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Occurrence and population dynamics of vesicular arbuscular mycorrhizae in the Indian orchards of litchi (*Litchi chinensis Sonn*), aonla (*Phyllanthus emblica* L.) and banana (*Musa paradisiaca* L.)

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Soil samples were collected from the rhizospheres of litchi, aonla and banana orchards to evaluate the population dynamics of VA mycorrhizae. Maximum colonization and spore population of VAM fungi were observed in litchi and aonla orchards planted in Basti and Pratapgarh. However, moderate colonization and spore population were also recorded in Faizabad and Sultanpur districts. Almost same pattern of population dynamics of VAM fungi was also observed in banana orchards of Faizabad and Sultanpur Districts. These VAM fungi were identified as species of Glomus, Endogone, Gigaspora, Rhizophagus and Acaulospora and population dynamics of VAM fungi was in order of Glomus > Gigaspora >Rhizophagus > Acaulospora > Endogone. Physico – chemicals properties of the soil especially pH, organic carbon, exchangeable sodium and calcium affected the population dynamics and colonization of VA mycorrhizae in the orchards.

Key words : Mycorrhiza, Litchi, Aonla, Banana.

INTRODUCTION

ROOT system in most of the plants form a symbiotic relationship with certain types of fungi and these association are called mycorrhizae. These fungi colonize roots intercellularly (Ecotomycorrhizae) or intracellularly (Endomyeorhizae). Endomycorrhizae are classified into three groups such as vesicular, arbuscular, orchidaceous and ericaceous. Vesicular arbuscular mycorrhizae (VAM) represent the association between fungi and majority of forest trees, agricultural crops and horticultural plants.

In VA mycorrhizae, the fungal hyphae develop special organs, called vesicles and arbuscles within the root cortical cells. These vesicles are food storage organs of the fungus. However, the arbuscles are more of less equivalent to the haustoria of the fungus but are believed to function in bi-directional transfer of nutrients. Mycorrhizal fungi benefit the plant by promoting nutrient uptake and water transport. The phosphorus is absorbed and converted into polyphosphate granules in the hyphae and translocated to the arbuscles for ultimate transfer to host plant (Ganinazzi et al.1979).VA-mycorrhizae stimulate uptake of zinc, copper, sulfur and potassium by the plant, enhanced nodulation in legumes, control the root rots disease caused by fungal pathogens and also check the larval development as well root penetration of nematodes. (Lambert et al., 1979). The association and importance of VAM fungi in agriculture and horticulture is well documented by Gerdemann (1968), Mosse (1973) and Smith & Read (1997). The beneficial effect of mycorrhizal associations have also been reported in citrus (Menge et al., 1978 and Nemec 1978), Litchi (Pandey & Misra 1971) and banana (Declerereck et al., 1995). In this paper, the occurrence and population dynamics of VAM fungi in the rhizospheres of litchi, aonla, and banana have been studied in Indian orchard of eastern Uttar Pradesh.

MATERIALS AND METHODS

Survey was conducted to collect the mycorrhizal fungi from the districts of Faizabad, Sultanpur, Basti and Pratapgarh of Eastern Uttar Pradesh to evaluate the natural status ant existing population of VAM- fungi in the rhizospheres of lithi, aonla and banana orchards. Soil samples (containing soil and fine roots) from rhizospheres of above fruit plants were dugout with the help of trowel to a depth of 20-25 cm after scraping away the top soil up to 1-2 cm. Samples of the entire root system were obtained (3-4 different sites of the single plant) and mixed together to get single sample for each plant. The samples were collected in polythene bags and stored at 2^0C till their processing.

To asses the colonization of VAM-fungi, clearing and staining of root segments were done as the procedures of Phillips and Hayman (1970). The per cent colonization of VAM-fungi was determined under microscope (100 root segments) as suggested by Giovanneti 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 features for identifications. Sizes of spores were measured with the help of occular and stage micrometer.

