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Mycorrhizal diversity of five different study localities of thiruvarur district.

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Abstract

Mycorrhizal Helper Bacterium (MHB) and Plant Growth Promoting Rhizomicroorganisms (PGPR) have emerged as an important component of integrated plant nutrient supply system and hold a promise for reducing the input cost, improve the crop yield and quality, nutrient supply and sustaining the productivity over a long period. Arbuscular Mycorrhizal (AM) fungal colonization in the roots and scale-like leaves of 'vasambu' (*Acorus calamus*) was positive in all the study localities, although the species of AM fungi colonizing the roots and scale like leaves of rhizome of different plants varied. The presence of high degree of AM colonization with various AM fungal structures such as infection pegs, pelotons, hyphal dimorphic structures, intracellular arbuscules, inter and intracellular vesicles in the root cortical cells were observed. Totally, 32 AM species were isolated from the rhizosphere soils of *A. calamus*. Of the 32 AM fungal species recorded, only two species (*Glomus fasiculatum* and *Gigaspora margarita*) were able to colonize in the roots of the plants.

Key words: AM fungi, *A.calamus*, vasambu, Mycorrhizal helper bacterium and Root colonization

INTRODUCTION

Mycorrhizal fungi show highest level of specialization of parasitism. But the major problems with them are their failure to grow on an artificial medium in the laboratory. Therefore, establishment and multiplication of mycorrhizal fungi on cultured tissue of the same host plant, if successfully developed, may be a good tool for handling mycorrhizal fungi, production of high potential inoculum and their establishment in root systems of nursery plants in horticulture and forestry and plantation of mycorrhiza-infested seedlings into field. Only one report is available on this aspect (Rhodes and Gerdemann, 1975).

Many attempts have been made to establish Vesicular Arbuscular Mycorrhizal (VAM) fungi in axenic culture but unfortunately none of them got success. It was assumed that self inhibition of hyphal growth occurs in the growing germ tubes and the self inhibition compounds were recovered by adding activated charcoal into an agar medium that absorbs inhibitory compounds produced by germ tubes into medium. The cultures of mycorrhizae synthesized aseptically are grouped into two: the plant cultures and excised root cultures (Manimekalai *et al*., 2011).r

Mycorrhizae are vital for the uptake and accumulation of ions from soil and translocation to hosts because of their high metabolic rate and strategically diffused distribution in the upper soil layers. In fact the mycorrhizal fungus becomes thet extension of the root system of the host for the efficient uptake of nutrients from the soil. Minerals at a distance of more than 4cm from the nearest host root can be absorbed by the fungal hyphae and translocated to roots of the mycorrhizal plants. Bieleski (1973) calculated that AM fungi may increase the effective absorbing surface of a host root by as much as ten times. Ions such as P, Zn and Cu do not diffuse readily through soil. Because of this poor diffusion, roots deplete the immobile soil nutrients from a zone immediately surrounding the root. Mycorrhizal fungal hyphae extend into the soil, penetrating the zone of nutrient depletion and can increase the effectiveness of absorption of immobile elements by as much as sixty times.In this context the present article deals with the diversity of mycorrhizal in different soi types of thiruvarur district.

MATERIALS AND METHODS

Selection of sampling area and sample collection

Five different areas of Thiruvarur District of Tamil Nadu, India with varying physico-chemical characteristics of soil were selected for the study on AM (Arbuscular Mycorrhizae). Average annual atmospheric temperature during the year of study (2014-2015) varied from 34.5^{o}C to 24.2^{o}C (Max 42^{o}C, Min 16^{o}C).

Annual rainfall was 830mm and the major precipitation was during the months of October and November. At each locality an area of 1000m^{2} was chosen for sampling. From each study site, 3-5 healthy plants were selected and their root, scale like leaves, rhizome and rhizosphere soil samples were collected at 0-40cm soil depth. The samples collected in triplicates were brought to the laboratory in sealed plastic bags and stored at 5-10^{o}C (Koske and Halverson, 1981). The scale like leaves of rhizome and root samples were washed thoroughly and made free of attached soil particles and cut into 1cm bits and fixed in Formalin Acetic Acid (FAA) in the field itself (Phillips and Hayman, 1970).

Analysis of soil physico-chemical characteristics

Soil samples collected from each study site were mixed thoroughly and a portion of soil was analysed for soil

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Table 1 Mycorrhizal diversity of five different localities of Thiruvarur district

List of AM fungi identified		Study localities						
		Code***	S1	S2	S3	S4	S5	Species frequency
1	Acaulospora							
	1.A.bireticulata	ABRT	+	+	+	+	-	80
	2.A.elegans	AEGS	-	+	+	-	-	40
	3.A.marrowae	AMRW	+	+	+	+	-	50
	4.A.scrobiculata	ASCB	+	+	+	+	+	100
2	Gigaspora							
	5.G.decipiens	GDCP	-	-	-	-	+	20
	6.G.gigantea	GGGT	-	+	+	-	-	40
	7.G.margarita	GMRG	+	+	+	+	+	100
3	Glomus							
	8.G.aggregatum	LAGR	+	+	+	+	+	100
	9.G.ambisporum	LABS	+	-	-	+	-	40
	10.G.botryoides	LBTR	+	-	-	-	-	20
	11.G.citricolum	LCTM	-	-	-	-	+	20
	12.G.constrictum	LCST	-	-	-	-	+	40
	13.G.deserticola	LDST	-	+	-	+	-	60
	14.G.fasiculatum	LFSC	+	+	+	+	+	100
	15.G.feugianum	LFGN	-	+	-	+	-	40
	16.G.fulvum	LFLV	-	-	-	-	+	20
	17.G.globiferum	LGFE	-	+	-	+	+	40
	18.G.geosporum	LGSP	-	+	+	-	-	80
	19.G.hoi	LHOI	-	+	+	-	-	60
	20.G.microcarpum	LMRC	+	-	+	-	-	60
	21.G.macropum	LMCC	-	+	-	+	+	60
	22.G.mosseae	LMSS	+	+	-	-	+	80
	23.G.reticulum	LRTC	-	+	-	-	-	40
	24.G.veriforme	LVSF	+	-	+	-	-	80
4	Sclerocystis							
	25.S.pakistanica	SPKS	-	+	+	-	+	60
	26.S.rubiformis	SRBF	-	+	+	-	-	40
5	Scutellospora							
	27.S.gregaris	CGRA	-	+	-	+	+	60
	28.S.heterogama	CHTG	-	+	-	-	+	60
	29.S.nigra	CNGR	-	+	-	-	-	40
	30.S.persica	CPCA	-	+	-	-	-	40
	31.S.pellucida	CPLC	-	-	-	-	+	20
	32.S.verrucosa	CVRC	-	-	-	-	+	20
	Site frequency (%)	-	34.4	75.0	78.1	37.5	40.6	-

