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Effect of Arbuscular Mycorrhiza Fungal Inoculation with Compost on Yield and Phosphorous Uptake of Berseem in Alkaline Calcareous Soil

Bismillah Jan[1], Amjad Ali[2*], Fazli Wahid[1], Syed Noor Muhammad Shah[3,4], Asif Khan[1], Farmanullah Khan[5]

[1]Department of Soil and Environmental Science, University of Agriculture, Peshawar, Pakistan
[2]College of Resource and Environment, Northwest A&F University, Yangling, China
[3]Department of Horticulture, Gomal University, D.I. Khan, Pakistan
[4]College of Horticulture, Northwest A&F University, Yangling, China
[5]Directorate of Soil and Water Conservation, Peshawar, Pakistan
Email: *amjadali@aup.edu.pk

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Abstract

An experiment was conducted in pots under natural conditions in alkaline calcareous soil to determine berseem (*Trifolium alexandrium*) yield and P uptake as affected by Arbuscular mycorrhizal fungi (AMF) inoculation with compost prepared from fresh animal dung and rock phosphate. Data indicated that berseem shoot and roots yields increased significantly ($P \le 0.05$) by inoculation of indigenous mycorrhiza (AMF-I) and half dose of compost. Shoot yield increased as 98% and 76% roots yield as 60% and 52% over control and N and K fertilizers. Maximum and significantly ($P \le 0.05$) increased plant N and P uptake by berseem was observed in the treatment inoculated by commercial mycorrhiza (AMF-II) with full dose of compost followed by the inoculation of AMF- II with half dose of compost. Plants uptake of Cu, Mn and Fe was improved significantly ($P \le 0.05$) by the inoculation of AMF-II with half dose of compost, while Zn uptake was increased in the treatment of AMF-II inoculation with full dose of compost. Maximum and significantly ($P \le 0.05$) increased soil spores density of AMF as 27 spores per 20 g soil was noted by inoculation of AMF-I with half dose of compost, while maximum roots infection intensity in berseem was observed by the inoculation of AMF-I with full dose of compost. Results suggest that inoculation of AMF with compost has potential to improve berseem yields and plants nutrients uptake under given soil conditions.

*Corresponding author.

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Keywords

AMF Inoculation; Alkaline Calcareous Soil; Berseem Crop; Compost; Plants Nutrients Uptake and Yield

1. Introduction

Mycorrhizal fungi are beneficial symbiotic microorganisms with their extra matrical hyphae, which increase growth and yield of most crop plant through increase absorption of relatively immobile elements in soil such as P, Cu and Zn by substantially extending the area of absorption beyond that of root hairs [1]. Enhanced uptake of P is generally regarded as the most important benefit that AMF provide to their host plant and soil P status is often the main controlling factor in the plant-fungal relationship [2]. Phosphorus plays a vital role in plant growth and is the second essential macronutrient after Nitrogen. It plays an important role in root elongation, root proliferation and P deficiency effect root architecture [3]. Plants required P in relatively large amount range from 0.2% - 0.8% of plant dry matter yield [4]. Phosphorus found in organic, inorganic or mineral forms. Organic form consists of plant and animals residues and microbes. Large fraction of total soil phosphorus is in organic form and is not directly available to the plant [5]. Phosphorus deficiency is one of major limiting factors in plant growth and its productivity in many ecosystems [6]. Poor availability of P is due to the presence of Ca in neutral to alkaline pH and Fe and Al in acidic soil, which leads to the fixation of P and thus unavailable to the plant [7] Composting is environmental friendly and cost effective technique of waste recycling [8]. Composts are prepared from roots, leaves, straw, stems and crop residues etc. through microorganism's action. These materials undergo decomposition under temperature in pits, heaps with adequate moisture. About 3 - 6 months are generally required for this process when brown to dark brown material with no odd smell is obtained then composts is prepared. Rock phosphate (RP) is the raw material of P fertilizer. It is estimated that the world's reserve would last for only 90 years [9]. The expected global peak of P production is predicted to occur around 2030 [10]. Rock phosphate is slowly available P source with total concentration of P relatively high (more than 15%) and soluble concentration is relatively low (less than 1%). The agronomic performance of the rock phosphate applied directly as phosphatic fertilizers depends on different factors and their interaction. These factors include the physical and chemical properties of RP, plant species and cropping system, soil and climatic factors and farm management practices. Berseem (*Trifolium alexandrinum*), the most common winter and spring fodder in many parts of Pakistan is low in phosphorus contents (0.14%) and abundant in calcium (1.44%). Owing to a wide calcium phosphorus ratio, animals fed predominantly on berseem unless supplemented with some rich source of phosphorus like grains may suffer from phosphorus deficiency syndromes [11]. Keeping in view the importance of AMF in nutrients solubilization and crop production, this study was initiated to determine the effects of AMF inoculation with compost on the yield and plants nutrients uptake of berseem.

