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EFFECT OF PHOSPHATE FERTILIZER AND AM FUNGI ON TWO VARIETIES OF FINGER MILLET (*Eleusine coracana* Gaertn.)

GEETA.B. PATIL*[1] H.C. LAKSHMAN[2] AND ROMANA.M.MIRDHE[2]

1. Department of Botany, P.C.Jabins Science College, Vidya nagar, Hubli, Karnataka, India
2. Post Graduate Department of Studies in Botany, Microbiology laboratory
Karnatak University, Dharwad-580 003, Karnataka, INDIA.

ABSTRACT

Green house pot experiments were conducted to evaluate the effect of AM fungi with recommended dose of super phosphate (P_2O_5) on two varieties of finger millet (TNAU 914 and GPU 45). The recommended dose of superphosphate was given 25%, 50%, 75% and 100% was applied to both varieties of finger millet along with AM fungi. Growth parameters such as plant height, dry weight of shoot and root, per cent root colonization, spore number, macro and micro nutrients were determined. Variety TNAU 914 showed an increase in all growth parameters when recommended dose of 50% was applied, there was also an increase in macro and micro nutrients. However, variety GPU 45 showed increase in growth parameters when recommended dose of 25% was applied. The variation in uptake of nutrients and per cent of root colonization in different recommend dose of super phosphate with AM fungi has been discussed.

KEY WORDS: **Finger millet, *Glomus fasciculatium*, super phosphate, per cent root colonization, spore number.**

GEETA.B. PATIL
Department of Botany, P.C.Jabins Science College,
Vidya nagar, Hubli, Karnataka, India

Corresponding author

INTRODUCTION

Mycorrhizal symbiosis aids the uptake of phosphorous in plants, especially under its low availability. Phosphorous is one of the most essential macro nutrient required by plants for its metabolic process such as photosynthesis, energy transformations, reproduction etc. The deficiency of phosphorous adversely effects carbohydrate and protein metabolism in plants. In addition, the fungus –root association is more efficient mineral element absorbing organ can selectively absorb nutrients providing benefits to the host plants [1]. More nitrogen and phosphorous are absorbed from the soil and accumulated in plants with AM fungi, by making feeder roots more resistant to infection by certain soil fungi such as *Phytophthora, Pythium* and *Fusarium*. The fungus capacity for extraction of elements from soil organic matter is assumed to be part of increased efficacy [2].

Application of fertilizer is an essential step to increase crop yield in nutrient deficient soils. Among the biofertilizers the AM fungi are considered to be the most important micro-organisms. The beneficial effect of AM fungi is well reported and significant in plants and poorly branched root system. Phosphorous is usually absorbed in the form of orthophosphate and transported to the much branched hyphae of polyphosphate. Crop plants fail to absorb the nutrients. Nutrients availability to plants is increased as result of microorganisms activities in soil [3]. Arbuscular Mycorrhizal fungi (AMF) form association between plants and fungi to colonize roots during the period of active plants growth and are distributed worldwide in the root system of most crops [4]. The AM fungi may improve crops yield by the increased nutrients uptake, particularly P [5]. Phosphorous is one of the major essential plant nutrients. The use of phosphate as a fertilizer for phosphorous deficient soils has received significant interest in recent years since they are natural, inexpensive and available fertilizers. The microbial groups that solubalize mineral phosphatases and improve plant phosphorous nutrition and AM fungi. Arbuscular mycorrhizal fungi play a significant role in nutrient cycling in agricultural and natural ecosystems. When nutrients are exhausted from soil, fertilizer has to be added in order to maintain nutrient balance in soil. It is suggested in literature that P is absorbed in the form of orthophosphate and transported activity in the hyphae as polyphosphate. The major transfer P from fungus to the plant occurred in those root cells that contain arbuscule. Overall the P transfer from the fungus to the host plant takes place in a process of interchange with carbon compound metabolites to the host fungus [6]. Phosphate fertilization harness atmospheric nitrogen with the help of specialized microorganisms which may be free living in the soil symbiotic plants. Recent reports indicated that these self-perpetuating bodies can make significant contributions in productivity improvement. The present study aims at the effect of different levels of P super phosphate on two finger millet varieties.

