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Research Article

Vesicular Arbuscular Mycorrhizal Fungi associated with the Medicinal plants of Mahadevpur Reserve Forests of Karimnagar East Division, Karimnagar District in Telangana State of India

Rajender Reddy. E[1], Anitha Devi. U[2], Balaraju. P[3] Chandraiah. G[4] Kanaka Rajesham. Ch[2] and *Ugandhar. T[5]

[1]Regional Director Regional Coordination Centre Dr.AOU Karimnagar- 505001
[2]Department of Botany, Govt Degree & P.G.College for Women Karimnagar 505001
[3]Department of Botany, Govt. Degree & PG College Peddapally - 505 172
[4]Department of Botany, SKNR Govt. Arts & Science College Jagityal–505327
[5]Department of Botany, SRR Govt. Arts & Science College Karimnagar - 505001
*tugandharbiotech@gmail.com

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Abstract

Highly variable diversity index in arbuscular-mycorrhizal spore densities and their spatial distribution and soil chemical composition was detected. Forty medicinal plants in the natural habitat form association with large number of micro-organisms, one among them are Vesicular Arbuscular Mycorrhizal Fungi (VAM), which represent an important component in the soil microbial biomass and which regulate several essential processes at the plant-soil interface. They are known to regulate the richness of the plant community and thus change biological natural ecosystem of the biosphere. Overall, spore densities were low which is usual for arid lands. Cleared and stained roots displayed the presence of vesicles, resting spores, dichotomously branched arbuscules and extrametrical hyphae. The root colonization status of Arbuscular-Mycorrhiza was highly variable even in the rhizosphere of same plant, ranging from 46 to 72%. Arbuscular mycorrhizal root colonization and spore distribution patterns in plant rhizosphere seemed also to be affected by edaphic factors, especially salinity and available phosphorus content. It was concluded that the native Arbuscular mycorrhizae associated with *T.chebula* are highly diverse and may have role in the establishment of vegetation in harsh desert conditions through enhancing resource allocation and salinity tolerance.

INTRODUCTION

Arbuscular mycorrhizae are perhaps the most common symbiotic associations with majority of the land plants, and are probably among the most important because they facilitate plant's uptake of phosphorus, which is a limiting nutrient in most of the soils (Yao *el al.*, 2001; Koide and Schreiner, 1992) and also useful in plant species lacking morphological or physiological mechanism for phosphorus uptake (Manjunath and Habte, 1992). Beside its role in enhancing nutrient uptake, arbuscular mycorrhizae also contribute to the plant health and productivity by the suppression of plant diseases (Khaosaad *et al*, 2007), controlling nematode infection (Elsen *et al.*, 2008), stimulation of phytohormone production (Martínez-Medina *et*

al., 2011), improve soil structure (Wu *et al.,* 2008) and plant tolerance to stress conditions including drought (Pinior *et al.,* 2005) and salinity (Hajiboland *et al.,* 2010). The diversity and distribution of arbuscular mycorrhiza is greatly affected both by biotic and abiotic factors (Mohammad *et al.,* 2003). Panwar and Tarafdar (2006) reported that the association of arbuscular mycorrhizae with plant species native to the harsh environmental conditions may play a significant role in the re-establishment and conservation of endangered plants. Similarly Panwar and Vyas (2002) indicated the significance of arbuscular mycorrhizae in restoration of stress affected vegetation in dry habitats. Many organizations who are concerned with the management of native flora, restoration of natural habitats and production of economically important agricultural and horticultural plants with minimal chemical inputs are interested in the use of arbuscular-mycorrhizal biofertilizer technology. Generally, the knowledge about restoration of salt affected ecosystems by arbuscular mycorrhizae is not too vast and required to undertake more plant re-establishment programmes through mycorrhizae.

Before the exploration of arbuscular mycorrhizal biofertilizer potential related to halophytic plants, it is necessary to investigate the spatial distribution and colonization of arbuscular mycorrhiza in the soil, because it varied with the ecosystems (Hart and Klironomos, 2003) and are affected by the edaphic factors (Sanders, 1990).

In the recent days the reserve forests have assumed as a special significance for collections of medicinal plants which exhibiting great diversity. The Mahadevpur Reserve Forests of Karimnagar East Division, Karimnagar District of Telangana, India, has spread over 5 lakh hectares geographically, but the forest cover with medicinal plants pool is limited to 1.5 hectares only. The symbiotic association between micro-organisms and the medicinal plants is found common and is of great significance in ecological importance of the natural biological systems. The degree of dependence of medicinal plants on the fungal symbionts varies with the inherent nature of the plant species and the prevailing environmental conditions, particularly soil fertility conditions. The forest plant species commonly have low rooting densities in the soil when compared to the agricultural species. This limits their absorbing ability of immobile soil nutrients, as such, the importance of the mycorrhizal association to the forest plant species is therefore related to the extension of absorptive area behind the depletion zone, volume of soil explored in search of nutrients an effective uptake and transport of nutrients (Osonubi 1989). Mycorrhizal fungi may particularly, be important for the establishment and early growth of the plants in the regions where growth and nutrient uptake are seasonal.

