Arbuscular Mycorrhizal Fungal Association in the Rhizosphere Soil and Root Colonization of Some Medicinal Plant Species in Sirumalai Hills Eastern Ghats of Dindugul District Tamilnadu

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Abstract: The present study was mainly conducted to investigate the survey of arbuscular mycorrhizal biodiversity in rhizosphere soil and root colonization of medicinal plant species in Sirumalai hills, Eastern Ghats of Dindugul district, Tamilnadu. Soil samples were collected during the month of September 2014 from the surface to 30 cm depth and pH was measured. Rhizosphere soil root of 20 plant species belonging to 20 families were investigated. The present result showed arbuscular mycorrhizal spore population in the rhizosphere soil and root colonization of all the plant species. A total of 39 AM fungal species belonging to six genera were isolated from the rhizosphere soil. The genus *Glomus* were found dominate followed by *Acaulospora*, *Sclerocystis*, *Entrophospora* and *Gigaspora*. The maximum spore population was found in the rhizosphere soil of *Bacoba moneeri* (480.65/100 g soil) which belongs to the family Scrophulariaceae and the least spore population was observed in the *Hygrophila auriculata* (140.78/100g soil) belongs to Acanthaceae family. The highest (85.33%) AM fungal infection was found in roots of *Mimosa pudica* belongs to the family Mimosaceae. While the lowest (17.33%) AM fungal association was found in the root of *Oxalis corniculata* (L.) belongs to the family Oxalidaceae.

Key words: Arbuscular mycorrhizal fungi - Sirumalai hills - Root colonization

INTRODUCTION

The soil micro organisms interacting with plant roots has gained increased attention in recent years [1, 2] and the interactions between beneficial and pathogenic organisms have been identified as being particularly relevant due to their important implications for plant fitness [3-5]. This is particularly evident with the Arbuscular Mycorrhizal (AM) fungi, which are obligate symbionts of a majority of all plant species and common across most terrestrial plants [6]. The occurrence of AM fungi has been reported in many plant communities such as forests [7, 8] grasslands, stepper and praires [9], deserts [10] and mangroves [11]. Earlier studies on the occurrence of AM fungi in medicinal plants mostly concentrate on rhizomes [12], later on [13-18] were reported the occurrence of medicinal plants from India. In recent studies also revealed that lower land plants, in particular species of hornworts and liverworts, associate with AM or ericoid mycorrhizal fungi [19-21]. Moreover, the ubiquity, cosmopolitism and low host-plant specificity of many plant species of AM fungi provide a good opportunity for medicinal plants to form a mycorrhiza in their new ranges [22]. Therefore, AM can be expected to have a favourable effect on the process of plant invasion [23].

In this symbiotic association of AM fungi in the medicinal plant species increasing uptake of macro elements N, K particularly phosphorus and micro nutrients such as Zn, Cu, S, Fe, Mg, Ca and Mn. The supply of these nutrients to the host plant roots [24-26] and it can also enhance tolerance of or resistance to root pathogens [27] abiotic stresses, such as drought and metal toxicity [28]. The importance of mycorrhizal fungi diversity and environment functioning is now being recognized, particularly with respect to their potential to control plant diversity and productivity [29]. There is also a growing understanding in the role of the plant...
community in determining the structure of mycorrhizal fungal communities [30, 31]. The present study area Sirumalai hill is one of the major areas of the Eastern Ghats region of Dindugul district Tamilnadu. Sirumalai is rich sources of numerous medicinal plants, orchids, ferns species and several endemic plants owing to the anthropogenic disturbances and increasing coffee estates, rubber plantations orchards and cultivation of several vegetation crops.

MATERIALS AND METHODS

Description of the Study Sites: The Present study area Sirumalai hills is a part of Eastern Ghats, is situated 28 km south of Dindigul District, Tamilnadu. So as to is rich biodiversity and indigenous population. It is located in the Eastern Ghats range in Dindugul district in the Southeast of Tamilnadu and lies between at 77°55’ - 78°12’ E longitudes and 10°07’ - 10°18’ N latitude form a portion of Tamilnadu. It has an average elevation of the hills ranges 1600 meters above (MSL) and about annual rainfall between 3523.3mm to 2882.7 mm and the temperature varies between 25°C to 28°C (Fig. 1). The vegetation of Sirumalai ranges from tropical thorn forest to mixed deciduous forest, dry deciduous forest, moist deciduous riparian forest and semi-evergreen forest.

