Int.J.Curr.Microbiol.App.Sci (2019) *8*(12): 3039-3048

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 8 Number 12 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.812.354

Growth and Yield Response of Mungbean Plants to Colonization of Arbuscular Mycorrhizal Fungi (AMF) (*Glomus macrocarpon*) and Phosphorus Amendments

Amandeep Singh*, Daljeet Singh and Narinder Singh

Senior Plant Pathologist, College of Agriculture, Punjab Agricultural University, Ludhiana-141004, India

**Corresponding author*

Keywords

AM Fungi, colonization, *Glomus macrocarpon*, Mungbean, Spore population

Article Info

Accepted:
04 November 2019
Available Online:
10 December 2019

A B S T R A C T

Arbuscular mycorrhizal fungi (AM fungi) have been found associated with a wide variety of agricultural and horticultural crops, but in legumes it occurs widely. The experiments were conducted during spring season 2017 under pot house conditions. The effect of inoculation of AM Fungi colonization and P amendments on growth and yield of Mungbean plants was investigated. The results revealed the overall increase in plant growth parameters and yield of Mungbean plants. In AM Fungi inoculated pots, the root as well as leaf surface area were also enhanced significantly due to the colonization of *Glomus macrocarpon* (AM Fungi) as compared to uninoculated plots. Among three levels of Phosphorus; 0, 40 and 80 mg/kg soil, the maximum increase in root and shoot length, their fresh and dry weight was recorded at 40 mg P/kg soil in 15, 30, 45 and 60 days old Mungbean plants as compared to 80 and 0 mg P/kg soil levels. The number of leaves and pods per plant, their fresh and dry weight was also found maximum at 40 mg P/kg soil level. Maximum increase in plant growth and yield of Mungbean plants were recorded in the pots combined inoculated with *Glomus macrocarpon* and phosphorus. It is suggested that Arbuscular Mycorrhizal Fungi have the potential to act as bio-fertilizer.

Introduction

Mycorrhihza refers to the mutualistic, symbiosis between fungi and roots of higher plants. The vesicular Arbuscular mycorrhizal fungi is very common and old among all mycorrhizal types (Mosse *et al.*, 1981). The VAM fungus occur widely in legumes (Bargali, 2011) and number of forage crops under different ecosystems (Souchie *et al.*, 2006). Mungbean is an important pulse crop as it supplies 25 per cent protein. So the interaction of mycorrhizal fungi with roots of Mungbean plants is very important. The mycorrrhizal colonization is facilitating the efficient use of nutrients and water up take by plants especially in infective soil (Harley and Smith, 1983). Symbiotic association between VAM and roots of plants enhanced the nutrient absorbing area of roots along with improvement in efficiency of nutrient absorption (Kadian *et al.*, 2014). In addition,

Arbuscular mycorrhizal fungus is known to protect the plants against several soil borne diseases (Davis and Menge, 1980; Singh *et al.,* 2017). VAM fungus improves the soil structure through the capacity to bind soil particles into crumbs, which is required soil structure for growth of plants (Manke *et al.,* 2008). Researchers in the last few decades have established that VAM improve the plant growth and have potential to act as plant biofertilizer.

Materials and Methods

Treatments

Different experiments were conducted to observe the impact of Arbuscular Mycorrhizal fungus on growth and yield parameters of mungbean plants in pots using sterilized soil. The experiments comprised of five treatments namely, 1. Arbuscular Mycorrhizal fungus (AMF) alone 2. Pathogen (*Macrocphomina phaseolina* (Tassi) Goid) alone 3. AMF/Pathogen (AMF was applied at the time of sowing and pathogen was applied after one week of sowing) 4. Pathogen/AMF (Pathogen was applied at time of sowing and AM F was applied after 5 days of sowing) 5. Uninoculated Control (without any treatment) and designed at 3 levels of phosphorus in soil i. e. (1) Control (P_0) (2) (P_{40}) (3) 80 mg 'P'/ kg soil (P_{80}) Total seven plants maintained per pot and treatments were replicated thrice.

