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Mycorrhizal population of Indian mustard at different location of district Baharaich, Uttar Pradesh

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Abstract

Soil samples were collected from the rhizosphere of Indian mustard [*Brassica juncea* (L.)Czern & Coss.] to evaluate the population dynamics of VA mycorrhizae. Root colonization in this crop varied from 27.53% to 43.53% at different places of district Baharaich of Uttar Pradesh, while spore population ranged between 100 to 380 per 100 g soil in different samples. Maximum colonization and spore population were observed in block Shivpur followed by Mihinpurwa and Huzurpur but these were at par. Sixteen species of VAM fungi belonging to 4 different genera were identified. Among these *Glomus mosseae* and *Glomus fasciculatum* were found most dominating and distributed in 10 blocks followed by *Acaulospora longula* and *Sclerocystis rubiformis* which were distributed only in 7 blocks of the district. VAM fungi *Acaulospora elegans* and *Acaulospora sporocarpa* were found only in block Nanpara. Colonization per cent has significant and positive correlation with spore density. Physico-chemical properties of the soil specially pH, organic carbon, available nitrogen, available phosphorus and available potassium influence the population dynamics and colonization of VA mycorrhiza in mustard crops.

Keywords: Mycorrhizal fungi, mustard, soil properties, population dynamics.

INTRODUCTION

Mycorrhizal fungi form symbiotic association with most of the economically important plants. Micorrhizal plant increase the surface area of root system and better absorption of nutrient from soil specially where the soil are deficient in phosphorus and other nutrient. These fungi improve plant growth under low fertility conditions, confer tolerance against certain plant pathogens, improve water balance of the plants, contribute to the formation of soil structure and help plants to establish in new areas (Janos, 1980; Harley and Smith, 1983; Tarafdar, 1995; Khaliq and Sandars, 2000; Garmendia *et al.,* 2004 and Nasim, 2005). In vesicular micorrhizae, the fungal hyphae develop special organ, called vesicle and arbuscles with in the root cortical cells. These vesicles are food storage organ of the fungus. However, the arbuscles are more or less equivalent to the haustoria of the fungus but are believed to function in bidirectional transfer of nutrients. Besides phosphorus translocation mycoorhizae also stimulate uptake of zinc, copper, sulfur, potassium and nitrogen by the plant and check the larval development as well as root penetration of nematodes (Lambert *et al.*, 1979). The association and importance of fungi in agriculture and horticulture is well documented (Gerdemann, 1968; Mosse, 1973, Smith and Reid, 1997). Most of the plants are found associated with VAM fungi in natural ecosystem in this region, though the extent of infection may vary from plant type, soil type and climatic factors (Singh and Prasad, 2006; Singh, 2007 and Parmar *et al.*, 2010). Our knowledge about this symbiosis in economically importance crop like mustard [*Brassica juncea* (L.) Czern & Coss.] is very limited. Hence, present investigation was under taken to study the population dynamics, of VAM fungi and their morphological characters in rhizosphere of mustard at different places of district Baharaich of Uttar Pradesh.

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MATERIALS AND METHODS

Periodical survey was conducted in 5 villages each from different 14 blocks of the district Baharaich of eastern Uttar Pradesh, to evaluate natural status and existing population of VAM fungi in the rhizosphere of mustard plants. Soil samples (containing soil and fine roots) from the rhizosphere of mustard plants were dugout with the help of trowel to a depth of 20-25 cm after scraping away the top soil upto 1 to 2 cm. Samples of the entire root system were obtained (3-4 different sites of the plants) and mixed together to get single sample for each plant. The samples were collected in polythene bags and stored at 2^{o}C till their processing.

To asses the colonization of VAM fungi, clearing and staining of root segments were done as the procedure of Phillips and Hayman (1970). The per cent colonization of VAM-fungi was determined under microscope (100 root segments) as suggested by Giovannetti and Mosse (1980). Mycorrhizal spores were isolated by wet sieving and decanting technique (Gerdemann and Nicolson, 1963). These spores were mounted in lactophenol and examined under stereo/research microscope for their counting and morphological feature for identification. Size of spores were measured with the help of occular and stage micro-meter. The identification of spores were done by the basis of description given by Gerdemann and Trappe (1974) and Trappe (1982). Soil samples were analysed for their physical and chemical properties following methods given by Jackson (1978).