* sampling areas
S1-Alivalam; S2-Selvapurum; S3-Kamalapurum; S4-Mannargudi; S5-Perumalnatham
** unique code for AM fungal species (Perez and Schenck,1990)
+ indicates present, - indicates absent

texture pH, ECse, OM, N, P, K, Zn, Ca, Mn and Fe at the soil testing laboratory, Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu following standard methods (Piper, 1950; Jackson, 1973; Sharma *et al.*, 1986).

Isolation and identification of AM fungal spores and sporocarps

Spore population of each soil sample was estimated by a modified wet-sieving and decanting technique (Gerdemann and Nicolson, 1963). 100g of soil particles were allowed to settle down for 5min. The suspension was passed through 180 and 38µm sieve were suspended in water, then loaded in a burette and left undisturbed for 5-10 minutes. The soil particles settled at the bottom were removed by opening the stopper for few seconds. The spores in the soil suspension were collected using filter paper. The filter paper was spread over a glass plate and the spores were counted under an appropriate magnification (×100) of a compound microscope.

The term frequency was used to assess the establishment and survivability of AM fungi in the rhizosphere of the host (Udaiyan *et al.*, 1996).

$$\text{Frequency (\%)} = \frac{\text{Number of sampling in which a particular AM fungus was recorded}}{\text{Total number of sampling made (10)}} \times 100$$

The density and distribution of AM fungi in the rhizosphere soil sub samples at each sampling was expressed in terms of percentage occurrence.

$$\text{Percentage Occurrence} = \frac{\text{Total number of spores of individual AM Fungus}}{\text{Total number of spore of all AM fungi}} \times 100$$

RESULTS AND DISCUSSION

Among the soil physico-chemical characteristics estimated at five localities of Thiruvarur district of Tamil Nadu, significant positive correlation was found among the following combinations:

ECse and pH	(r = + 0.46* at Mannargudi locality)
Mn and ASN	(r = + 0.86** at Mannargudi locality)
ECse and pH	(r = + 0.65* at Selvapurum locality)
Mn and ASN	(r = + 0.57* at Selvapurum locality)
P and ECse	(r = + 0.73* at Selvapurum locality)
K and ECse	(r = + 0.95* at Selvapurum locality)
Mn and ASN	(r = + 0.96* at Kamalapuram locality)
ECse and pH	(r = + 0.72** at Kamalapuram locality)
ECse and pH	(r = + 0.72* at Alivalam locality)
Mn and P	(r = + 0.96* at Perumalnatham locality)
P and ECse	(r = + 0.85* at Perumalnatham locality)

Among the soil physico-chemical characteristics estimated, significant negative correlation was found among the following combinations:

Zn and ECse	(r = - 0.56* at Mannargudi locality)
K and OM	(r = - 0.47* at Selvapurum locality)
P and N	(r = - 0.73* at Kamalapurum locality)
Zn and K	(r = - 0.60* at Kamalapurum locality)
Fe and Zn	(r = - 0.78* at Alivalam locality)
OM and ECse	(r = - 0.71* at Perumalnatham locality)

The following genera were identified from the samples of the five different study locality of Thiruvarur district, namely *Acaulospora, Gigaspora, Glomus, Sclerocystis* and *Scutellospora*. Totally 32 mycorrhizal species were identified (Table 1).

Species diversity was also apparent in each locality of Tamil Nadu. *Acaulospora scrobicuta, Glomus aggregatum* and *Gigaspora margarita* were found in all the five study sites. The marked difference observed in the composition of AMF spores in the soils of all the five study sites of Tamil Nadu can be attributed to the influence of edaphic factors. The climatic variation also influences the selection of AMF as it regulates the incidence of certain specific strains in the soil (Harikumar and Potty, 1999; Ararsa Leta and Thangavel Selvaraj 2013).

G.margarita, A.scrobiculata and *G.aggregatum* were the predominant species in root-zone soils of vasambu in Tamil Nadu. Observations of this nature are well documented in several other instances in sweet potato soil (Potty, 1990). Tejavathi *et al.*, (2011) reported the positive correlation between percent mycorrhizal colonization and plant growth in Andrographis paniculata. All the morphological parameters assessed were significantly influenced by AM fungal association both in normal and micro-propagated plants.

In relation with the diversity index, Sensu Whittaker, there are no comparable data in the literature except that of Cuenca and De Andrade (1996). Using the same sampling procedure they reported values 3.9 and 4.0 for a sclerophyllous shrub land and an evergreen forest in Venezuela, respectively.

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