Cleaning and staining of roots were done by using method of Philips and Haymann (1970). The mycorrhizal colonization was measured by using the method of Biermann and Linderman (1981). Extraction of spores of AM fungi was done by using wet sieving and decanting technique (Gredmann and Nicolson 1963). Observations regarding the percentage colonization, spore population and plant growth parameters were taken after 15, 30, 45 and 60 days of sowing. After taking fresh weight, the plant parts were kept separately in the oven at 80º C for 48 hours for complete drying of samples in order to record their dry weight.

Results and Discussion

Mycorrhizal colonization and spore population

The inoculation of *Glomus macrocarpon* showed the maximum colonization at 40 mg 'P'/ kg soil (36.60, 52.50, 69.10 and 78.00 per cent after 15, 30, 45 and 60 days of sowing) as compared to 31.25, 44.60, 62.00 and 72.20 per cent colonization at 80 mg 'P'/ kg soil level. There is direct relationship between spore population and mycorrhizal colonization. The spore population was 400, 593, 785 and 950 per 100 g soil at 40 mg 'P'/ kg soil as compared to 350, 480, 710 and 825 spores per 100 g soil at 80 mg 'P'/ kg soil level. It was found that with increase in mycorrhizal colonization is directly proportional to the age of the plant. At initial stages the colonization is very less, but with age of the plants the colonization increased. There is no colonization observed in root samples collected from the uninoculated plants.

Effect on plant growth parameters

The plant growth responses with respect to root, shoot length, fresh and dry weight along with number of leaves their fresh and dry weight were significantly higher in *Glomus macrocarpon* inoculated plants at all level of 'P' in soil as compared to uninoculated plants (Table 3 to 6). It was found that the application of phosphorus at different levels significantly affect the colonization as well as growth of plants. Among the three levels of P, the plants were more responsive to 40 mg 'P'/ kg soil level as compared to the 80 mg P/kg soil and control plants (Fig. 1). Rabie (2005) studied that the dry weight as well as plant

height of mungbean plants colonized by *G. clarum* was significantly higher than untreated plants. Similar results were found by Sohrabi *et al.,* (2015).

Fig. 1 Comparison of Plant growth of AM inoculated and un-inoculated plants at different levels of P

