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Mycorrhizal colonization in plants from selected home garden of Tripura

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Mycorrhizal fungi forms mutualistic association with higher plants and are provided with carbohydrates and other essential organic components and in return it helps the plant take up nutrients by extending the reach of its root system. The present investigation was carried out in two sites to examine mycorrhizal colonization in ten fruit plants of Tripura. Arbuscular mycorrhizal (AM) fungal colonization (%) was found in all the fruit plant species and Dark septate endophyte (DSE) colonization (%) was found in 5 fruit plants. In this study, AM fungal colonization were recorded within the range of 39.70% to 80.83%. Root length with arbuscules was recorded highest in *Phyllanthus emblica* (22.85%). Root length with vesicles was highest recorded in *Musa paradisiaca* (30.86%) and root length with hyphae in *Citrus maxima* (68.00%). The percentage of root length with DSE fungal structures were present in *Mangifera indica*, *Psidium guajava*, *Phyllanthus emblica*, *Artocarpus heterophyllus* and *Citrus maxima*. DSE fungal colonization was maximum in *Citrus maxima* (8.62%). AM fungal spore density was 32 in Town Bordowali soil and 44 in Pratapgarh soil. A total of 9 spore species were isolated from both the sites. Of which, *Acaulospora rehmii, Glomus* sp 1 and *Glomus* sp 2 present in Town Bordowali soil. *Acaulospora* sp 1, *Glomus microaggregatum* and *Glomus* sp 3 and *Glomus* sp 4 present in Pratapgarh soil. *Glomus* sp 5 and *Glomus* sp 6 were present in both the sites. The study provides the gist of mycorrhizal colonization in plants from home garden of Tripura.

Key words: AM fungi, DSE, Fruit plants, AM fungal spore

INTRODUCTION

Mycorrhiza literally means fungus-root, and describes the mutualistic association existing between a group of soil fungi and higher plants. The association is based on the plant component providing carbohydrates and other essential organic compounds to the fungi. In return, the fungal component, which colonizes both the root and the adjacent soil, helps the plant take up nutrients by extending the reach of its root system. Arbuscular mycorrhizal (AM) fungi are widely distributed and form mycorrhizas with 80% of vascular plants on earth. AM fungi can increase plant nutrient uptake, reduce pathogenic infection and enhance the resistance of host plants to abiotic stresses such as drought tolerance under certain conditions. AM fungi therefore play an important ecological role in potentially influencing the plant diversity and species composition, soil aggregation, and carbon and nitrogen storage in terrestrial ecosystems.

It has been discovered that mycorrhizal plants can absorb and accumulate several times more phosphate from the soil or solution than non–mycorrhizal plants. Plants inoculated with endomycorrhiza have been shown to be more resistant to some root disease. AM fungal communities have been

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shown to vary with plant community (Borstler *et al,* 2006; Aldrich 2007; Li *et al*, 2010), as well as abiotic factors. Therefore, understanding the differences in AM fungal communities in various habitats is key to understanding the ecology and function of fungus-plant associations in natural ecosystems.

However, AMF-inoculation could effectively improve the fruit yield and fruit nutrient quality, compared with ordinary cultivation (Han *et al*, 2012). The availability of N to plants also affects the AMF-plant interaction, as it is an essential component of numerous plant compounds affecting fruit quality which suggests that the quality of fruits could be affected by both factors (Castellanos *et al.* 2010).It was suggested that AMF could promote the plant growth and increase the plant salt-tolerance, and improve the fruit yield and its nutrient quality (Han *et al,* 2012).

Home garden is a complete and practical guide to the planting and care of all vegetables, fruits and berries worth growing for home use. Home fruit gardening offers many benefits such as exercise, enjoyment, a supply of delicious fruits, enhancement of the home landscape, and a truly educational experience. There is, however, more to growing fruit than simply planting the crop and harvesting the fruit. Fruits are an important part of a healthy diet with low calorie source of vitamins, minerals, and carbohydrates. In addition, research suggests that certain fruits contain materials that may have additional health benefits.

In this study, mycorrhizal colonization in 10 different fruit plants have been studied from two different home garden of Tripura.