2. Materials and Methods

A pot experiment was conducted under natural conditions to determine yield and P uptake of berseem (*Trifolium alexandrium*) as influenced by AMF inoculation with compost. Berseem crop was grown in pots summer, 2011with three replications in completely randomized design (CRD) in green house. Surface soil sample was collected at depth of 0 - 30 cm from research farm of the University of Agriculture, Peshawar and filled in pots at the rate of 3 kg per pot. Physicochemical characteristics (**Table 1**) of the soil under investigation were determined for texture by method described by Koehler [12], soil pH by procedure of McClean [13], lime was determined by method described by Richard [14]. For determination of organic matter method was used as described Nelson and Sommers [15]. Soil total N was determined by Kjeldhal method of Bremner [16]. P and K were determined by method used by Soltanpour and Schwab [17]. The soil under investigation was clay loam in texture and alkaline in nature, low in O.M, N contents and AB-DTPA extractable P and calcareous in nature. Compost was prepared from the fresh animal dung and rock phosphate (RP) of Hazara area. Fresh animal dung was mixed with RP at the ratio of 2:1 (Dung:RP) according to the method as described by Hauck [18]. Dose of N was applied at the rate of 120 kg N ha^{-1} in three splits doses as Urea. Phosphorous was applied as SSP or compost at the rate of 90 kg P ha^{-1} and K as potassium sulphate at the rate of 60 kg K ha^{-1}. All P and K fertilizers were applied at sowing time. Pots were randomized completely with one week interval to minimize the side effect. All agronomic practices were strictly followed uniformly throughout the growing season for optimum crop growth. Mycorrhizal spores extracted from 100 g fresh soil of sorghum crop grown for the production of AMF inoculum in same soil conditions were used as indigenous inoculum. This indigenous AMF inoculum was dominated with *Glomus intraradices*, where as the spores of *G. fasiculatum* and *G. mossea* were present in minor quantity. These spores were inoculated uniformly in the pots of AMF inoculation at the rate of 100 spore pot^{-1}. The commercial AMF inoculum was received from BioMyc^{TM}, Germany which consists of species *Glomusintraradices*. This inoculum was inoculated at the rate of 10 ml pot^{-1} by the method as described by BioMyc Environment GmbH, Germany [19]. Twenty seeds of berseem were sown initially in each pot and were thinned to ten plants per pot after germination. Plants were harvested at maturity stage. Post harvest shoot dry matter yield of berseem was recorded in each treatment after drying. Plants samples were digested and analyzed according to the procedure as described by Walsh [20]. Plants N, P and micronutrients concentrations of berseem were determined. To avoid the effect of dilutions or concentrations caused by variation in wheat plants yield, the nutrients concentration were converted into total amount of nutrients uptake plants by multiplying nutrient concentrations with total dry matter in kg ha^{-1} by the procedure as described by Barber [21]. Roots of plants were removed from the soil, washed and dried at 65˚C - 70˚C till constant weight and root dry weights were recorded. Fresh soil and roots samples were also collected and stored at 4˚C for the determination of spores density and AMF root infection intensity. Plants' N concentration was determined by Kjeldah Method [22], while P and micronutrients concentration by Wet-Digestion Method [23]. Post harvest total soil N content was determined by kjeldhal method of Bremner [16]. AB-DTPA extractable P, Cu, Fe, Zn and Mn were analyzed by the method as described by Soltonpour and Schwabe [17]. Phosphorous was measured using Lambda 35 pectrophotometer and micronutrients by Perkin Elmer atomic absorption spectrophotomer. The AMF spores were isolated from soil by wet-sieving and decanting techniques as described by Brundrett [24]. Infection intensity of AMF in the roots was determined according to the procedures of Philips and Hayman [25] and Koske and Gemma [26]. Isolated spores were identified according to the procedure described by Schenck and Parez [27]. Statistical analysis of the collected data was carried out by conducting ANOVA and the means were compared by LSD test [28].

3. Results and Discussion

An experiment was conducted in pots in Institute of Biotechnology and Genetics Engineering (IBGE), the University of Agriculture, Peshawar in summer 2011to determine berseem (*Trifolium alexandrium*) yield and yield components and plants nutrients uptakes as influenced by AMF and compost prepared from fresh animal dung and RP. Physicochemical characteristics of soil are shown in **Table 1**.