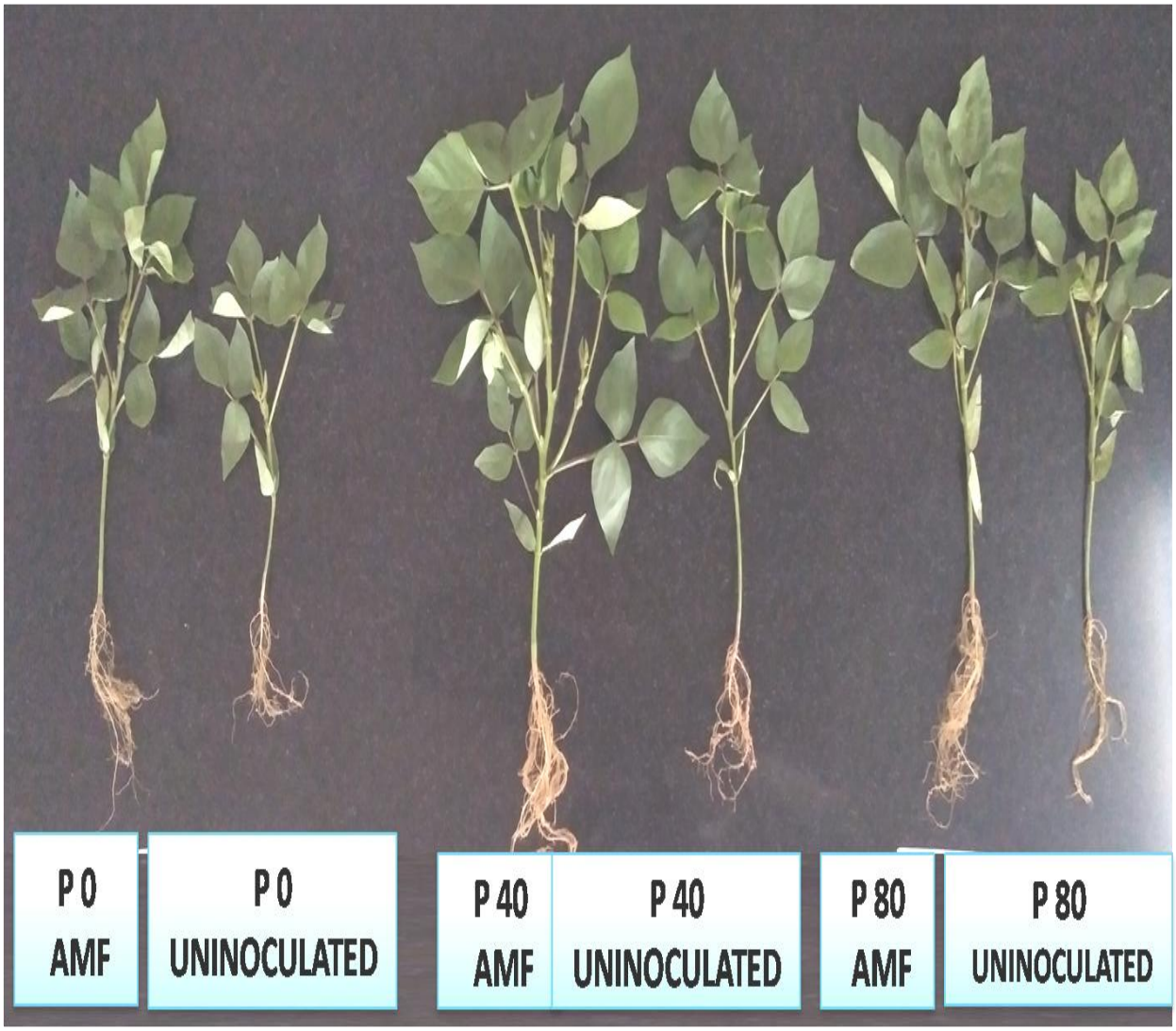

Table.1 Effect of *Glomus macrocarpon* inoculation and 'P' amendment on Arbuscular mycorrhizal colonization in roots of Mungbean

Treatment	Observations after Days															
	15				30				60				90			
	Coloni-zation (%)	Mycorrhizal Structures			Coloni-zation (%)	Mycorrhizal Structures			Coloni zation (%)	Mycorrhizal Structures			Coloni-Zation (%)	Mycorrhizal Structures		
		Myce-lium	Arbus-cules	Vesi-cles		Myce-lium	Arbus-cules	Vesic-les		Myce-lium	Arbu-scules	Vesic-les		Myce-lium	Arbus-cules	Vesic-les
Main effects																
U	00.00 (00.00)	-	-	-	00.00 (00.00)	-	-	-	00.00 (00.00)	-	-	-	00.00 (00.00)	-	-	-
I	31.72 (34.22)	+ + +	+ +	-	44.90 (42.00)	+ + +	+ + +	+	62.60 (52.30)	+ +	+ +	+ +	72.20 (58.20)	+ +	+	+ + +
C D at 5%	0.29				0.26				0.31				0.22			
P_0	13.60 (15.70)	+ +	+	-	18.70 (18.80)	+ +	+ +	+	28.30 (24.40)	+	+ +	+ +	33.20 (27.20)	+	-	+ +
P_{40}	18.30 (18.60)	+ +	+	-	26.20 (23.20)	+ +	+ +	+	34.50 (28.12)	+	+ +	+ +	39.00 (31.00)	+	-	+ + +
P_{80}	15.60 (16.90)	+ +	+	-	22.30 (20.90)	+ +	+ +	+	31.00 (25.90)	+	+ +	+ +	36.10 (29.00)	+	-	+ +
C D at 5%	0.36				0.32				0.38				0.27			
Interaction effects																
P_0 U	00.00 (00.00)	-	-	-	00.00 (00.00)	-	-	-	00.00 (00.00)	-	-	-	00.00 (00.00)	-	-	-
P_{40} U	00.00 (00.00)	-	-	-	00.00 (00.00)	-	-	-	00.00 (00.00)	-	-	-	00.00 (00.00)	-	-	-
P_{80} U	00.00 (00.00)	-	-	-	00.00 (00.00)	-	-	-	00.00 (00.00)	-	-	-	00.00 (00.00)	-	-	-
P_0 I	27.20 (31.40)	+ +	+ +	-	37.50 (37.73)	+ + +	+ + +	+	56.70 (48.80)	+ +	+ +	+ + +	66.40 (54.50)	+ +	+	+ + +
P_{40} I	36.60 (37.20)	+ +	+ +	-	52.50 (46.45)	+ + +	+ + +	+ +	69.10 (56.20)	+ +	+ +	+ + +	78.00 (62.00)	+ +	+	+ + +
P_{80} I	31.25 (33.90)	+ +	+ +	-	44.60 (41.80)	+ + +	+ + +	+ +	62.00 (51.90)	+ +	+ +	+ + +	72.20 (58.10)	+ +	+	+ + +
C D at 5%	0.51				0.46				0.54				0.38			