Soil samples of different orchards of litchi, aonla and banana were analysed for their physical and chemical properties (Jackson, 1970) and presented in Table-1

RESULTS AND DISCUSSION

Total 107 samples (litchi-23, aonla-60 and banana-24) were examined and out of these only 81 samples (litchi-19, aonla-48 and banana-14) were found infected with VAM-Fungi (Table-2). In the case of litchi, all the samples collected from Pipera and KVK Research farm Basti have maximum infection /colonization (57.5 to 65.43 %) whereas spore population varied from 1113-2010/ 100g soil. Out of 8 samples collected from Horticulture farm NDUAT, Kumarganj, Faizabad only 4 samples showed 33 to 35 % colonization with 326 to 575 spores / 100g soil. In the case of aonla plants, the maximum colonization was observed in Pratapgarh and Basti whereas sample collected from Horticultural Farm NDUAT campus and Sultanpur district showed moderate colonization. The samples of aonla plant collected from Pratapgarh having maximum colonization (70.18%) with 1072-2708 spores / 100 g soil. Samples collected from two places of Basti, KVK Research Farm and Government Research Farm having more or less similar colonization and spore population (60.00 and 62.32 % with 973- 2364 and 1177- 2496 spores/ 100g soil). While very poor colonization and spores population of VAM fungi were

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observed in the samples collected from Sultanpur and NDUAT Campus Faizabad (Table-2). The soil samples collected from aonla orchards of district Sultanpur and Faizabad having only 30.23 % and 41.45 % colonization and spore population ranges from 607 to 1421 and 712 to 1586 spores /100g soils, respectively. In the case of Banana, the maximum colonization (65%) and spore population (983-2003 / 100g soil) were found in Horticultural Farm NDUAT Campus and also similar pattern was observed in the samples of banana collected from Sultanpur (62.50% spore population ranges from 900-1607 /100g soil).

Physico-chemical properties of soil from different locations are shown in Table-1. All the soil samples are sandy loam which are having different pH, Ec, organic carbon, available N, P, K, Fe, Zn, exchangeable Na and Ca. It is also clear from the observatio0ns that characteristics of soils are different and variations are due to location.

Genera of VAM fungi were identified on the basis of morphology of their resting spores. The detail information about characteristics of spores and their morphological feature are given in Table 3. The identification of these spores was done of the basis of descriptions given by Gerdemann and Nicolson (1963), Gerdemann and Trappe (1974) and Tarppe (1982). The presence of vesicles and arbuscules is most diagnostic criterion for the identifying a vesicular arbuscular mycorrhizal fungi in roots. Vesicles were usually oval to round in appearance which are distinguished by staining in trypan blue dye. The results of present study indicated that colonization and spore population of VAM- fungi are correlated with the soil characteristics, plant types and locations.

In the case of litchi and aonla, samples collected from Basti and Pratapgarh having maximum colonization and spores population as compare to the samples collected from NDUAT, Faizabad and Sultanpur Table-2.It may be due to the higher content of organic carbon, greater exchangeable Ca^{++} and low exchangeable Na in soil samples. Which resulted significantly enhanced colonization and spore population of VAM- fungi in the orchards of litchi and aonla at Basti and Pratapgarh. However, samples collected from banana plants of Faizabad and Sultanpur district, colonization and spore population of VA mycorrhizae are almost similar to the litchi and aonla plant collected from Basti and Pratapgarh.

The soil characteristics given in Table-1 and their impact on the colonization and spore population is clear and these observations are comparable with the findings of Hayman (1982) and Allen et al. (1995). While in banana plants this trend in not exactly same as in the case of litchi and aonla plants. This variation

Table 1: Chemical and Physical properties of the soils colleted from different locations of Eastern Uttar Pradesh to study the population dynamics of VA-mycorrhizae.