RESULTS AND DISCUSSION

A perusal of Table-1 indicates that availability of organic carbon in the soil samples collected from different location of the district ranged between 0.342 to 0.422 per cent. pH of the soil varied from 6.68 to 7.00, available nitrogen 168.68 to 195.48 kg/ha, available phosphorus 12.02 to 16.56 kg/ha and available potassium 262.20 to 289.37 kg/ha, respectively. Total 167 samples were examined out of which only 133 samples were found infected with VAM fungi (Table-2). Per cent root colonization in this crop varied at different places from 27.53% to 43.53 per cent. Maximum mean root colonization was recorded in samples collected from block Shivpur (43.53%) followed Mihinpurwa (41.53%) and Huzurpur (41.33%) respectively but these were at par. Minimum root colonization was recorded in block Kaiserganj (27.53%) followed by Prayagpur (28.53%) and Nawabganj (29.20%), respectively. These were also found at par. Variable spore population was recorded in samples collected from different locations of different blocks. Maximum spore population per 100 g of soil was recorded in samples collected from block Shivpur (278-402) followed by Mihinpurwa (210-380) and Huzurpur (210-300), respectively. While minimum spore population 100-200 per 100 g of soil was recorded from the samples of block Kaiserganj. It was observed from the results that colonization per cent has significant and positive correlation with spore populations.

Vesicular arbuscular fungi were identified on the basis of morphology of their resting spores. The detail information about characteristics of spores and their morphological features are given in Table-3. The identification of these spores were done on the basis of presence of vesicles and arbuscles which are the most important diagnostic criteria for identifying a vesicular arbuscular mycorrhizal fungi in roots. Shape of spores are generally globose or ellipsoidal. In some cases they are irregular in shape. Colours of spores are generally black, brown, yellow brown or brown black. The total 16 species of VAM fungi belonging to 4 genera were identified. Among these species *Glomus mosseae* and *Glomus fasciculatum* were found most dominating and widely distributed in 10 blocks followed by *Acaulospora longula* and *Sclerocystis rubiformis* which were found in 7 blocks of the district. VAM fungi *Sclerocystis sinuosa* identified and isolated from the soil samples collected from 6 different blocks, while *Endogone pisiformis* and *Glomus occulatum* were recorded from 5 blocks. VAM fungi *Acaulospora elegans* and *Acaulospora sporocarpa* both were found only in block Nanpara. Prevelence of the rest of VAM fungi is given in Table-4. VAM fungi occur over a broad ecological range from aquatic to dessert environment and possess specific individual traits with respect of tolerance to soil temperature, pH, moistures, fertility, salinity and toxicants (Smith and Reid, 1997). These factors may provide the host plant with ecological competitive advantages facilitating increased plant survival, growth, nutrition and yield under different conditions.

The present findings showed positive and non significant correlation between pH and VAM fungi colonization while spore population showed negative correlation (Table-5). The effect of pH may altered the nutrient level in soil that influence the colonization and spore population of VAM fungi and the present findings supports the views of Mosse (1972). Available phosphorus showed the positive but non significant effect on VAM colonization and population density of spore in present study support the findings of earlier workers (Mosse, 1972; Hayman, 1982; Sasai, 1990; Singh and Prasad, 2006)

High level of nitrogen have also negative effect on mycorrhizal development and growth stimulation (Brown, 1980 and Hayman, 1982). The present investigation showed a positive but non-significant correlation between available nitrogen and VAM colonization as well as spore population. Non-significant effect of N-fertilizer was also reported by Brown (1980), Hayman (1982) and Land *et al.* (1990). Organic carbon have positive correlation on mycorrhizal infection and spore density (Sharma *et al.*, 1986; Singh and Prasad, 2006 and Singh, 2007; Parmar *et al.*, 2010). Available potassium also influence the colonization and spore population. In the present investigation available potassium showed the negative correlation with VAM colonization and spore density but non-significant. It may be due to potassium increase resistance in plants against pathogens causing diseases. However, Diaz and Honrubia (1994) have reported no relationship between spore population and VAM fungi while Singh (2007) have reported negative correlation. Correlation between root colonization and spore population in present study was found positive. It indicates the high density of spores enhanced the colonization of VAM fungi in this crop.