MATERIALS AND METHODS

Collection of Samples

Root samples of individual plant of prevalent plant species were collected randomly during January, February and March from Town Bordowali and Pratapgarh in the year 2015. Root samples were collected using a trowel to dig a constant maximum depth of 10 cm of the soil profile. Roots were traced to their origin to ensure that they were from the desired plants. The rhizospheric soil, at depths of 10 cm, surrounding the roots of the different plant species were collected from eight different points. Approximately 500 g soil of different plant species were mixed, laced in polythene bag, labelled, their opening with tight rubber band and were transported to the laboratory for further analysis.

Soil Physico-chemical properties

The pH and electrical conductivity were determined by taking 10 g of soil dissolved in 50 ml distilled water and stirred for 20 mins. The solution is kept for overnight. Measurement of the soil pH and electrical conductivity were determined using digital pH meter and conductivity meter. Soil moisture content was determined by drying 10 g fresh soil sample at 60^0C for 24 h in a hot-air oven. The Organic Carbon was estimated by using Walkley-Black method. The soil available Nitrogen was estimated by the method of Black. Available Phosphorus of soil was determined using Jackson method.

Processing of roots and assessment of AMF and DSE

Collected plant root samples were washed thoroughly with tap water and taken in a beaker. Then the washed root samples were cut into small pieces, approximately 1 cm in size. After that the roots were cleared and stained with Black Faber Castell stamp pad ink (Das and Kayang, 2008). The root sample were mounted on slide and observed under compound microscope for assessment of mycorrhizal structures. The estimation of AM fungal colonization was done by the magnified intersection method..

Isolation of AM fungal spore and identification:

AM fungal spores in the soil sample were isolated by following the modified wet sieving and decanting method (Muthukumar *et al*, 2006). For this 25 g of soil sample was suspended in water and passed through a sieve of 35 µm in size. The residues on the sieve were then filtered by using filter paper. Then the spores were picked up with needle in 1–2 drops of polyvinyl alcohol-lactoglycerol under a dissecting microscope for enumeration. Taxonomic identification of spores up to the species level was done on the basis of sporocarpic size, colour, ornamentation and wall characteristics of the isolated spores by matching with original descriptions (http://www.invam.caf.wvu.edu &

http://www.lrzmuenchen.de/~schuessler/ amphylo).

Data analysis

Standard errors of means were calculated. The calculations were done in MS Excel, 2007 and Origin 7.

RESULTS AND DISCUSSION

Soil properties

Content of moisture % of Town Bordowali soil was lower than Pratapgarh soil. The soil pH of both the sites was basic while electrical conductivity showed difference. The organic Carbon (%) was significantly higher in Town Bordowali. Available Nitrogen was higher in Pratapgarh soil. While available Phosphorus was nearby similar (Table 1).

Root colonization

Among the 10 different fruit plant species, AM fungal colonization (%) was found in all the studied 10 different types of fruit species and DSE colonization (%) was found in 5 fruit plants. Root length with arbuscules (RLA) ranged from 6.77% (*Carica papaya*) to 22.85% (*Phyllanthus emblica*). Root length with vesicles (RLV) ranged from 7.04% (*Phyllanthus emblica*) to 30.86% (*Musa paradisiaca*) and root length with hyphae (RLH) ranged from 20.00% (*Citrus medica)* to 68.00% (*Citrus maxima*). The percentage of root length with DSE fungal structures were absent in *Carica papaya, Aegle mermelos, Musa paradisiacal, Citrus medica* and *Litchi chinensis* and ranged from 0.97% (*Phyllanthus emblica*) to 8.62% (*Citrus maxima*) (Table 2).