MATERIALS AND METHODS

The pot experiments were conducted in triplicate. Each pot measuring about 30cm in diameter were filled with soil and sand in the ratio of 2:1 which was sterilized by fumigating with 5% methyl bromide. The following treatments were given to the experimental pots. Two varieties of finger millet TNAU-914 and GPU-45 were selected for the present investigation. Experimental plants were treated with four different levels of phosphate and were maintained in triplicate. The following treatments were given to the experimental pots.

1. Zero (P_2O_5)
2. 25% PRD of P_2O_5 (0.20g per 8kg soil)
3. 50% PRD of P_2O_5 (0.40g per 8kg soil)
4. 75% PRD of P_2O_5 (0.80g per 8kg soil)
5. 100% PRD of P_2O_5 (0.160g per 8kg soil)

Watering of experimental pots was made on every alternate days in order to maintain soil moisture content. Growth parameters such as plant height, dry weight of shoot and root, percent of root colonization, spore number

and nutrient content viz N, P, K, Cu, Zn and Mg in both shoot and root were recorded at 30,60 and 90 days of mycorrhizal inoculation. Percentage mycorrhizal infection of the roots was determined by the root slide technique [7] after clearing the roots with 10% KOH and stained with 0.05% trypan blue [8].

$$\text{Root colonization} = \frac{\text{Number of colonized segments}}{\text{Total number of segments examined}} \times 100$$

Number of spores in the soil surrounding the roots was determined by the wet sieving and decanting technique [9]. Nitrogen was determined by microkjeldal method [10] and phosphorous was determined by phosphoric acid yellow colour method [11]. Other nutrients were determined by acid digestion.

RESULTS AND DISCUSSION

Different levels of super phosphate along with AM fungi were given to two varieties of finger millet viz, TNAU-914 and GPU-45. The plants supplemented with different levels of phosphate showed an increase in plant height, dry weight of shoot and root than the control. The variety TNAU-914 showed increase in all the growth parameters when a recommended dose of 50% and 75% of phosphate was applied at 90 days of mycorrhizal inoculation(Table 1). But the variety GPU-45 showed decrease in growth parameters when supplemented with more than 75% of recommended dose of phosphorous (Table,2). The results obtained from the experiment clearly demonstrated that there was an increase in nutrient uptake viz, nitrogen, phosphorous and potassium and micro element like zinc in mycorrhizal plants when compared to control plants. In shoots of mycorrhizal plants, the nutrients were found higher in both finger millet varieties treated with different levels of phosphate and AM fungi than the control but magnesium was found to be higher in control than the phosphate and AM fungal treated plants. However the increase in concentration of N, K, was observed in the shoots of both varieties of finger millet when supplemented with 50% and 75% of recommended dose of phosphate but it was not significant when treated with 100% recommended dose of phosphate along with AM fungal treatment. Soil micro-organisms play a vital role in solubilization of mineral compounds and convert the insoluble inorganic compounds into soluble forms. The results recorded in the present investigation on two varieties of finger millet TNAU-914 and GPU-45 showed a positive response when subjected to different levels of super phosphate and AM fungi when compared to control. In variety TNAU-914 50% recommended dose of phosphate with mycorrhizal inoculation greatly influenced the growth of crop plants as indicated by an increase in plant height, dry weight of root and shoot, percent root colonization. These findings are consistent with earlier work carried out in Niger [12]. 75% of recommended dose of phosphate was favourable to variety GPU-45. This result confirms the findings of earlier workers in other crop plants [13].