Arbuscular Mycorrhizal (AM) symbiosis is formed by approximately 80% of the vascular plant species in all terrestrial biomes (Smith *et al,* 2010). Arbuscular mycorrhizal fungi (AMF) are of great ecological importance, since arbuscular mycorrhizae is the most widespread plant symbiosis that often improves plant productivity (Fedderman *et al,* 2010). The main advantage of mycorrhizae to the host plants is the extension of the penetration zone of the root fungus system. The interconnected networks of external hyphae act as an additional catchment and absorbing surface in the soil (Sharma, 2004). The increased efficiency of mycorrhizal roots versus non mycorrhizal roots is caused by the active uptake and transport of nutrients especially immobile minerals like P, Zn and Cu (Phiri *et al.,* 2003; Jamal *et al.,* 2002).

In the present studies, the colonization of the VAM fungi with some important medicinal plants of Mahadevpur Reserve Forests of Karimnagar East Division, Karimnagar District of Telangana, India, has been assessed. Most of the plant species, showed the mycorrhizal dependency. The mycorrhizal colonization and the production of spore population concerned, varied from plant to plant. Laboratory experiments in terms of the 40 plant species of which *Terminalia chebula.* L. revealed the enhanced plant growth and biomass production in the mycorrhiza inoculated plants over the control.

The present study indicates that the improved growth is obtained with many medicinally important plant species of the forest by the inoculation of the seedlings with specific mycorrhizal fungi strains' Bagyaraj DJ. (1989) reported that species and strains of AM fungi differed to the extent by which they increased nutrient up take and plant growth. Hence some researchers suggested the need for selecting efficient VAM fungi that can be used for inoculating different plants (Bagyaraj Byra Reddy and Nalini, 1989; Mallesh and Bagayaraj, 1994; Hemalth *et al.,* 2003 and Murugan *et al.,* 2003) also increased "P" content in medicinal plants.

MATERIALS AND METHODS

Rhizosphere soil samples of 40 medicinal plants were collected up to a depth of 10 cms. Four soil samples were collected for a plant growing at different regions (Table-1). For the quantitative studies four sub-samples were collected in the polythene bags and labeled, brought to the laboratory and stored at 4^{o} C for the analysis. The sub-samples were mixed thoroughly and the 50 grams of the composite soil was kept for spore isolation. The mycorrhizal spores were recovered by wet sieving and decanting method (Gerdmann and Nicolson, 1963). The total spore count and number of individual spores of each sample were determined and frequency of spore occurrence was calculated as here under.

$$\textbf{Frequency (\%)} = \frac{\textbf{No. of Samples in which a particular VAM fungi was recorded x 100}}{\textbf{Total number of Samplings made}}$$

The seeds of *Terminalia chebula* were scarified with 10% $H_2SO_4$for 10 minutes and followed by successive rinses with sterile water. Now these seeds were surface sterilized with 2% Sodium hypochloride followed by successive rinses with sterile water.

Then all the seeds were placed in plastic pots containing sterilized sand and soil mixture in 2:1 proportion and germinated at 25^{0}C. Now, 10 gm. of inoculum of the frequently observed VAMF species *Glomus fasculatum* was placed as a layer 5 cm, below the germinated seeds of the selected pants. Thus the experiment consists of an un-inoculated control and mycorrhizal treated plants

The potted plants were watered daily with sterilized water. The mycorrhizal inoculated seedlings were harvested after 90 days of inoculation. The rate of root colonization and number of VAM fungi spores in the pots were determined

RESULTS AND DISCUSSION

During the survey of entire Mahadevpur Reserve Forests of Karimnagar East Division, Karimnagar District of Telangana (15,000 km^2), it was found that *Terminalia chebula* is a common halophyte and occurred commonly over the area. Soil texture varies from loam to sandy loam. The soil pH ranged from 7.80 to 8.11, organic carbon content from 0.34 to 0.69% and electrical conductivity from 1.73 to 7.13dSm-1. The soil available phosphorus was from 4.83 to 7.81 ppm and potassium content ranged from 70 to 140 ppm respectively. Saturation percentage varies as the texture of the soil, showing low water holding capacity at the sites having sandy soil. Generally the soil of Mahadevpur Reserve Forests of Karimnagar are characterized as alkaline soil with low available P, low organic matter and resultantly low saturation percentage, which in combination with low annual rainfall results in harsh arid conditions leading to increased significance of arbuscular mycorrhizal fungi like biofertilizer technology. The effect of biofertilizers like *Rhizobium*, AM seedling production of *Acacia nilotica* was studied by Rajendran and Jayasree (2007). They showed that the total length of seedlings and biomass were significantly increased in all the treatments when compared to control. Among the treatments maximum growth and biomass were recorded in *Rhizobium*+AM + *Azospirillum* combination and it was 156.8% more than the control. The efficacy of microbial bioagents for the control of collar rot disease in chick pea was studied (Ashraf Zahid *et al*, 2007). Maximum reduction in seedling mortality was obtained in combination of *Rhizobium* and VAM compared to control (100% seedling mortality). It was inferred that both the amendments used have effectively improved various yield parameters by controlling the disease and reducing seedling mortality.