3.1. Berseem Yield and Yield Components

Data on shoots and roots yields of berseem as influenced by AMF inoculation with compost are presented in **Table 2**. Data showed that maximum shoot dry matter yield of 4333 kg ha^{-1}, was recorded in the treatment of inoculation of indigenous mycorrhiza (AMF-I) with half dose of compost, which was significantly ($P \leq 0.05$) higher by 98% and 76%, respectively over control and N and K fertilizers (**Figure 1**). The data indicated that highest berseem roots dry weight of 793 kg ha^{-1} was observed in the inoculation of AMF-I with half dose of compost, and was significantly ($P \leq 0.05$) increased as 60% and 52%, respectively over control and N and K fertilizers (**Figure 2**). Habashy *et al.* [29] reported that the highest grain production was obtained in the treatment of AMF inoculation with compost combination with 15 and 30 kg P_2O_5 fed^{-1}. El-Goud [30] found that highest yield of maize plants was found in the treatment of inoculation of AMF with the application of 75% compost and 100% N of recommended dose of nitrogen fertilizer. El-Sayed *et al.* [31] reported that the highest yield was obtained in the treatment 75% compost of recommended dose and NPK fertilizer application. Filho [32] reported maximum growth and shoot dry matter yield in jack-bean and pigeon-pea inoculated with AMF and compost than AMF inoculation or compose alone. Sharif and Jan [33] found that shoot and root dry matter were significantly increase by the inoculation of AMF with rock phosphate. Sharif *et al.* [34] reported that shoot and root dry mater yields of wheat crop significantly increased with inoculation of AMF alone and in combination with poultry manure (PM), farmyard manure (FYM) and humic acid (HA).

Table 1. Physico chemical characteristics of soil under investigations.

Property	Units	Concentration
Sand	%	28.4
Silt	%	66.2
Clay	%	5.4
Textural class	-	Silt loam
pH	-	7.56
EC_e	d Sm^{-1}	2.76
Lime	%	16.5
O.M content	%	0.73
Total N content	%	0.08
P (AB-DTPA extractable)	mg kg^{-1}	2.25

Table 2. Effect of AMF inoculation with compost on shoots and root dry matter yield of berseem.

Treatments	Shoot dry matter yield (kg ha^{-1})	Root dry matter yield (kg ha^{-1})
Control (No fertilizer)	2094 c*	496 e*
N and K fertilizer (Basal dose)	2348 c	521 e
Full dose of compost	3033 b	703 cd
Indigenous AMF (AMF-I)	2843 b	676 d
Commercial AMF (AMF-II)	2863 b	686 d
Half dose of compost + AMF-I	4333 a	793 a
Half dose of compost + AMF-II	4150 a	770 ab
Full dose of compost + AMF-I	4051 a	749 ab
Full dose of compost + AMF-II	4033 a	743 bc
Full dose of SSP	4026 a	742 bc

*Means with different letter(s) in columns are significantly different at $P \leq 0.05$. N-P-K = 120-90-60 kg ha^{-1}, respectively, compost = 4500 kg ha^{-1}, AMF-1 = 70 spores pot^{-1}, AMF-II = 10 ml pot

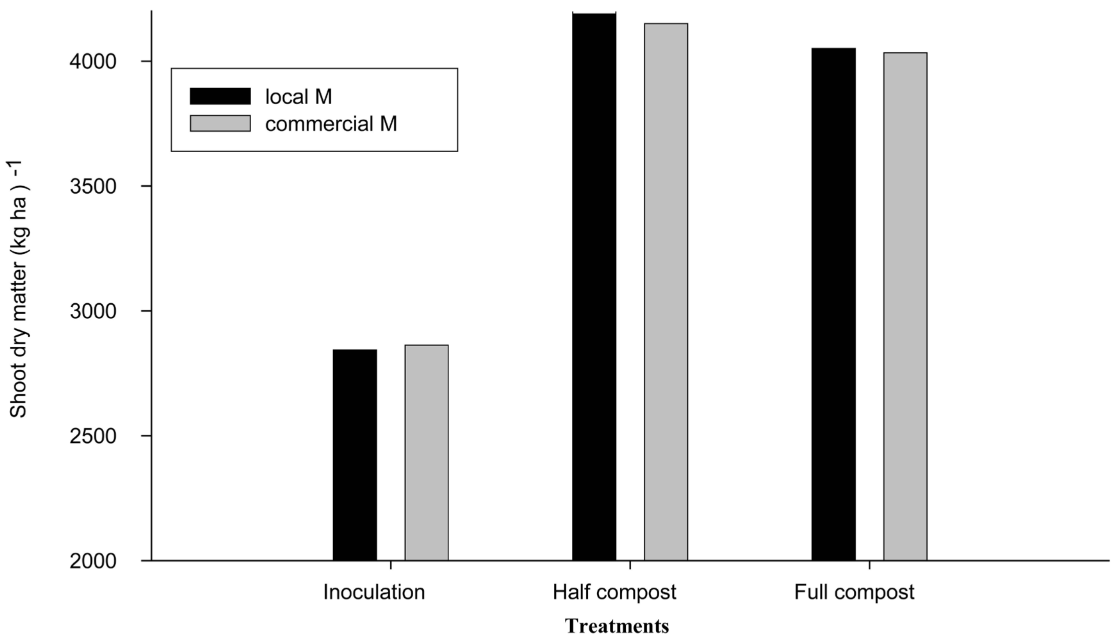

Figure 1. Effect of AMF inoculation with compost on shoot dry matter yield of berseem.

