64.03 cm), root length (31.10 cm), number of rootlets (16.33), number of leaves (7.33) per cent root colonization (75.69%), spore number per 50 g soil (258 spores/ 50 g soil), shoot dry weight (0.42 g), root dry weight (0.8 g) and phosphorus content in shoot (0.31%) which is dominant over the 25% (8.75 mg P_2O_5/pot), 50% (17.5 mg P_2O_5/pot), 100% (35 mg P_2O_5/pot), only mycorrhizal (zero level) and UIC.

The 60 day plant showed significant result when supplemented with 75% (26.25 mg P_2O_5 /pot) by increased plant height (81.70 cm), root length (28.80 cm), number of rootlets (15.0), number of leaves (8.0), per cent root colonization (81.08%), spore number per 50 g soil (286 spores/ 50 g soil), shoot dry weight (2.22 g), root dry weight (0.12 g) and phosphorus content in shoot (0.37%) which was dominant over the 25% (8.75 mg P_2O_5/pot), 50% (17.5 mg P_2O_5/pot), 100% (35 mg P_2O_5/pot), only mycorrhizal (zero level) and UIC (Waterer DR & Coltman RR, 1989).

The plant when supplemented with 75% recommended dose of superphosphate, after 40 days of inoculation showed increase in percent of root colonization (81.08). After 60 days of inoculation the Foxtail Millet SiA-326 variety showed increase in plant height, root length, number of rootlets, number of leaves, per cent root colonization, spore number per 50 g soil, shoot and root dry weight and 'P' uptake in shoots.

DISCUSSION

The soil microorganisms play an important role in solubilization of mineral compounds, which later on mobilized by the production of organic acids. But many microorganisms can bring the insoluble organic compounds into soluble form. In such case, VAM fungi clearly increase the absorbing root area by changing morphology of the feeder roots (Harley and Smith, 1983). The data obtained in the present study showed the influence of different levels of single dose of super phosphate inoculated with *Glomus*

fasciculatum on Foxtail Millet (SiA-326 var). Recommended dose of superphosphate (75%) with mycorrhiza, influenced SiA-326 variety showing significant increase in shoot height, root length, number of rootlets, number of leaves, per cent root colonization, spore number per 50 g soil, shoot-root dry weight and 'P' uptake. These results are in accordance with the earlier workers (Naik et al., 1994).

The per cent of mycorrhizal root colonization and spore count was increased significantly with 'P' levels up to 75% recommended doses (RD) in Foxtail Millet var SiA-326. However further increase in 'P' dose significantly decreased both per cent root colonization and spore number in Foxtail Millet SiA-326 variety. Better development of AM in the host root at lower 'P' dose is evident (Harley & Smith, 1983). In split root technique, Menge et al., (1978) proved that it was not the soil 'P' but the host 'P' concentration that governed the development of mycorrhiza in roots. Few physiological reasons for the reduction in the mycorrhizal development at higher host "P" concentration are known. At higher "P" concentration, the permeability of plasma membrane decreased due to higher amount of phospholipids in the membrane. This in turn reduced the exudation of amino acids in plant roots, which are essential for the mycorrhizal development (Ratnayake et al., 1978; Graham et al., 1981). Further, Jasper et al., (1979) have reported that reduced concentrations of soluble carbohydrates in the mycorrhizal roots at high "P" dose resulted in the decreased AM development. However this hypothesis was found to be incorrect by Amijee et al., (1990) who found no change in the soluble carbohydrates in the roots of *Allium cepa* (leek) at high "P" dose when *Glomus mosse* was inoculated. Present investigation showed the decreased number of chlamydospores and per cent root colonization with increase level of superphosphate treatments. The trend of decreased colonization with increased superphosphate of the present study is confirmed. (Sylvia & Schenck, 1983; Schenck et al., 1984). On the other hand, VAM are known to occur in soils with higher phosphorus content (Davis et al., 1981). The Foxtail Millet var-SiA326 inoculated with *Glomus fasciculatum* with different levels of superphosphate showed enhanced nutrient concentration in shoots compared to those treatments without 'P'. The findings support the workers Harley and Smith (1983); Suriyapperuma and Koske (1995).

CONCLUSION

Therefore, the study showed that different levels of superphosphate with mycorrhiza enhanced the plant height and 'P' uptake. It is concluded that, inoculum of the respective efficient AM fungi in Foxtail Millet SiA-326 variety supplemented with 75% is recommended 'P' fertilizer would save 25% of 'P' fertilizer.

REFERENCES

Amijee F, Stribley DP, Tinker PB (1990). Soluble carbohydrates in roots of leek (*Allium porrum*) plants in relation to phosphorus supply and VA mycorrhizas. Plant Nut Physiol App. 161-164.