However further increase in P dose significantly decreased plant height, dry weight of shoot and root, root colonization in both the varieties of finger millet. Growth response in the AM fungal root was better when supplied with lower dose of P fertilizer [14]. The physiological reason for the reduction in the mycorrhizal development may be due to the high amount of phospholipids in the plasma membrane that reduces its permeability, inturn reducing the exudation of amino acids in the plant roots which is essential for mycorrhizal development [15]. The effectiveness of lower concentration of superphosphate in increasing the root length may be due to the direct effect of superphosphate fertilizers or indirectly through the microbial propagation activation. AMF enhanced nutrient uptake by increasing surface area of roots with the development of an extensive extra-radical hyphae network. The importance of AM fungi in crop production lies in their ability to stimulate plant growth in soils with limited amounts of available P,

where the AM fungal external mycelium provides a larger surface area for increased uptake of nutrients specially P [16]. The present data indicated decrease in percent root colonization with an increase in phosphate fertilizer. These results are considered with earlier contributors [17, 18]. In the present study both the plants responded well to the inoculation of efficient AM fungi in respect of phosphorous uptake and plant height as compared to uninoculated and control plants. AM fungi stimulates the growth and yield of host mainly through uptake of P and other micro nutrients [19] by extending the absorption of area of shoot system. [20] demonstrated that effect of long term fertilization with organic and inorganic fertilization of mycorrhizal mediated P uptake in subterranean clover. Phosphorous is one of the major essential plant nutrients. There is much evidence in the literature that the presence of mycorrhizae deceases the root/shoot ratio by increasing aboveground production and possibly by reducing the heed for below ground production[21]. The use of rock phosphate as a fertilizer for phosphorous deficient soil has received significant interest in recent years since they are natural, inexpensive and available fertilizers.

Table 1

Showing the effect of different levels of phosphorus fertilizer on growth and nutrient uptake of finger millet variety TNAU-914

Treatments	Plant height (cm)	DWS (g)	DWR (g)	% root colonization	Spore number	Macro and micro nutrients in shoot					Macro and micro nutrients in root			
						N	P	K	Zn	Mg	N	P	K	Zn
30 days														
NM	4.36a	0.28a	0.22a	0.00a	0.00a	3.15a	1.51a	0.62a	0.05a	0.06b	1.40a	0.64a	0.27a	0.003a
25% RDSP1+M	8.26bc	0.60b	0.26b	34.6b	68.13b	4.01b	2.41bc	0.97b	0.08c	0.05a	2.35d	1.10c	0.51e	0.01d
50% RDSP2+M	9.60d	0.78e	0.37c	38.4d	70.73bc	4.95d	2.67d	1.23d	0.01d	0.05a	2.08b	1.90d	0.41b	0.07c
75% RDSP3+M	8.43bcd	0.71d	0.33d	36.2bc	70.20c	4.21c	2.30b	0.97b	0.08c	0.05a	2.32d	0.92b	0.46d	0.06b
100% RDSP4+M	7.50b	0.67c	0.27bc	35.4bc	71.10c	4.72e	2.54cd	1.00bc	0.07b	0.06b	2.25c	0.95bc	0.42bc	0.06b
60 days														
NM	13,53a	0.67a	0.28a	0.00a	0.00a	7.88a	4.24a	2.03a	0.02a	0.04e	3.98a	1.83a	0.92a	0.01a
25% RDSP1+M	34.36cd	0.83cd	0.43b	52.2b	73.03b	9.30bd	5.94bc	2.81b	0.04b	0.03cd	4.98b	2.31b	1.44b	0.02b
50% RDSP2+M	38.40e	0.92d	0.45b	57.5b	75.20bc	9.80e	6.03d	2.97b	0.06c	0.03b	5.48e	3.19e	1.60c	0.03d
75% RDSP3+M	32.50bc	0.84bc	0.40b	54.4b	85.10d	9.27b	5.95bc	2.82b	0.04bc	0.03bc	5.38cd	2.61c	1.54c	0.02bcd
100% RDSP4+M	30.73b	0.82b	0.37ab	53.5b	80.1bcd	9.30bc	5.96b	2.80b	0.05d	0.02a	5.35c	2.89d	1.58c	0.02bc
90 days														
NM	18.4a	0.72a	0.33a	0.00a	0.00	9.70a	4.92a	3.15a	0.03a	0.083d	5.08a	2.26a	1.61a	0.02a
25% RDSP1+M	41.93b	0.93b	0.47b	61.8bc	89.2b	11.7b	5.53b	3.78b	0.06b	0.08bc	5.66b	2.85b	1.87b	0.04b
50% RDSP2+M	48.00e	1.01d	0.61e	67.2c	93.3bc	12.0b	6.23e	3.96e	0.09e	0.081cd	6.03c	3.27e	2.04e	0.05d
75% RDSP3+M	44.13cd	0.97bcd	0.55cd	63.2bc	97.3bc	11.6b	5.70c	3.86cd	0.07bc	0.071a	5.94bc	3.02c	1.99d	0.05c
100% RDSP4+M	43.16c	0.94b	0.55c	61.3b	97.7d	11.7b	5.80cd	3.85c	0.08d	0.078b	5.95bc	3.05cd	1.91c	0.05c