Conclusions

- The rhizosphere of *T. chebula* had shown a highly diversified arbuscular mycorrhizal fungal consortium with respect to soil chemical composition and AMF spore densities.
- Arbuscular mycorrhizal fungal root colonization status and spore distribution seemed also to be affected by edaphic factors, especially salinity and available phosphorus content.
- Arbuscular mycorrhizal fungal root colonization status and spore distribution seemed also to be affected by edaphic factors, especially salinity and available phosphorus content.
- Arbuscular mycorrhizal fungal association enhances in response to increased salinity and decreased phosphorus content.

- Arbuscular mycorrhizal fungal colonization of host plant root may have role in the establishment of vegetation in harsh desert conditions through enhancing resource allocation and salinity tolerance

Table 1: VAM Fungi Dependency of 40 Selected Medicinal Plants of MahadevpurReserve Forests of Karimnagar East Division, Karimnagar District, Telangana, India.

Sl. No.	Medicinal Plant Species	Family	% of VAMF colonization	Spore Numbers/ 50 gm. Soil (S.E.)*
1	*Abrusprecatorius*	Fabaceae	72	14.2 ± 0.23
2	*Acacia arabica*	Mimosaceae	84	15.2 ± 0.53
3	*Acacia catechu*	Mimosaceae	49	10.2 ± 0.43
4	*Acacia chundra*	Mimosaceae	52	10.1 ± 0.53
5	*Acacia leucocephalae*	Mimosaceae	53	10.4 ± 0.63
6	*Aeglemarmelos*	Rutaceae	80	14.2 ± 0.23
7	*Albizialebbeck*	Mimosaceae	78	7.2 ± 0.23
8	*Annonareticulata*	Annonaceae	50	9.4 ± 0.43
9	*Annonasquamosa*	Annonaceae	48	7.5 ± 0.32
10	*Aristolochiaindica*	Aristolochiaceae	82	10.2 ± 0.53
11	*Asparagus recemosus*	Liliaceae	76	9.5 ± 0.23
12	*Azadirachtaindica*	Meliaceae	52	10.5 ± 0.53
13	*Bambusabambos*	Poaceae	42	9.6 ± 0.23
14	*Bauhinia purpurea*	Caesalpiniaceae	47	9.6 ± 0.43
15	*Borassusflabellifer*	Palme	78	12.4 ± 0.23
16	*Buteamonosperma*	Fabaceae	44	12.1 ± 0.53
17	*Calotropisgigantia*	Asclepiadaceae	54	10.5 ± 0.73
18	*Cappariszeylanica*	Capparidaceae	64	7.08 ± 0.63
19	*Cassia auriculata*	Caesalpiniaceae	70	9.20 ± 0.33
20	*Datura alba*	Solanaceae	69	9.02 ± 0.53
21	*Dichrostachyscineria*	Mimosaceae	77	9.02 ± 0.53
22	*Eclipta alba*	Asteraceae	41	9.02 ± 0.32
23	*Emblicaofficinalis*	Euphorbiaceae	57	10.2 ± 0.63
24	*Euphorbia tirucalli*	Euphorbiaceae	72	12.2 ± 0.23
25	*Feroniaelephantum*	Rutaceae	61	11.2 ± 0.53
26	*Ficusbengalensis*	Moraceae	62	10.2 ± 0.23
27	*Ficusreligiosa*	Moraceae	67	12.2 ± 0.53
28	*Gloriosasuperba*	Liliaceae	32	9.02 ± 0.52
29	*Gymnemasylvestre*	Asclepiadaceae	48	7.02 ± 0.54
30	*Hardwickiapinnata*	Caesalpiniaceae	51	7.02 ± 0.53
31	*Hemidesmusindicus*	Periplocaceae	65	11.4 ± 0.23
32	*Loranthuslongiflorus*	Loranthaceae	46	6.02 ± 0.52
33	*Mimosa pudica*	Mimosaceae	57	10.4 ± 0.52
34	*Ocimum sanctum*	Lamiaceae	50	8.02 ± 0.23
35	*Oroxylumindicum*	Bignoniaceae	77	9.02 ± 0.23
36	*Terminaliaarjuna*	Combretaceae	79	10.3 ± 0.52
37	*Terminaliabellerica*	Combretaceae	81	10.4 ± 0.54
38	*Terminaliachebula*	Combretaceae	88	11.2 ± 0.23
39	*Withaniasomnifera*	Solanaceae	85	10.2 ± 0.23
40	*Zizipuszuzuba*	Ramnaceae	63	8.02 ± 0.23

***S.E. Standard Error**

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