Babu HR, Lokeshwar D, Rao NS, Bhaskar Rao BR (1988). The response of chilli (*Capsicum annuum L.*) plants to early inoculation with mycorrhizal fungi at different levels of phosphorus. J Horticultural Sci. 63: 315-320.

Bagyaraj DJ, Manjunath A (1980). Response of crop plants to VA mycorrhizal inoculation in an unsterile Indian soil. New Phytologist. 85: 33-36.

Daft MJ, El-Giahmi AA (1976). Studies on nodulated and mycorrhizal peanuts. Annals Applied Bio. 83: 273-276.

Daniels BA, Trappe JM (1980). Factors affecting spore germination of the vesicular-arbuscular mycorrhizal fungus, *Glomus epigaeus*. Mycologia. 72: 457-471.

Davis RM, Menge JA (1981). *Phytophthora parasitica* inoculation and intensity of vesicular-arbuscular mycorrhizae in citrus. New Phytologist. 87: 705-715.

Donahude RL (1965). Soil testing in India. Usaid, New Delhi. 47-77.

Graham JH, Leonard RT, Menge JA (1981). Membrane-mediated decrease in root exudation responsible for phosphorus inhibition of vesicular-arbuscular mycorrhiza formation. Plant Physiol. 68: 548-552.

Harley JL, Smith SE (1983). Mycorrhizal symbiosis. Academic Press, London. 483.

Iqbal SH, Qureshi KS (1977). Effect of vesicular arbuscular mycorrhizal associations on growth of sunflower (*Helianthus annuus L.*) under field conditions. Biologia.

Jackson ML (1973). Soil chemical analysis, pentice hall of India Pvt. Ltd., New Delhi, India. 498: 151-154.

Jasper DA, Robson AD, Abbott LK (1979). Phosphorus and the formation of vesicular-arbuscular mycorrhizas. Soil Bio Biochem. 11: 501-505.

Joner EJ, Jakobsen I (1995). Uptake of 32P from labelled organic matter, by mycorrhizal and non-mycorrhizal subterranean clover (*Trifolium subterraneum L.*). Plant Soil. 172: 221-227.

Menge JA, Steirle D, Bagyaraj DJ, Johnson EL, Leonard RT (1978). Phosphorus concentrations in plants responsible for inhibition of mycorrhizal infection. New Phytologist. 80: 575-578.

Naik BH, Nalawadi UG, Sreenivasa MN, Patil AA (1995). Field responses of China aster (*Callistephus chinensis* (L) Nees.) cv.'Ostrich plume'to the inoculation of vesicular arbuscular mycorrhizal fungi at different phosphorus levels. Scientia Horticulturae. 62: 129-133.

Pandey SP, Mishra AP (1975). Mycorrhiza in relation to growth and fruiting of *Litchi chinensis.* J Ind Bot Soc. 54: 282-293.

Pearson JN, Jakobsen I (1993). Symbiotic exchange of carbon and phosphorus between cucumber and three arbuscular mycorrhizal fungi. New Phytologist. 124: 481-488.

Citation: Kadam LB (2022). Effect of different levels of phosphate fertilizer on foxtail millet (*Setaria italica* (L.) Beauv) VAR-SIA-326 inoculated with VA Mycorrhiza (*Glomus fasciculatum*). IRJPS. 13: 010.

Ratnayake M, Leonard RT, Menge JA (1978). Root exudation in relation to supply of phosphorus and its possible relevance to mycorrhizal formation. New Phytologist. 81: 543-552.

Schenck NC, Spain JL, Sieverding E, Howeler RH (1984). Several new and unreported vesicular-arbuscular mycorrhizal fungi (Endogonaceae) from Colombia. Mycologia. 76: 685-699.

Srihari PC, Sreenivasa MN, Chittapur BM, Bablad HB (1993). Field response of sunflower to the inoculation of vesicular-arbusculor mycorrhizal at different phosphorus levels. J Oilseeds Research. 10: 325.

Suriyapperuma SP, Koske RE (1995). Attraction of germ tubes and germination of spores of the arbuscular mycorrhizal fungus *Gigaspora gigantea* in the presence of roots of maize exposed to different concentrations of phosphorus. Mycologia. 87: 772-778.

Sylvia DM, Schenck NC (1983). Application of superphosphate to mycorrhizal plants stimulated sporulation of phosphorus tolerant vesicular arbuscular mycorrhizal fungi. New Phytologist. 95: 655-661.

Waterer DR, Coltman RR (1989). Response of mycorrhizal bell peppers to inoculation timing, phosphorus, and water stress. World Veg. 24: 688-990.