M= mycorrhizal; RDSP= recommended dose of super phosphate. Mean values followed by the same letter within a column do not differ significantly at P=0.05

Table 2

Showing the effect of different levels of phosphorus fertilizer on growth and nutrient uptake of finger millet variety GPU-45

Treatments	Plant height (cm)	DWS (g)	DWR (g)	% root colonization	Spore number	Macro and micro nutrients in shoot					Macro and micro nutrients in root			
						N	P	K	Zn	Mg	N	P	K	Zn
	30 days													
NM	5.00a	0.40a	0.24a	0.00a	0.00a	2.92a	1.57a	0.68a	0.00a	0.08b	1.47a	0.69a	0.34a	0.004a
25% RDSP1+M	8.30b	0.63b	0.36b	40.4c	65.1bc	4.19b	2.36b	1.08b	0.03d	0.06a	2.18b	0.97b	0.47b	0.009bc
50% RDSP2+M	8.61bc	0.67bc	0.38b	42.04c	63.1b	4.75b	2.61c	1.15bcd	0.01b	0.06a	2.39bc	0.99b	0.49bc	0.008b
75% RDSP3+M	9.65d	0.74d	0.45b	33.2b	75.1e	5.11b	2.74c	1.30e	0.02bc	0.08b	2.43c	1.10b	0.58e	0.011c
100% RDSP4+M	9.13cd	0.80c	0.42b	43.2c	70.3d	4.92b	2.69c	1.10bc	0.01b	0.07ab	2.25bc	1.03d	0.50bcd	0.008b
	60 days													
NM	12.5a	0.64a	0.28a	0.00a	0.00a	7.64a	4.21a	2.00a	0.02a	0.05b	3.98b	1.80a	0.90a	0.016a
25% RDSP1+M	26.1b	0.80b	0.38b	50.2b	70.3b	9.24b	5.90b	2.73b	0.04b	0.05b	4.95c	2.30b	1.40b	0.023b
50% RDSP2+M	27.1bc	0.82b	0.40b	52.2bc	80.2c	9.41bc	5.95b	2.73b	0.05c	0.04a	5.20cd	2.25bc	1.45b	0.028cd
75% RDSP3+M	29.1d	0.85b	0.43b	55.4c	84.1e	9.78d	5.99b	2.99c	0.06d	0.04a	3.35a	3.13d	1.55b	0.031d
100% RDSP4+M	28.0cd	0.84b	0.41b	55.0c	82.2e	9.48bcd	5.96b	2.81bc	0.05bcd	0.05b	5.28d	2.90d	1.50b	0.026bc
	90 days													
NM	17.7a	0.67a	0.27a	0.00a	0.00	9.65a	4.94a	3.15a	0.03a	0.08c	5.07a	2.25a	1.62a	0.028a
25% RDSP1+M	36.4b	0.88b	0.43b	57.3b	85.4bc	11.7b	5.47b	3.72b	0.06b	0.07a	5.91bc	2.08b	1.77b	0.042b
50% RDSP2+M	38.1bc	0.93c	0.45bc	64.3c	88.2cd	11.8bc	5.65bc	3.83bc	0.07c	0.08c	5.94bc	3.02bc	1.99cd	0.048c
75% RDSP3+M	40.4c	0.93c	0.50d	61.2bc	94.4e	11.9c	6.20e	3.95c	0.08e	0.08a	5.99c	3.22c	2.04d	0.055cd
100% RDSP4+M	39.0bc	0.91c	0.47cd	63.1c	82.1b	11.9bc	5.85cd	3.85bc	0.80d	0.07b	5.87b	2.90d	1.94c	0.050cd