P_0 = No phosphorous application; P_{40} = 40 mg `P`/ kg soil; P_{80} = 80 mg `P`/ kg soil; U =Uninoculated; I = Inoculated; Figures in parentheses are arc sin transformed value of respective data; + = Scanty; + + = Moderate; + + + = Abundant

Table.2 Effect of *Glomus macrocarpon* and P amendments on plant growth parameters of Mungbean after 15 days of sowing

15 DAYS											
Treatment	Root			Shoot			Leaves			Branches	Nodu-lation
	Length (cm)	Fresh weight (g)	Dry weight (g)	Length (cm)	Fresh weight (g)	Dry weight (g)	Number	Fresh weight (g)	Dry weight (g)	Number	
Main effects											
U	8.72	0.96	0.54	8.53	2.00	1.06	5.13	1.64	0.79	1.27	-
I	15.53	2.52	1.30	16.33	6.30	3.13	8.26	4.06	2.10	2.27	+ +
C D at 5 %	0.56	0.06	0.07	0.23	0.04	0.09	0.36	0.09	0.04	0.29	
P_0	10.30	1.22	0.60	10.60	2.75	1.45	5.80	1.95	0.96	1.50	+
P_{40}	14.20	2.24	1.26	14.60	5.35	2.70	7.60	4.00	2.03	2.25	+ +
P_{80}	11.88	1.77	0.90	12.10	4.35	2.15	6.70	2.60	1.35	1.58	+
C D at 5 %	0.69	0.07	0.08	0.29	0.05	0.11	0.44	0.11	0.05	0.36	
Interaction effects											
P_0 U	7.20	0.64	0.30	7.20	1.30	0.80	4.40	1.14	0.42	1.00	-
P_{40} U	10.20	1.30	0.82	10.20	2.70	1.40	5.60	2.18	1.16	1.50	-
P_{80} U	8.76	0.93	0.50	8.20	2.00	1.00	5.40	1.60	0.80	1.33	-
P_0 I	13.40	1.80	0.90	14.00	4.20	2.10	7.20	2.76	1.50	2.00	+
P_{40} I	18.20	3.18	1.70	19.00	8.00	4.00	9.60	5.82	2.90	3.00	+ +
P_{80} I	15.00	2.60	1.30	16.00	6.70	3.30	8.00	3.60	1.90	1.83	+ +
C D at 5 %	0.98	0.11	0.12	0.41	0.07	0.15	0.63	0.16	0.07	0.36	

P_0 = No phosphorous application.; P_{40} = 40 mg `P`/ kg soil; P_{80} = 80 mg `P`/ kg soil; U = Uninoculated; I = Inoculated; + = Scanty; + + = Moderate; + + + = Abundant