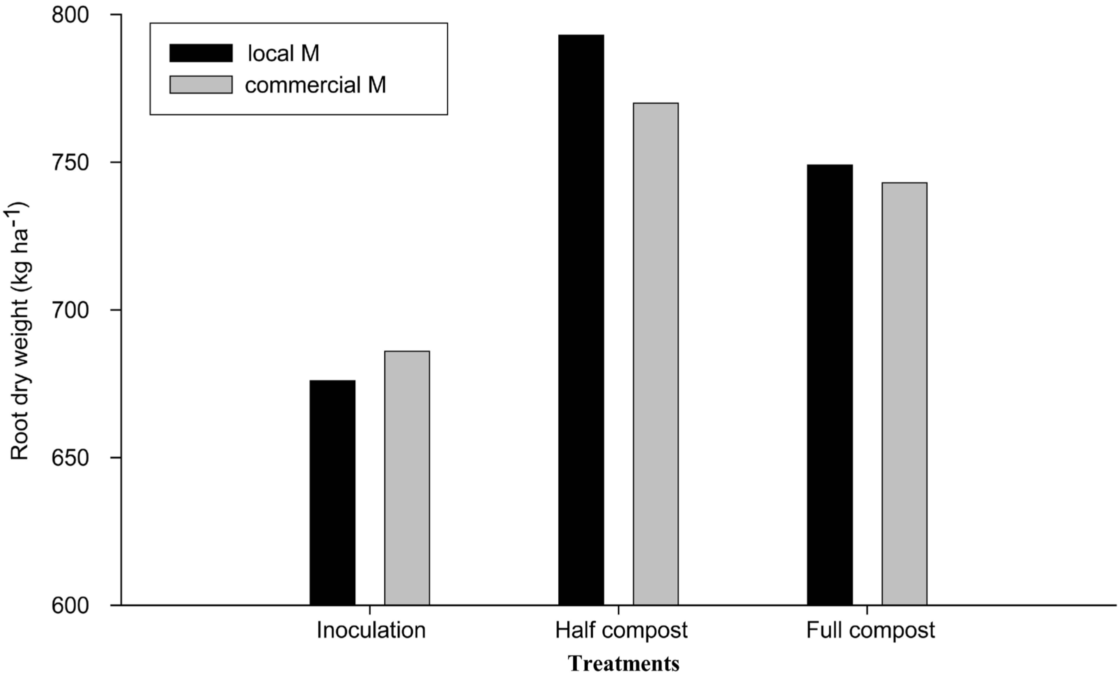

Figure 2. Effect of AMF inoculated with compost on root dry weight of berseem.

3.2. Post Harvest Soil N, P and Micronutrients Contents

Data of post harvest soil N, P and Zn, Cu, Mn and Fe contents as affected by the AMF inoculation with compost are presented in **Table 3**. The data indicated that the treatment of AMF-I inoculation with full dose of compost released maximum total N content of 1242 mg kg^{-1} followed by the AMF-II inoculation with full dose of compost. Maximum AB-DTPA extractable P content of 7.76 mg kg^{-1} was recorded in the treatments of AMF-II inoculation with full dose of compost followed by the treatment of AMF-I inoculation with full dose of compost. The data revealed that soil Zn content of 1.40 mg kg^{-1} was found in the treatments of AMF-I inoculation with full dose of compost followed by the AMF-II inoculation with full dose of compost. The treatment received AMF-I inoculation and full dose of compost released maximum Cu content of 4.30 mg kg^{-1} followed by the inoculation of AMF-II with full dose of compost. Maximum Mn content 10.20 mg kg^{-1} was recorded in the treatments of AMF-I inoculation with full dose of compost and AMF-II followed by the treatments of inoculation of AMF-II with full dose of compost. The maximum Fe content of 3.80 mg kg^{-1} was found in the treatment of AMF-I inoculation with half dose of compost followed by of inoculation of AMF-I with full dose of compost. Similar results were recorded by Habashy *et al*. [29] that highest P content was obtained in the treatment of inoculation of AMF with compost over alone inoculation of AMF or alone compost application and stated that when organic matter was added to the calcareous soil and thus may applied organic matter released phosphate in the soil and more available to the plant.