Location of soil sample	pH	Ec (Sm^{-1})	Organic Carbon (%)	Available N (kg/ha)	Available P(kg/ha)	Available K(kg/ha)	Available Fe (mg/kg soil)	Available Zn (mg/kg soil)	Exchangeable Na (%)	Exchan-geable Ca (%)	Texture class
Horticultural Farm NDUAT, Faizabad	8.6	0.23	0.33	112.3	13.6	187	3.2	0.37	18.5	2.2	Sandy loam
Lalapur, Haliyapur, Sultanpur	8.8	0.26	0.25	110.5	14.0	189	2.8	0.39	19.2	2.1	Sandy loam
Pipera, Jilebiganj, Basti	7.5	0.11	0.63	185.0	19.0	389	16.0	0.82	2.3	38.0	Sandy loam
KVK Reserch Farm, Basti	7.1	0.10	0.41	2.5	25.5	401	17.2	0.89	2.4	42.0	Sandy loam
Government Research Farm, Basti	7.3	0.14	0.44	200.0	21.9	393	15.0	0.85	2.5	40.8	Sandy loam
Gonden Goan, Ghilbilla, Pratapgarh	7.4	0.16	0.53	181.0	19.9	383	17.8	0.77	2.2	39.5	Sandy loam

Table 2 : Natural population of VAM fungi in the orchards of litchi, aonla and banana in different district of Eastern U. P.

Fruit crops	Locations	No. of Samples examined	No. of Samples infected	Colonization of VAM (%)	No. of spores/ 100g soil
Litchi	NDUAT,Horticultural Farm Faizabad	8	4	35.33	326-515
	Pipera, Jilebiganj, Basti	12	12	65.42	1405-2010
	KVK Research Farm Banjaria, Basti	3	3	57.50	1113-1596
Aonla	NDUAT,Horticultural Farm Faizabad	10	4	30.23	607-1421
	Lalapur, Haliyapur, Sultanpur	8	6	41.45	712-1586
	KVK Research Farm Basti	5	4	60.00	973-2364
	Government Research Farm Basti	9	8	62.32	1177-2496
	Gonden Goan, Chilbilla, Pratapgarh	28	26	70.18	1072-2708
Banana	NDUAT,Horticultural Farm Faizabad	14	9	65.00	983-2003
	Lalapur, Haliyapur, Sultanpur	8	5	62.50	900-1607

Table 3 : Morphological characters of VAM-fungj found in the rhizosphere of litchi, aonla and banana orchards in different districts of Eastern Uttar Pradesh

Host	Locality	Shape of Vesicle	Spore size (µm)	Shape of spores	Spore colour	Identification of VAM-fungi
Litchi	NDUAT, Horticultural Farm Faizabad	Oval	50-200	Globose & same sproe rough	Brown & yellow	*Glomus* sp. *Endogone* sp. *Rhizophagus* sp.
	Pipera, Jilebiganj, Basti	Oval	60-240	Globose & irregular shape	Brownish black & yellow	*Acaulospora* sp.
	KVK Research Farm Banjaria, Basti	Oval and vesicles absent in few case	80-200	Globose	Dark brown & black	*Gigaspora* sp. *Rhizophagus* sp.
Aonla	NDUAT, Horticultural Farm Faizabad	Oval	72-220	Globose & oval	brownish black	*Glomus* sp. *Gigaspora* sp.
	Lalapur, Haliyapur, Sultanpur	Oval	60-240	Globose & single layer	Brownish & yellow	*Glomus* sp
	KVK Research Farm Basti	Oval	80-320	Globose & single layer	Yellow	*Glomus* sp
	Government Research Farm Basti	Oval	70-240	Globose incluster	Yellow & brown	*Glomus* sp
	Gonden Goan, Chilbilla, Pratapgarh	Oval	72-320	Globose & oval rough margin with bulbous base	Brown & black	*Glomus* sp. *Gigaspora* sp.
Banana	NDUAT, Horticultural Farm Faizabad	Oval to round	52-200	Globose, oval rough & smooth with 2-3 layers	Brownish black & yellow	*Glomus* sp. *Gigaspora* sp. *Acaulospora* sp.
	Lalapur, Haliyapur, Sultanpur	Oval to round	72-240	Globose	brown	*Glomus* sp.

may be due to the changes in the plant type (Allen et al. 1995). Present findings related to spore population is more or less similar to the findings of Hayman (1978) for grassland, scrubland and forest soil in New Zeland.