Sample Collection: Root and rhizosphere soil samples were collected from 20 plant species in the month of September 2013 to October 2014. Samples were placed in the polyethylene bags, labelled and then transported to the laboratory. The root samples were freshly processed, whereas rhizosphere soil samples were analyzed for mycorrhizal spore population and AM fungal root colonization.

Estimation of AM Fungal Root Colonization: The root samples were stained by using modified method [32]. Root samples of each plant species were washed gently under tap water and cleared in 2.5% KOH, acidified in 5 N HCL and stained in lacto glycerol with 0.05% Trypan blue. The stained roots were examined under a compound microscope (40x–100x). Hundred root segments for each sample were randomly selected for microscopic observation and the degree of colonization was estimated using the slide method [33].

The percentage of AM fungal infection was calculated using the formula:

\[
\text{Colonization} \% = \frac{\text{No. of root segments colonized}}{\text{Total no of root segments Tested}} \times 100
\]

![Fig. 1: Map Showing study area of Sirumalai hills.](image-url)
AMF Spore Identification: AM fungal spores were extracted from 25 g rhizosphere soil by wet-sieving and decanting method [34] through a series of 710 to 37ìm size sieve filter. For the identification and nomenclature of these AM fungal spore synoptic keys developed by [35, 36] were used. The classification was based upon the colour, shape, hyphae, structure, size and cell wall thickness and spore diameter.

Soil pH: The pH of the soil samples was determined (soil-water suspensions 1:5) with the help of pH meter (Elico) and values were recorded.

RESULTS

The present result confirmed that the AM fungal infection and spore population of 20 plant species belonging to 20 families were recorded. In all the plant species rhizosphere soil samples AM fungi of the genus *Glomus* was recorded as the most population, followed by *Sclerocystis, Acaulospora, Gigaspora, Scutellospora and Entrophospora* are recorded in (Table 2; Fig. 3, 4 and 5). The maximum spore population was found in the rhizosphere soil of *Bacoba moneeri* (480.65/100 g soil) belongs to the family Scrophulariaceae and the least spore population was observed in the *Hygrophiula auriculata* (140.78/100g of soil) belongs to Acanthaceae family. The highest (85.33%) AM fungal infection found in roots of *Mimosa pudica* belongs to the family Mimosaceae. The lowest (17.33%) AM fungal association was found in the root of *Oxalis corniculate* belongs to the family Oxalidaceae. Totally 39 AM fungi species belongs to 6 genera were isolated rhizosphere soil Table 2, Fig. 3.

Table 2: AM fungal species in rhizosphere soil and root colonization of herbaceous plant species in Sirumalai hills Eastern Ghats of Southern India