3.3. Plant N and P Concentrations and Their Uptakes

Data regarding plants N and P concentrations and their uptakes by berseem as affected by AMF inoculation with compost are presented in **Table 4**. The data indicated that maximum plant N uptake of 173 kg ha^{-1} was found in the treatment of AMF-II inoculation with full dose of compost, which was higher significantly ($P \leq 0.05$) by 268% and 188%, respectively over control and N and K fertilizers followed by inoculation of AMF-II with half dose of compost (**Figure 3**). Maximum P uptake 17.47 kg ha^{-1} was noted in treatment of AMF-II inoculated with full dose of compost (**Table 4**) and increased significantly ($P \leq 0.05$) by 308% over control and 229% over N and K fertilizers followed by inoculation of AMF-II with half dose of compost (**Figure 4**). El-Goud [30] investigated that highest uptake of N was found in the treatment 100% compost and 100% N inoculated with AMF and maximum P uptake in the treatment 75% C and 100% inoculated with AMF. Lambert *et al*. [35] reported

Table 3. Post harvest soil N, P and micronutrients contents as affected by AMF inoculation with compost.

Treatments	Total N	P	Zn	Cu	Mn	Fe
		AB-DTPA extractable				
	soil contents (mg kg^{-1})					
Control (No fertilizer)	480 e*	5.40 d*	0.98 d*	3.50 d*	7.70 c*	3.20 d*
N and K fertilizer (Basal dose)	785 d	5.66 d	1.13 cd	3.61 d	8.00 c	3.40 cd
Full dose of compost	913 cd	6.50 c	1.23 bc	3.73 cd	8.30 c	3.43 cd
Indigenous AMF (AMF-1)	918 cd	6.76 bc	1.25 bc	3.75 cd	8.33 c	3.53 bc
Commercial AMF (AMF-II)	956 cd	6.63 bc	1.23 bc	3.73 cd	8.33 c	3.46 c
Half dose of compost + AMF-I	1163 ab	7.23 abc	1.27 ab	4.10 abc	9.60 ab	3.80 a
Half dose of compost + AMF –II	1146 ab	7.30 ab	1.26 abc	4.16 abc	9.66 ab	3.73 ab
Full dose of compost + AMF-I	1242 a	7.66 a	1.40 a	4.30 a	10.20 a	3.65 abc
Full dose of compost + AMF-II	1233 ab	7.76 a	1.35 ab	4.25 ab	9.93 ab	3.63 abc
Full dose of SSP	1101 b	7.30 a	1.23 ab	3.81 bcd	9.20 ab	3.55 abc

*Means with different letter(s) in columns are significantly different at P ≤ 0.05. N-P-K = 120-90-60 kg ha^{-1}, respectively, compost = 4500 kg ha^{-1}, AMF-1 = 70 spores pot^{-1}, AMF-II = 10 ml pot^{-1}.

Table 4. Plant N and P uptake as influenced by AMF inoculation with compost.

Treatments	N	P
	Plant uptake (kg ha^{-1})	
Control (No fertilizer)	**47 e***	**4.28 d***
N and K fertilizer (basal dose)	**60 e**	**5.30 d**
Full dose of compost	**85 d**	**7.62 c**
Indigenous AMF inoculation (AMF-1)	**98 d**	**7.79 c**
Commercial AMF inoculation (AMF-II)	**95 d**	**7.69 c**
Half dose of compost + AMF-I	**155 abc**	**16.59 a**
Half dose of compost + AMF –II	**170 ab**	**17.00 a**
Full dose of compost + AMF-I	**147 bc**	**16.55 a**
Full dose of compost + AMF-II	**173 a**	**17.47 a**
Full recommended dose of SSP	**132 c**	**14.16 b**

*Means with different letter(s) in columns are significantly different at P ≤ 0.01. N-P-K = 120-90-60 kg ha^{-1}, respectively, compost = 4500 kg ha^{-1}, AMF^{-1} =70 spores pot^{-1}, AMF-II = 10 ml pot^{-1}

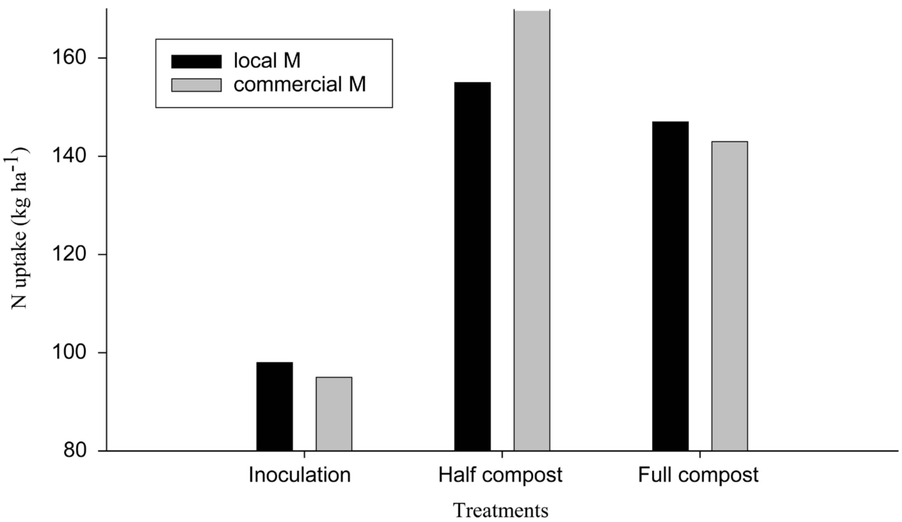

Figure 3. N uptake by berseem as affected by AMF inoculation with compost.