Table 1. Physico-chemical properties of soil collected from mustard cultivated fields of different blocks of Baharaich on the mean basis

S.N.	Name of blocks	Organic carbon (%)	pH	Available nitrogen (kg/ha)	Available phosphorus (kg/ha)	Available potassium (kg/ha)
1.	Chittora	0.402	6.72	191.62	16.56	258.66
2.	Tejwawapur	0.422	6.90	168.68	13.70	267.56
3.	Fakkarpur	0.352	6.76	192.90	14.30	262.20
4.	Kaiserganj	0.422	6.84	182.88	14.50	269.63
5.	Nanpara	0.368	6.68	190.08	12.30	258.58
6.	Risiya	0.414	7.00	188.36	14.59	276.20
7.	Mihinpurawa	0.342	6.76	189.88	13.57	264.30
8.	Jarwal	0.422	6.96	184.28	14.50	279.45
9.	Huzurpur	0.362	6.88	187.08	12.41	276.68
10.	Prayagpur	0.354	6.78	185.14	12.02	264.63
11.	Visheshwarganj	0.374	6.76	195.48	12.47	277.58
12.	Balha	0.372	6.98	191.68	14.75	274.36
13.	Shivpur	0.360	6.82	189.14	14.25	266.56
14.	Nawabganj	0.352	6.76	185.68	13.27	289.37

Table 2. Natural population of VAM fungi in Indian mustard in different blocks of district Baharaich, Uttar Pradesh

S.N.	Blocks	No. of samples examined	No. of samples infected	Colonization of VAM (%)	No. of spores/100 g soil
1.	Chittora	10	6	32.87 (32.57)	105-230
2.	Tejwawapur	12	10	38.00 (36.47)	195-295
3.	Fakkarpur	8	8	31.93 (32.45)	180-280
4.	Kaiserganj	10	8	27.53 (28.02)	100-200
5.	Nanpara	15	12	34.67 (34.12)	190-310
6.	Risiya	9	6	34.47 (34.53)	160-290
7.	Mihinpurawa	16	15	41.53 (39.00)	210-380
8.	Jarwal	14	12	(36.07 (35.35)	200-310
9.	Huzurpur	20	16	41.43 (38.83)	210-300
10.	Prayagpur	10	10	28.53 (28.70)	185-275
11.	Visheshwarganj	9	7	33.73 (33.77)	160-264
12.	Balha	8	5	38.20 (36.76)	278-402
13.	Shivpur	12	7	43.53 (40.32)	168-288
14.	Nawabganj	14	11	29.20 (29.45)	
	SEm ±			1.242	
	(CD 5%)			3.45	

Note: Figures given in parentheses are sin arc transformed value.

Table 3. Spore characters of VAM fungi found in rhizosphere of mustard in different blocks