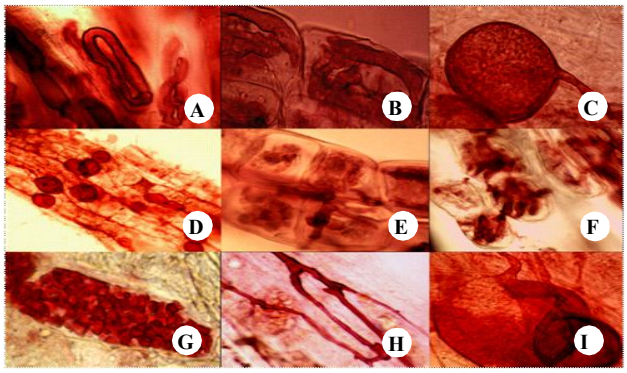

Fig. 1: Mycorrhizal colonization in different types of fruit plants from two different site.(a) Root segment of *Phyllanthus emblica showing* hyphal coil. (b) Root segment of of *Carica papaya* showing hyphal coil. (c) Root segment of *Aegle marmelos* showing vesicles. (d) Root segment showing *Citrus medica* vesicles. (e) Root portion of *Mangifera indica* showing arbuscules. (f) Root segment of *Musa paradisiaca* showing arbuscules. (g) Root segment of *Litchi chinensis* showing DSE. (h) Roots of Citrus maxima showing hyphae. (i) Root segment of *Artocarpus heterophyllus* showing vesicles.

Distribution of spore

AMF fungal spore density per 25 g of soil was 32±2.08 in Town Bordowali soil and 44 ± 3.05 soil in Pratapgarh soil. A total of 9 spore species were isolated from both the sites. of which, *Acaulospora rehmii, Glomus* sp 1 and *Glomus* sp 2 are present in Town Bordowali soil. *Acaulospora* sp 1, *Glomus microaggregatum*, *Glomus* sp 3 and *Glomus* sp 4 are present in Pratapgarh soil. *Glomus* sp 5 and *Glomus* sp 6 are present in both the sites.

In the present study AMF colonization of 10 differ-

Table 1 : Soil properties of soils collected from two locations

Soil samples	Moisture content (%)	pH	Electrical conductivity (cS cm^{-1})	Organic carbon (%)	Nitrogen (kg/ha)	Phosphorus (kg/ha)
Town Bordowali	8.41±0.006	6.42±0.012	21.67±0.33	0.21±0.28	246.12±2.52	27.06±0.49
Pratapgarh	8.50.003	5.79±0.003	71.33±0.33	0.13±0.03	312.61±2.36	26.53±1.21

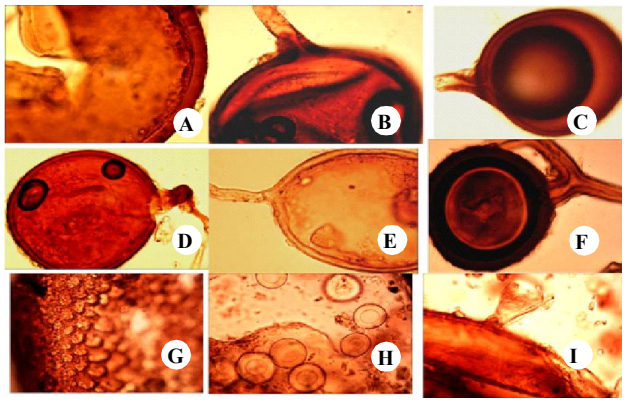

Fig. 2: Spores isolated from the rhizospheric soil of Town Bordowali and Pratapgarh (a) *Glomus* sp 1 (b) *Glomus* sp 2(scale bar = 50 µm) (c) *Glomus* sp 2 (scale bar = 50 µm) (d) *Glomus* sp 2 (scale bar = 50 µm) (e) *Glomus* sp 2 (scale bar = 50 µm) (f) *Glomus* sp 2 (scale bar = 50 µm) (g) wall ornamentation of *Acaulospora rehmii* (scale bar = 100 µm) (h) *G. microaggeratum* (scale bar = 100 µm). (i) *Acaulospora* sp 1(scale bar = 100 µm)

Table 2 : AMF colonization (%) in the roots of different plants

Plant	AMF			AM colonization %	DSE %
	RLA%	RLV%	RLH%		
Carica papaya	6.77±1.36	14.47±2.17	25.74±1.78	46.98±3.37	0.00±0.00
Mangifera indica	13.77±2.01	24.10±2.92	32.68±2.68	70.54±2.84	0.84±0.60
Psidium guajava	6.41±1.46	18.68±2.39	37.11±1.88	60.55±6.77	0.95±0.66
Phyllanthus emblica	22.85±3.00	7.04±1.67	23.35±2.44	53.23±4.15	1.01±0.58
Artocarpus heterophyllus	13.64±2.49	21.48±3.11	22.11±1.94	53.22±8.06	1.98±0.86
Citrus maxima	12.66±1.96	8.24±1.51	27.96±2.47	48.87±3.04	8.62±1.11
Aegle mermelos	14.43±2.01	8.49±1.93	20.01±1.31	39.92±3.43	0.00±0.00
Musa paradisiaca L.	12.47±2.06	30.86±1.44	37.50±2.16	80.83±1.69	0.00±0.00
Citrus medica L	20.18±3.71	10.87±2.17	20.00±1.45	39.70±2.91	0.00±0.00
Litchi chinensis	8.25±2.38	23.74±3.01	68.00±3.68	59.37±1.93	0.00±0.00