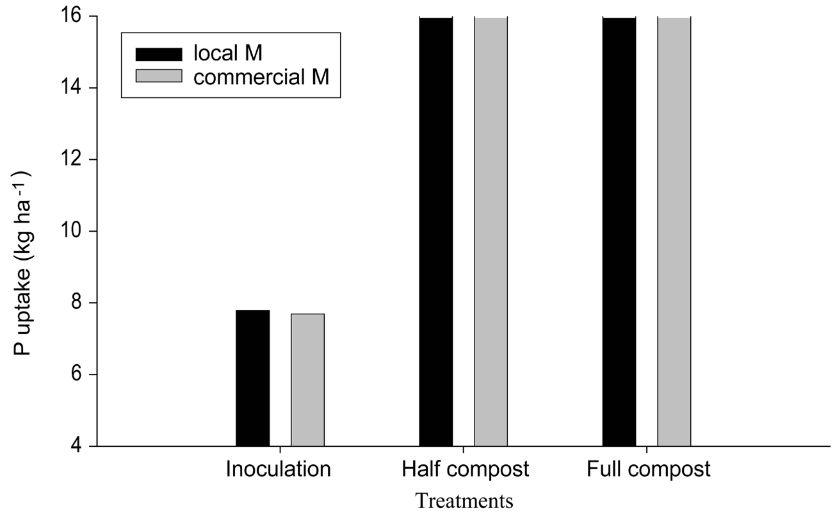

Figure 4. P uptake by berseem as affected by AMF inoculation with compost.

that AMF increased uptake of immobile nutrients such as P, Cu and Zn. The study conducted by Maksoud *et al*. [36] their result indicated that leaf P content was significantly increased by inoculation of AMF with rock phosphate. Habashy *et al*. [29] reported that P uptake increased when organic matter was added to the alkaline calcareous soil and thus may applied organic matter released phosphate in soil and more available to the plant. Sharif and Jan [33] found that the inoculation of AMF with rock phosphate was significantly increased the uptakes of N and P. Sharif *et al*. [34] reported that N uptake by wheat significantly increased with inoculation of AMF alone and in combination with poultry manure (PM), farmyard manure (FYM) and humic acid (HA).

3.4. Plants Micronutrients Uptakes

Plants Zn, Cu, Fe and Fe uptakes by berseem plants as affected by AMF inoculation with compost are presented in **Table 5**. The data revealed that maximum plants Zn uptake of 286 g ha^{-1} was found in the treatment of inoculation of AMF-II with full dose of compost, which was significantly ($P \le 0.05$) higher by 191% and 138%, respectively over control and N and K fertilizers followed by inoculation of AMF-II with half dose of compost (**Figure 5(a)**). The data showed that maximum Cu uptake by berseem of 59 g kg ha^{-1} was recorded in the treatment of inoculation of AMF-II with half dose of compost and increased significantly ($P \le 0.05$) by 300% over control and 222% over N and K fertilizers followed by inoculation of AMF-II with full dose of compost (**Figure 5(b)**). Maximum Mn uptake of 1225 g ha^{-1} was noted in the treatment which inoculated with AMF-I half dose compost, which was significantly ($P \le 0.05$) higher by 192% and 148%, respectively over control and N and K fertilizers followed by inoculation of AMF-II with full dose compost (**Figure 5(c)**). Maximum Fe uptake by berseem of 643 g ha^{-1} was found in the treatment of inoculation of AMF-II with half dose of compost and was increased significantly ($P \le 0.05$) by 249% over control and 161% over N and K fertilizers followed by inoculation of AMF-I with half dose of compost (**Figure 5(d)**). Lambert *et al*. [35] reported that AMF increased uptake of Cu and Zn.