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Plant species</th>
<th>pH</th>
<th>Mean spore density 100^-1 g of rhizosphere soil</th>
<th>AM fungal colonization</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Centella asiatica (L.)</td>
<td>5.5</td>
<td>254.6±3.21</td>
<td>Hyphae +, Arbuscles +, Vesicles -</td>
</tr>
<tr>
<td>2</td>
<td>Acalypha indica L.</td>
<td>4.9</td>
<td>357.43±4.76</td>
<td>+, - +</td>
</tr>
<tr>
<td>3</td>
<td>Ahatlon indicum Sweet</td>
<td>6.1</td>
<td>293.47±5.05</td>
<td>+, - +</td>
</tr>
<tr>
<td>4</td>
<td>Catharanthus roseus (L.) G.Don</td>
<td>5.2</td>
<td>216.81±1.98</td>
<td>+, - +</td>
</tr>
<tr>
<td>5</td>
<td>Caasia auriculata Linn.</td>
<td>4.4</td>
<td>183.58±2.08</td>
<td>- + +</td>
</tr>
<tr>
<td>6</td>
<td>Mimosa pudica L</td>
<td>4.6</td>
<td>210.65±1.34</td>
<td>+, - +</td>
</tr>
<tr>
<td>7</td>
<td>Oxalis corniculata Linn</td>
<td>6.2</td>
<td>278.63±1.87</td>
<td>+, - +</td>
</tr>
<tr>
<td>8</td>
<td>Rauwolfia serpantina (L.) Bent. ex Kurz</td>
<td>5.9</td>
<td>223.56±12.6</td>
<td>+, - +</td>
</tr>
<tr>
<td>9</td>
<td>Hygrophiula auriculata Heine.</td>
<td>5.1</td>
<td>140.78±1.77</td>
<td>+, - +</td>
</tr>
<tr>
<td>10</td>
<td>Rhinocanthus nasutus (L.) Kurz</td>
<td>4.1</td>
<td>375.11±14.5</td>
<td>+, - +</td>
</tr>
<tr>
<td>11</td>
<td>Hemidesmus indicus R.Br.</td>
<td>5.8</td>
<td>297.99±16.03</td>
<td>+, - +</td>
</tr>
<tr>
<td>12</td>
<td>Bacoba moneeri (L.) Pennell</td>
<td>6.5</td>
<td>480.65±17.32</td>
<td>+, - +</td>
</tr>
<tr>
<td>13</td>
<td>Vexx negundo L.</td>
<td>6.0</td>
<td>216.81±1.2</td>
<td>+, - +</td>
</tr>
<tr>
<td>14</td>
<td>Tribulus terrestris L.</td>
<td>5.4</td>
<td>321.33±4.07</td>
<td>+, - +</td>
</tr>
<tr>
<td>15</td>
<td>Basella alba L.</td>
<td>4.7</td>
<td>303.03±4.09</td>
<td>+, -</td>
</tr>
<tr>
<td>16</td>
<td>Curculigo orchioides</td>
<td>4.6</td>
<td>260.2±3.87</td>
<td>- +</td>
</tr>
<tr>
<td>17</td>
<td>Solanum seforthianum</td>
<td>5.0</td>
<td>246.7±7.03</td>
<td>+, -</td>
</tr>
<tr>
<td>18</td>
<td>Toddalia asiatica</td>
<td>6.2</td>
<td>209.5±1.8</td>
<td>+, -</td>
</tr>
<tr>
<td>19</td>
<td>Smilax zeylanica</td>
<td>6.9</td>
<td>194.8±2.6</td>
<td>+, -</td>
</tr>
<tr>
<td>20</td>
<td>Ipomea nil</td>
<td>4.2</td>
<td>238.06±1.5</td>
<td>+, -</td>
</tr>
</tbody>
</table>

Each value represents mean ± SD.

Table 3: AM fungal spore population isolated from rhizosphere soil at Sirumalai Hills, Eastern Ghats of Tamilnadu

<table>
<thead>
<tr>
<th>S. No.</th>
<th>AM Fungal genera</th>
<th>AM Fungi Spores species</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Glomus</td>
<td>*Gl. albidum, Gl. arboresis, Gl. austral, Gl. canadense, Gl. citricola, Gl. claroide, Gl. clarum, Gl. constrictum, Gl. delhense, Gl. dimorphicum, Gl. domini, Gl. etunicatum, Gl. fasciculatum, Gl. fistulosum, Gl. flaviscorpus, Gl. fragilissatum, Gl. fulvum, Gl. geosporum, Gl. glomeratum, Gl. heterosporum, Gl. hoi, Gl. intraradix, Gl. invermeyanum, Gl. macrocarpum, Gl. deserticola, Gl. boreale, Gl. pulvinatum, Gl. ambisporum,</td>
</tr>
<tr>
<td>2</td>
<td>Acaulospora</td>
<td>*A. gdanskensis, A. rehemi, A. thomii,</td>
</tr>
<tr>
<td>3</td>
<td>Scutellospora</td>
<td>*Scu. heterogama, Scu. Scutata Scu. auriglobosum</td>
</tr>
<tr>
<td>4</td>
<td>Gigaspora</td>
<td>*G. candida, G. decipiens,</td>
</tr>
<tr>
<td>5</td>
<td>Sclerocystis</td>
<td>*Scl. pachycaulis, Scl. rubiformis</td>
</tr>
<tr>
<td>6</td>
<td>Entrophospora</td>
<td>*E. infrequens</td>
</tr>
</tbody>
</table>
Fig. 2: AM fungal species isolated from the rhizosphere soil samples of herbaceous plant species in Sirumalai hills.