Table.3 Effect of *Glomus macrocapon* inoculation and P amendments on plant growth parameters of Mungbean 30 days after sowing

30 DAYS											
Treatment	Root			Shoot			Leaves			Branches	Nodu-lation
	Length (cm)	Fresh weight (g)	Dry weight (g)	Length (cm)	Fresh weight (g)	Dry weight (g)	Number	Fresh weight (g)	Dry weight (g)	Number	
Main effects											
U	13.13	1.51	0.79	14.60	4.10	1.90	10.73	2.95	1.39	3.13	-
I	22.40	3.70	1.77	23.40	8.27	4.08	18.33	6.86	3.54	6.60	+ +
C D at 5 %	0.44	0.05	0.04	0.52	0.06	0.04	0.93	0.06	0.06	0.29	
P_0	14.20	2.15	1.02	15.10	4.11	2.05	12.00	3.70	1.85	3.70	+
P_{40}	22.10	3.12	1.55	22.50	8.27	4.01	17.10	6.24	3.21	6.40	+ +
P_{80}	17.00	2.55	1.28	19.40	6.19	2.92	14.50	4.79	2.35	4.50	+
C D at 5 %	0.54	0.06	0.05	0.64	0.08	0.05	1.14	0.08	0.08	0.35	
Interaction effects											
P_0 U	9.20	1.16	0.58	10.00	2.12	1.06	9.00	2.00	1.00	2.00	-
P_{40} U	17.20	1.96	1.00	18.00	6.46	2.96	12.20	3.78	1.76	4.40	-
P_{80} U	13.00	1.42	0.80	15.80	3.74	1.70	11.00	3.08	1.42	3.00	-
P_0 I	19.20	3.14	1.46	20.20	6.10	3.04	15.00	5.40	2.70	5.40	+
P_{40} I	27.00	4.28	2.10	27.00	10.08	5.06	22.00	8.70	4.66	8.40	+ +
P_{80} I	21.00	3.68	1.76	23.00	8.64	4.14	18.00	6.50	3.28	6.00	+ +
C D at 5 %	0.77	0.09	0.08	0.90	0.11	0.07	1.61	0.11	0.11	0.50	

P_0 = No phosphorous application; P_{40} = 40 mg `P`/ kg soil; P_{80} = 80 mg `P`/ kg soil; U = Uninoculated; I = Inoculated; + = Scanty; + + = Moderate; + + + = Abundant

Table.4 Effect of *Glomus macrocapon* inoculation and P amendments on plant growth parameters of Mungbean 45 days after sowing

45 DAYS											
Treatment	Root			Shoot			Leaves			Branches	Nodu-lation
	Length (cm)	Fresh weight (g)	Dry weight (g)	Length (cm)	Fresh weight (g)	Dry weight (g)	Number	Fresh weight (g)	Dry weight (g)	Number	
Main effects											
U	21.33	2.26	1.24	26.60	7.58	3.21	17.66	6.05	2.77	5.93	-
I	30.33	4.88	2.44	41.93	13.20	6.38	26.33	11.00	5.35	9.93	+ + +
C D at 5 %	0.53	0.21	0.07	0.46	0.44	0.07	0.30	0.31	0.05	0.25	
P_0	20.50	2.70	1.36	28.40	7.76	3.47	18.50	5.89	2.65	5.80	+ +
P_{40}	31.50	4.42	2.33	40.20	13.52	6.41	25.50	12.08	5.85	10.00	+ + +
P_{80}	25.50	3.60	1.84	34.20	9.90	4.52	22.00	7.61	3.69	8.00	+ +
C D at 5 %	0.65	0.26	0.09	0.57	0.54	0.08	0.37	0.38	0.07	0.31	
Interaction effects											
P_0 U	17.00	1.60	0.93	21.80	4.52	2.06	15.00	4.78	1.94	4.00	-
P_{40} U	25.00	2.84	1.60	31.00	11.04	4.66	21.00	8.16	3.88	8.00	-
P_{80} U	22.00	2.34	1.20	27.00	7.20	2.92	17.00	5.22	2.50	5.80	-
P_0 I	24.00	3.80	1.78	35.00	11.00	4.88	22.00	7.00	3.36	7.60	+ +
P_{40} I	38.00	6.00	3.06	49.40	16.00	8.16	30.00	16.00	7.82	12.00	+ + +
P_{80} I	29.00	4.86	2.48	41.40	12.60	6.12	27.00	10.00	4.88	10.20	+ + +
C D at 5 %	0.92	0.36	0.13	0.80	0.76	0.12	0.53	0.54	0.10	0.44	