3.5. Soil Spores Density of AMF and Their Roots Infection Intensity in Berseem Crop

Data in **Table 6** showed soil spores density and their roots infection intensity in berseem crop as influenced by AMF inoculation with composts in the area under investigations. Data showed that maximum AMF spores density of 27 spores per 20 g soil was observed in the treatment received inoculation of AMF-I and full dose of compost, which was significantly ($P \le 0.05$) increased by 80% and 69%, respectively over control and N and K fertilizers followed by the treatments of inoculation of AMF-I with half dose of compost and inoculation of AMF-II with half dose of compost. The highest berseem roots infection intensity 37% was observed in the treatment of AMF-I inoculation with full dose of compost and was significantly ($P \le 0.05$) higher by 85% over control and 60% over N and K fertilizers followed by the treatment which received AMF-I inoculation with half dose of compost. Isolated spores were identified according to the procedure as described by Schenck and Parez

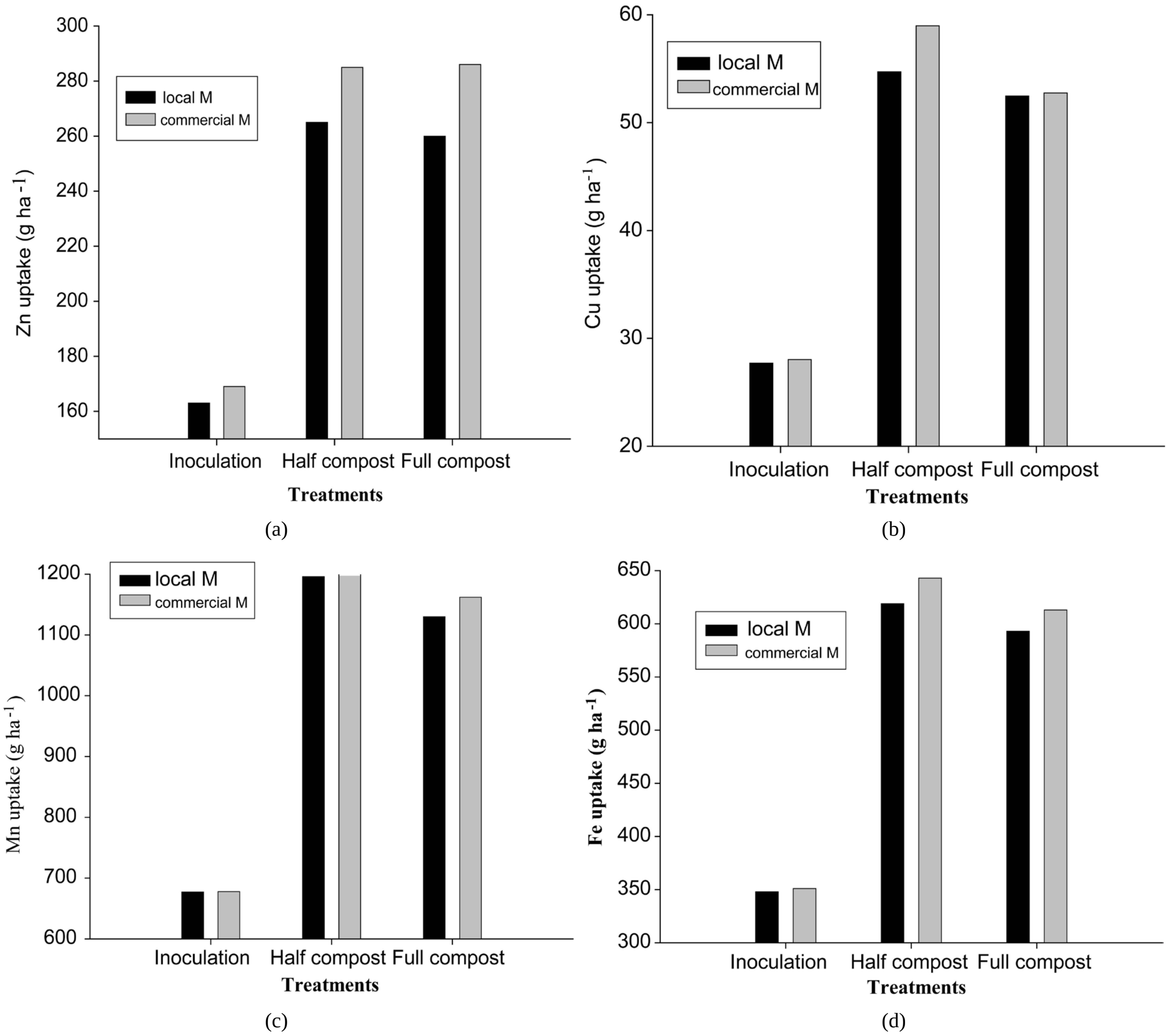

Figure 5. Plants uptake of Zn, Fe, Cu and Mn, respectively as affected by AMF inoculation with compost.

Table 5. Plants micronutrients uptakes of berseem plants as affected by AMF inoculationwith compost.