M= mycorrhizal; RDSP= recommended dose of super phosphate. Mean values followed by the same letter within a column do not differ significantly at P=0.05

Figure A
Showing Plant height for 30, 60 and 90 days in variety TNAU-914

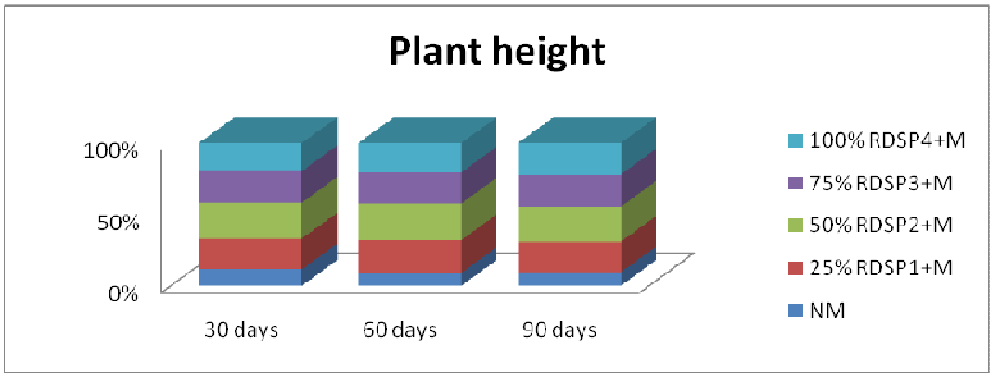


Figure B
Showing Macro nutrients in shoot for 90 days in variety TNAU-914

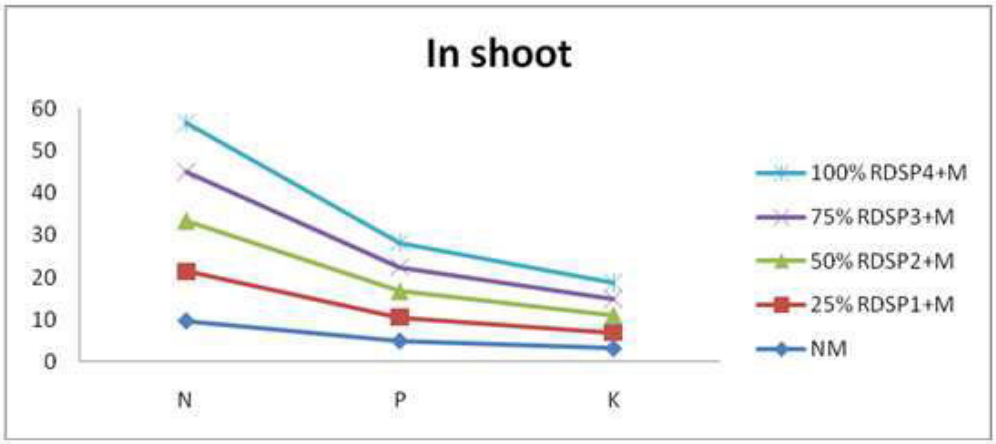


Figure C
Showing Macro nutrients in root for 90 days in variety TNAU-914

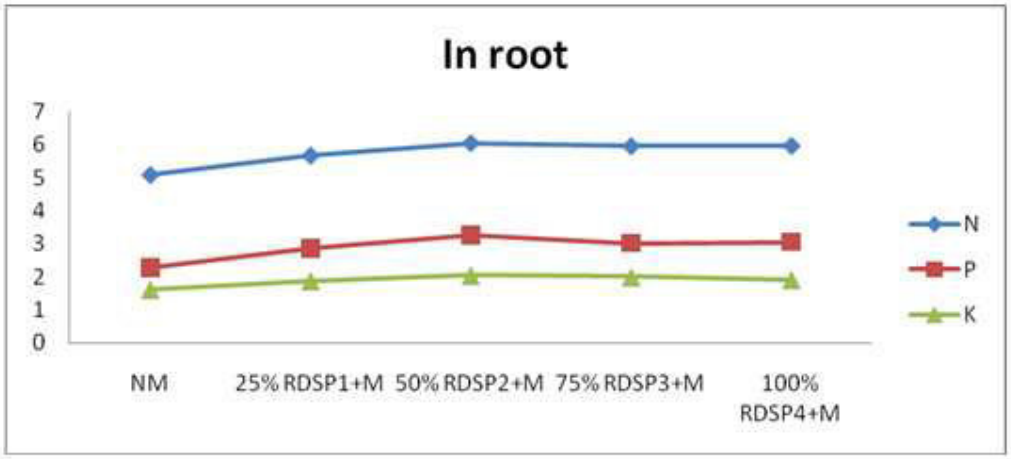


Figure D
Showing Plant height for 30, 60 and 90 days in variety GPU45

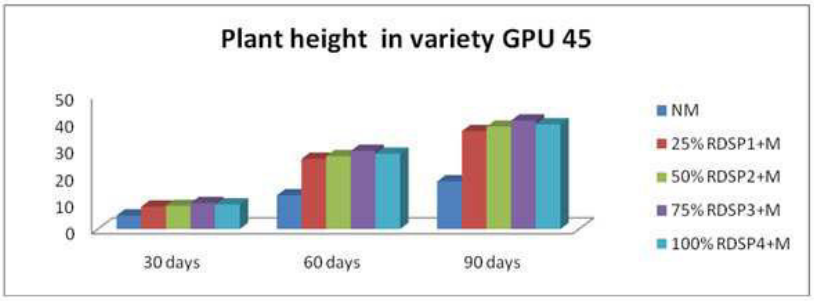