Fig. 3: Showing the vesicles, arbuscules type of hyphal infection in plant species, of Eastern Ghats.

Fig. 4: Frequency occurrence of AM fungal species in rhizosphere soil samples of Sirumalai hills, Dindugul district.
DISCUSSION

Arbuscular mycorrhizal (AM) fungi have been described as ‘keystone mutualists’ in ecosystems due to their unique position at the root-soil interface [37]. In the present study effort was made to estimate the rhizosphere soil and root colonization of AM fungi in the herbaceous plants species of Sirumalai hills Eastern Ghats of Dindugul district, Tamilnadu. The spore population recorded in our study is much higher in ranges from 140.78 to 480.65 spores 100 g of rhizosphere soil and root infection ranges 17.33% to 85.33%. Ferrol et al. [38] and Radhika and Rodrigues [39] reported that AM fungal diversity in thirty-six medicinal plant species belonging to 25 families of different localities of North and South of Western Ghats, Goa region. They were isolated from the rhizosphere soil samples of AM fungi totally forty two AM fungal species belonging to five genera such as Glomus, Acaulospora, Scutellospora, Gigaspora and Ambispora. Similarly our present investigation deals about 20 plant species belongs to 20 families of Sirumalai hills Eastern Ghats of Dindugul district. From these plant species totally 39 AM fungi species belongs to 6 genera like Glomus, Acaulospora, Sclerocystis, Entrophospora and Gigaspora in rhizosphere soil samples. Koul et al. [40] recently reported that the total 42 AMF species associated with the medicinal plants and are predominantly distributed amongst 4 genera. The genus Glomus is represented by 21 species which is around 50 percent of the total AMF species, followed by genus Scutellospora (10), Acaulospora (07) and Gigaspora (04) respectively. Our present study deals with 39 AM fungal species and 6 genera were isolated in the rhizosphere soil samples of 20 plants species. The Glomus was maximum population 28 species followed by Acaulospora (03), Scutellospora (03), Gigaspora (02), Sclerocystis (02) and Entrophospora (01) were recorded. Sundar et al. [41] reported that totally 21 AM fungal species were isolated from the rhizosphere soil samples of medicinal plants species of Kanyakumari District, Tamil Nadu and Nasim and Bajwa [42] were investigated that AMF symbiotic association in the plant species such as Crotalaria anagyroides, Eupatorium adenophorum and Hedychium coronarium from subtropical pine forest of Meghalaya, North East India. Among this plant species AM fungal spore ranges from 319 to 661 in 25 g⁻¹ and root colonization 66–71%. Colonization of dark septate endophyte was also evaluated and ranged from 0.17–0.85%. Similarly our result showed that AMF association in the plant species and their spore abundance range from 140.78 to 480.65/100 g soil and root colonization ranges from 17.33% - 85.33%. Uma Sarkar [43] recently reported that vesicular arbuscular mycorrhizal spore diversity across the soil of degraded forest and rubber plantation. They isolated AM fungal species from the rhizosphere soil of 25 species were obtained from degraded forest, 17 species from rubber plantation and 14 species were common in both sites. In degraded forest, the percent (%) contribution of total spore density was shared by Genus Acaulospora (13.04%), Gigaspora (20.58%), Glomus (27.54%) and Scutellospora (8.99%). Our present result showed that among the studied AM fungal species the genus Glomus (70%) followed by Scutellospora (9%), Acaulospora (7%) Gigaspora (7%) Sclerocystis (5%) and Entrophospora (2%) were found dominant, respectively.

CONCLUSIONS

Here in, we have reported first time in the AM diversity in rhizosphere soil and root colonization of herbaceous plant species in the Sirumalai hills Eastern Ghats of Dindugul district, Tamilnadu. Throughout the study a root segment was considered as important organ for mycorrhizal association, even if any three structures like hyphae, vesicles and arbuscles were present. In this mutualistic association of AM fungi in the medicinal plant species more beneficial effects of nutrient uptake, especially phosphorous and biological control of root pathogens, pesticides regarding environment pollution.

REFERENCES