Treatments	Zn	Fe	Cu	Mn
	Plant uptake (g ha^{-1})			
Control (No fertilizer)	98 d*	14.76 d*	420 d*	184 c*
N and K fertilizer (basal dose)	120 d	18.29 d	493 d	246 c
Full dose of compost	161 c	27.82 c	686 c	339 b
Indigenous AMF(AMF-1)	163 c	27.70 c	677 c	348 b
Commercial AMF (AMF-II)	169 c	28.03 c	678 c	351 b
Half dose of compost + AMF-I	265 ab	54.70 ab	1196 a	619 a
Half dose of compost + AMF –II	285 a	58.98 a	1225 a	643 a
Full dose of compost + AMF-I	260 ab	52.47 ab	1130 ab	593 a
Full dose of compost + AMF-II	286 a	52.75 ab	1162 ab	613 a
Full recommended dose of SSP	250 b	51.68 b	988 b	591 a

*Means with different letter(s) in columns are significantly different at $P \leq 0.05$. N-P-K = 20-90-60 kg ha^{-1}, respectively, compost = 4500 kg ha^{-1}, AMF-1 = 70 spores pot^{-1}, AMF-II = 10 ml pot^{-1}.

Table 6. Soil spores density and roots infection intensity in berseem crop as affected by AMF inoculation with compost.

Treatments	AMF spores density (20 g soil)	AMF root infection intensity (%)
Control (No fertilizer)	15 d*	20 e*
N and K fertilizer (Basal dose)	16 d	23 de
Full dose of compost	17 d	26 cde
Indigenous AMF (AMF-I)	21 c	29 bcd
Commercial AMF (AMF-II)	21 c	28 bcd
Half dose of compost + AMF-I	25 ab	35 ab
Half dose of compost + (AMF-II)	25 ab	33 ab
Full dose of compost + AMF-I	27 a	37 a
Full dose of compost + AMF-II	23 b	29 bcd
Full dose of SSP	20 c	25 de

*Means with different letter(s) in columns are significantly different at $P \leq 0.01$. N-P-K = 120-90-60 kg ha^{-1}, respectively, compost = 4500 kg ha^{-1}, AMF^{-1} = 70 spores pot^{-1}, AMF-II = 10 ml pot^{-1}.

[27]. Spores were dominated with *Glomus intraradices*, where as the spores of *G. fasiculatum* and *G. mossea* were present in minor quantity. The result of Habashy *et al*. [29] showed increased spore density and mycorrhizal root colonization gradually with the inoculation of AMF and organic waste compost, while significantly increased with the organic compost alone comparing to control one and also increased significantly by combined inoculation of AMF and compost over control and AMF or compost alone. Sharif and Jan [33] reported that mycorrhizal spore density and root infection intensity increased by inoculation of AMF and application of RP. The endomycorrhizal fungi are obligate symbiotic fungi, the hyphae of which develop mycelia, arbuscules and in most fungal genera vesicles in roots. Phosphorus is the second essential macro nutrient after nitrogen required for the growth of plant and found in organic and inorganic form. Due to its low solubility and mobility plant cannot utilize phosphorus is an in organic or complex form [37]. Inorganic P present in the soil, which is readily available to the plant, but in limited amount. Thus AMF enhance the nutrient uptake through its external hyphae into the surrounding soil and hydrolyzed unavailable source of phosphorus with the help of secreted enzymes such as phosphate [37]. These fungi dissolve relatively insoluble nutrients more efficiently even from very low nutrient concentration because of their ability to produce organic acids, exploration of more area beyond the root zone and release of CO_2. Mycorrhizal fungi are beneficial symbiotic microorganisms with their extra metrical hyphae, which increase growth and yield of most crops. The AMF improve soil structure and thus enhance physically, chemically and biological soil quality and improve soil physical structure. Mycorrhiza play significant role in the uptake of P from RP and mycorrhizal plants are more effective in the utilization of RP than non-mycorrhizal plants. According to Ness and Vlek [38] only mycorrhizal maize took up phosphorus from hydroxyl-apatite, and that P subsequently transferred to maize. Rock phosphate, being the cheapest source of P, can be best utilized as P fertilizer only when it is dissolved properly by chemical or biological means. Compost is environmental friendly and cost effective technique of waste recycling [8]. The composted materials are better than raw materials due to C: N, C: P and C: K ratios. Microbes produce organic acid, hormones; enzymes which help in mineralization of nutrients including P which release from organic matter and available for plant uptake. Mycorrhizal inoculations with compost application are more effective in improving the physical properties of soil than inorganic fertilizer. The long term organic fertilizers and mycorrhizal inoculation could improve soil physical properties which are the indicator for development of roots and improvement of crop production [39].

4. Conclusion

It could be concluded from the results of the conducted experiment that berseem shoot and root yield were improved significantly by the inoculation of indigenous AMF with half dose of compost. Soil contents of N, P, Zn, Cu, Fe and Mn were improved by the inoculation of AMF with compost. Plants uptakes of nutrients improved significantly AMF-I inoculation with compost. Improved soil spores density of AMF by their inoculation with compost showed positive correlation with root intensity of berseem. Inoculation of AMF with compost has potential to improve yield and plants N, P, Zn, Cu, Mn and Fe uptakes of berseem under given soil conditions.

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