Note: AMF=arbuscular mycorrhizal fungi, RLA=root length with arbuscules, RLV= root length with vesicles, RLH= root length with hyphae, DSE=dark septate endophyte.

ent species of fruit plants of Tripura were studied. AM fungal colonization (%) was found in all the fruit plant species and DSE colonization (%) was found in 7 fruit plants. The different fungal structures including intra-radical hyphae, hyphal coils, arbuscules, vesicles and DSE were observed. Root length with arbuscules (RLA) were present in all of the species. In this study, AMF colonization were recorded within the range of 39.70% to 80.83%. A related work on fruit plants from Bangladesh had been reported earlier by Khanam (2007). In that study the range of AMF colonization in *Artocarpus heterophyllus* is 56.7%, *Mangifera indica* is 30%, *Phyllanthus emblica* is 60.0% and *Psidium guajava* is 26.7%. Our result revealed 53.22 % colonization in *Artocarpus heterophyllus,* 70.54% colonization in *Mangifera indica,* 53.23% colonization in *Phyllanthus emblica,* 59.37% in *Litchi chinensis* and 60.54% colonization in *Psidium guajava.* Most of which are showing higher colonization than that of Khanam (2007), except *Artocarpus heterophyllus* and *Litchi chinensis* which are showing slight differences.

Table 3. Distribution of spores extracted from Town Bordowali and Pratapgarh

AM fungi	Town Bordowali	Pratapgarh
Acaulospora rehmii	+	-
Acaulospora sp 1	-	+
Glomus microaggregatum	-	+
Glomus sp 1	+	-
Glomus sp 2	+	-
Glomus sp 3	-	+
Glomus sp 4	-	+
Glomus sp 5	+	+
Glomus sp 6	+	+

In a work by Trindade *et al,* (2006), papaya roots showed considerable arbuscular mycorrhizal (AM) colonization, ranging from 6% to 83%. In the present study AM colonization percentage of *Carica papaya* was 46.98 % which is between the range given by Trindade *et al,* (2006).

On the other hand the occurrence of arbuscular mycorrhizal (AM) fungi was investigated in six varities of *Carica papaya* by Khade and Rodridge (2009) in tropical agrobased ecosystem of Goa, India. The degree of root colonization by native AM fungi varied significantly in these six papaya varieties and ranged from 26% to 77%. In the present study the percentage of AM colonization of *Carica papaya* (46.98) also falls in the same range given by them.

In determining the properties of soils collected from the rhizosphere of fruit plants of Town Bordowali and Pratapgarh, it was found that the moisture

content of Town Bordowali soil and Pratapgarh soil were moreover similar to each other. The soil pH was found to be basic while the electric conductivity Pratapgarh soil was much higher than Town Bordowali soil. The organic Carbon (%) was significantly higher in Town Bordowali. Available Nitrogen was higher in Pratapgarh soil. While available Phosphorus was nearby similar.

Nutrient concentration, PH, and soil humidity level can influence fungal distribution, root colonization, and mycorrhizal efficiency. In general, soils having pH 6.0-6.3 support greater number of AM propagules than soils having pH 5.3-5.7.

The symbiotic association between AM fungi and the roots of plants is widespread in the natural environment. The present study showed that the multiplication of AM fungi in two home gardens may possibly help in the growth of the plants. From the study, we may conclude that the biodiversity of AM fungi was abundant, though *Glomus* was the dominant genus. The degree of colonization varied markedly among plant species. Appropriate strategies have to be carried out for the artificial inoculation of one or some of these AM fungal during the process of cultivation which would help in improving growth and yield of crop.

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