P_0 = No phosphorous application; P_{40} = 40 mg `P`/ kg soil; P_{80} = 80 mg `P`/ kg soil; U = Uninoculated; I = Inoculated; + = Scanty; + + = Moderate; + + + = Abundant

Table.5 Effect of *Glomus macrocarpon* inoculation and 'P' amendment on plant growth parameters after 60 days of sowing

Treatment	Root			Shoot			Leaves			Branches	Pods			Nodulation
	Length (cm)	**Fresh weight (g)**	**Dry weight (g)**	**Length (cm)**	**Fresh weight (g)**	**Dry weight (g)**	**Number**	**Fresh weight (g)**	**Dry weight (g)**	**Number**	**Number**	**Fresh weight (g)**	**Dry weight (g)**	
Main effects														
U	23.66	3.14	1.44	29.40	9.19	4.20	18.6	7.02	3.40	8.93	12.40	10.53	4.79	-
I	33.00	5.34	2.50	46.06	17.00	8.05	28.00	13.48	6.32	12.93	20.06	20.40	10.10	+ + +
C D at 5 %	0.43	0.08	0.05	0.25	0.29	0.05	0.21	0.16	0.05	0.25	0.45	0.43	0.21	
P_0	22.80	3.46	1.54	33.20	9.96	4.70	19.80	6.53	3.43	8.80	12.40	11.50	5.53	+ +
P_{40}	33.50	5.01	2.41	43.00	16.83	7.89	27.00	14.12	6.47	13.00	20.30	19.90	9.66	+ + +
P_{80}	28.70	4.26	1.98	37.00	12.50	5.80	23.10	10.11	4.69	11.00	16.00	15.00	7.15	+ + +
C D at 5 %	0.53	0.10	0.06	0.31	0.36	0.07	0.26	0.20	0.07	0.31	0.55	0.53	0.26	
Interaction effects														
P_0 U	18.40	2.34	1.04	25.00	5.92	2.26	15.6	4.62	2.76	7.00	8.40	7.00	3.56	-
P_{40} U	28.40	4.00	1.94	34.00	13.26	6.18	22.00	9.24	4.16	11.00	16.20	13.60	6.22	-
P_{80} U	24.20	3.10	1.36	29.20	8.40	3.78	18.20	7.22	3.28	8.80	12.60	10.00	4.60	-
P_0 I	27.20	4.58	2.04	41.40	14.40	6.74	24.00	8.44	4.10	10.60	16.40	16.00	7.50	+ +
P_{40} I	38.60	6.02	2.88	52.00	20.40	9.60	32.00	19.00	8.78	15.00	24.40	26.20	13.10	+ + +
P_{80} I	33.20	5.42	2.60	44.80	16.60	7.82	28.00	13.00	6.10	13.20	19.40	19.00	9.70	+ + +
C D at 5 %	0.75	0.14	0.09	0.44	0.51	0.09	0.37	0.28	0.09	0.44	0.79	0.75	0.37	

P_0 = No phosphorous application; P_{40} = 40 mg `P`/ kg soil; P_{80} = 80 mg `P`/ kg soil; U = Uninoculated; I = Inoculated; + = Scanty; + + = Moderate; + + + = Abundant

Effect on root nodulation

Plants exhibited higher nodulation in the mycorrhizal inoculated plants as compared to non-mycorrhizal. Results showed the scanty to moderate level of nodules per plant at the initial stages of plant i.e. after 15 and 30 days of sowing. But with increase in colonization of AM fungi and age of plant, nodulation increased to abundant in after 45 and 60 days of sowing (Table 3-6). P application also enhanced the nodulation in mycorrhizal inoculated plants. Singh *et al.,* (2017) also observed that the inoculation of *Glomus bagyaraji* significantly increased the nodulation of chickpea plants.