Name of blocks	Spore size (µm)	Shape of spores	Colour of spores	Identification of VAM fungi
Chittora	34.8-194.4	Globose	Yellow-brown	*Glomus mosseae, G. monosporum, G. fasciculatum, G. microcarpum, Endogon pisiformis*
Tejwawapur	20.5-129.4	Globose	Brown	*Glomus mosseae, G. fasciculatum, G. occulatum, G. diaphanum*
Fakkarpur	48.5-145.6	Ellipsoid	Brown	*Acaulospora trappei, A. longula, Glomus mosseae, Sclerocystis rubiformis, S. dussii, S. sinuosa*
Kaiserganj	16.2-114.5	Globose, Ellipsoid	Brown, Black	*Sclerocystis rubiformis, S. clavispora, S. coccogena, Glomus fasciculatum,G. occulatum*
Nanpara	64.8-194.4	Globose, irregular	Brown, Yellow	*Acaulospora longula, A. elegans, A. sporocarpa, Glomus fasciculatum, G. mosseae, Endogon pisiformis*
Risiya	32.4-129.6	Globose, Ellipsoid	Black, Brown	*Sclerocystis rubiformis, S. dussii, Glomus mosseae, G. occulatum, Endogon pisiformis*
Mihinpurawa	16.4-112.6	Ellipsoid	Brown, Black	*Sclerocystis rubiformis, S. sinuosa ,S. clavispora, Acaulospora trappei, A. longula, Glomus mosseae*
Jarwal	32.6-178.2	Globose	Brown	*Glomus mosseae, G. fasciculatum, G. diaphanum, G. microcarpum, Endogon pisiformis*
Huzurpur	45.6-210.2	Ellipsoid	Black	*Sclerocystis rubiformis, S. sinuosa, Glomus fasciculatum*
Prayagpur	55.8-119.6	Ellipsoid	Black, Brown	*Sclerocystis rubiformis, S. sinuosa, S. clavispora, Acaulospora trappei, A. longula, Glomus mosseae, G. fasciculatum*
Visheshwarganj	36.6-105.5	Ellipsoid	Black	*Acaulospora longula, Glomus fasciculatum, Sclerocystis sinuosa, S. rubiformis, S. dussii, S. clavispora, S. coccogena*
Balha	68.8-192.6	Globose	Brown, Yellow brown	*Glomus mosseae, G. fasciculatum, G. occulatum, G. microcarpum, Endogon pisiformis*
Shivpur	36.4-130.4	Globose, Irregular	Brown	*Acaulospora longula, Glomus fasciculatum, G. diaphanum, G. occulatum, G. monosporum*
Nawabganj	16.2-120.6	Globose, Ellipsoid	Brown, Black	*Glomus mosseae, G. occulatum, G. diphanum, Acaulospora trappei, A. lonula, Sclerocystis sinuosa, S. dussii*

Table 4. Prevalence of VAM fungi in soil samples of mustard [*Brassica juncea* (L.)]

Name of blocks	Identified species of VAM fungi															
	Ae	Al	As	At	Ep	Gd	Go	Gmi	Gmon	Gmos	Gf	Scl	Sd	Sc	Sr	Ss
Chittora					+			+	+	+	+					
Tejwawapur						+	+			+	+					
Fakkarpur		+		+						+			+		+	+
Kaiserganj							+				+	+		+	+	
Nanpara	+	+	+		+					+	+					
Risiya					+		+			+			+		+	
Mihinpurawa		+		+						+		+			+	+
Jarwal					+	+		+		+	+					
Huzurpur											+				+	+
Prayagpur		+		+						+	+	+			+	+
Visheshwarganj		+									+	+	+	+	+	+
Balha					+			+	+	+	+					
Shivpur		+				+	+		+		+					
Nawabganj		+		+		+	+			+			+			+

Ae = *Acaulospora elegans*
Sd = *Sclerocystis dussii*
Al = *A. longula*
As = *A. sporocarpa*
At = *A. trappei*
Ep = *Endogone pisiformis*
Gd = *Glomus diaphanum*
Go = *G. occulatum*
Gmi = *Glomus microcarpum*
Gmon = *Glomus monosporum*
Gmos = *Glomus mosseae*
Gf = *Glomus fasciculatum*

Scl = *Sclerocystis clavispora*
Sd = *S. dussii*
Sc = *S. coccogena*
Sr = *Sclerocystis rubiformis*
Ss = *Sclerocystis sinuosa*
Aspo = *Acaulospora sporocarpa*

Table 5. Correlation coefficient between soil physico-chemical properties and population dynamics of VAM fungi

	Organic carbon	pH	Available nitrogen	Available phosphorus	Available potassium	Per cent root colonization	Spore population
Organic carbon	1						
pH	-0.175	1					
Available nitrogen	0.269	0.520	1				
Available phosphorus	-0.133	-0.167	0.0659	1			
Available potassium	0.009	0.482	0.255	0.380	1		
Per cent root colonization	0.077	0.081	0.457	0.147	-0.159	1	
Spore population	0.488	-0.466	0.362	0.048	-0.257	0.575	1

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