Figure E
Showing Macro nutrients in shoot for 90 days in variety GPU45

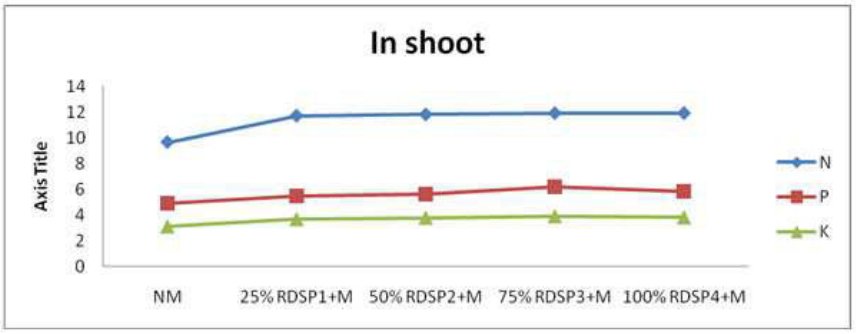
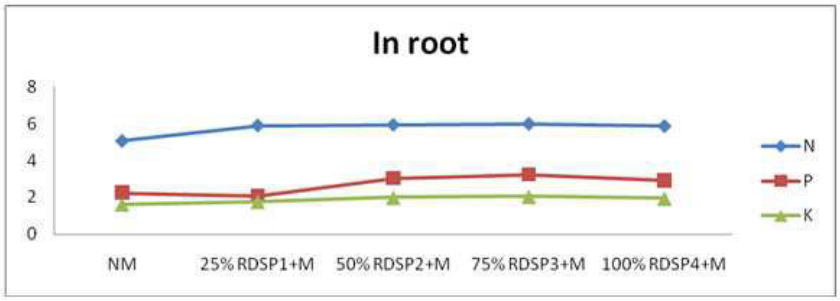


Figure F
Showing Macro nutrients in root for 90 days in variety GPU45



CONCLUSION

The results in the present study revealed that high concentration of phosphorous is detrimental to proliferation of the fungal symbiont and subsequent spore production. Thus it can be concluded from the present investigation that maximum beneficial effect of mycorrhizal symbiosis may be achieved at lower levels of soil fertility.

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