Plants inoculated with AM fungi showed more number of pods as compared to uninoculated once. It was also noticed that the plants mycorrhizal inoculated plants showed more fresh as we ll as dry weight along with vigorous pods at 40 mg P/kg soil level as compared to 80 and 0 mg P/kg soil level. There were 16.40, 24.40 and 19.40 number of pods recorded in AMF inoculated plants at 0, 40 and 80 mg 'P'/kg soil level after 60 days of sowing. It is suggested that AM fungi enhanced the plant growth as well as yield and yield parameters.

References

Bargali K (2011) Screening of leguminous plants for VAM association and their role in restoration of degraded lands. *J Ame Sci* 7: 7–11.

Biermann B and Lindermann R G (1981) Quantifying arbuscular mycorrhizae: A proposed method towards standardization. *New Phytol* 87: 63-67.

Davis E A and Menge J A (1980) Influence of *Glomus fasciculatum* and soil phosphorus on *Phytophthora* root rot of citrus. *Phytopathol* 70: 447-52.

Gerdemann J W and Nicolson T H (1963) Spores of mycorrhizal *Endogone* species extracted from soil by

wet sieving and decanting. *Trans Br Mycol Soc* 46: 235-44.

Harley J L and Smith S E (1983). *Mycorrhizal symbiosis*. pp 483. Academic Press, London, New York.

Kadian N, Yadav K and Anggarwal A (2014) Application of AM Fungi with *Bradyrhizobium japonicum* in Improving Growth, Nutrient Uptake and Yield of *Vigna radiata* L. under Saline Soil. *J Stress Physiol Biochem* 10: 134-52.

Manke N M, Potdukhe S R, Bramhankar S B and Padghan P R (2008) Effect of rhizobidm and VAM on growth parameters and yield of mungbean. *J Pl Dis Sci* 3*:* 185–88.

Mosse B (1973) Advances in the study of VA mycorrhiza. *Ann Rev Phytopath* 11: 171-96.

Phillips J M and Hayman D S (1970) Improved procedures for clearing roots and staining parasitic and VA mycorrhizal fungi for rapid assessment of infection. *Trans Br Mycol Soc* 55:158-61.

Rabie G H (2005) Influence of arbuscular mycorrhizal fungi and kinetin on the response of mungbean plants to irrigation with seawater. *Mycorrhiza* 15: 225–30.

Singh N, Singh D and Singh N (2017) Effect of *Glomus bagyaraji* inoculation and phosphorus amendments on Fusarium wilt of chickpea. *Agric Res J* 54: 236-43.

Sohrabi M, Mohammadi H and Mohammadi A H (2015) Influence of AM fungi, *Glomus mossae* and *Glomus intraradices* on chickpea growth and root rot disease caused by *Fusarium solani* f.sp. *pisi* under green house conditions. *J Agr Sci Tech* 17: 1919-29.

Souchie E L, Orivaldo J, Saggin-Junior O J, Silva E M R, Campello E F C, Azcon R and Barea J M (2006) Communities of P-solubilizing bacteria, fungi and arbuscular mycorrhizal fungi in grass pasture and secondary forest of Paraty, RJ-Brazil. *Ann Acad Bras Cienc* 78: 183-93.

How to cite this article:

Amandeep Singh, Daljeet Singh and Narinder Singh. 2019. Growth and Yield Response of Mungbean Plants to Colonization of Arbuscular Mycorrhizal Fungi (AMF) (*Glomus macrocarpon*) and Phosphorus Amendments. *Int.J.Curr.Microbiol.App.Sci.* 8(12): 3039-3048. doi: https://doi.org/10.20546/ijcmas.2019.812.354