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REFERENCES

Allen, E.B;Allen, M.F., Helm, D.J.,Trappe, J.M., Molina, Ra. and Risncon (1995). Pattern and regulation of mycorrhizal plant and fungal diversity. *Plant and Soil* **170:**47-62.

Declereck, S. Plenchette, C. and Strulla, D.G. (1995). Mycorrhizal dependency of Banana (Musa acuminate, AAA group) cultivar. *Plant and Soil* **176:**183-187.

Gerdemann, JW. (1968). Vesicular- arbuscular mycorrhiza and plant growth. *Annual Review of Phytopathology* **6:** 397-418.

Gerdemann, J.W. and Nicolson, T.H. (1963). Spores of mycorrhizal Endogone species extracted from soil by wet – sieving and decanting. Transactions of British Mycological Society **46:** 235-244.

Gerdemann, J.W.and Trappe, J.M. (1974). The Endogonaceae in the Pacific north West. *Mycologia Memories.* **5:** 1-76

Gianinazzi, S: Gianinazzi- Person, V. and Dexheimaer J. (1979). Enzymatic studies of the metabolism of vesicular arbuscular mycorrhizae III. Ultra structural localization of acid and alkaline phosphatase in onion roots infected by Glomus mosseae (Nicol & Gerde) *Ger. & Trappe. New Phytologist* **82:** 127-132.

Giovannetti, M. and Mosse, B. (1980). An evaluation of techniques for measuring vesicular- arbuscular mycorrhizal infection in roots. *New Phytologist* **84;** 489-500.

Hayman, D.S. (1978). Mycorrhizal population of sown pastures and native vegetation in Otago, New Zealand. *New Zealand jounal of Agricultural Research.* **21:** 171-176.

Hayman, D.S. (1982). Influence of soil and fertility on activity and survival of vesicular- arbuscular mycorrhiza fungi. *American Phytopathological Society* **71:** 1119-1125.

Jackson, M.L. (1978). Soil chemical analysis. Prentice hall New Delhi India.

Lambert, D.H;Baker, D.F.and Cole, H. (1979). The role of mycorrhizae in the interactions of phosphorus with zinc, copper and other elements. Journal of Soil Scientists Society of America **43:** 976-980.

Mosse, B. (1973). Plant growth responses to vesicular arbuscular mycorrhizae IV. In soil given additional Phosphate. *New Phytologist* **72:**127-136.

Menge, J.A; Johnson, E.L.V. and Plant, R.H. (1978). Mycorrhizal dependency of citrus cultivars under tree nutrient regimes. *New Phytologist* **81:** 553-559.

Nemec, S. (1978). Response of six citrus root stocks to three species of Glomus, a mycorrhizal fungi. Proceedings of Florida State Horticultural Society **91:** 10-14.

Pandey, S. and Misra, A.P.(1971). Rhizophagus in mycrrhizal association with Litchi chinensis Sonn. Mycophathologia and Mycologia Applicata. **45:** 337-354.

Phillips, J.M. and Hayman, D.S. (1970). Improved procedure for clearing roots and staining parasitic and vesicular arbuscular mycorrhizal fungi for rapid assessment of infection. Transaction of British Mycological Society **55:** 158-161.

Smith, S.E. and Read, D.J. (1997). Mycorrhizal symbiosis second edition pp 1- 589 Academic Press Cambrige U.K.

Trappe, J.M. (1982). Synoptic keys to the genera and species of Zygomycetous mycorrhizal fungi. *Phytopathology* **72:** 1102-1108.