STUDIES ON THE ARBUSCULAR MYCORRHIZAL FUNGAL BIODIVERSITY IN THE PLANT SPECIES OF KONDRANGHI HILLS, DINDUGUL DISTRICT, TAMIL NADU, INDIA

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ABSTRACT
The present study to investigated that the arbuscular mycorrhizal fungal root colonization and spore population in some medicinal at Kondrangi hills Eastern Ghats of Dindugul district, Tamilnadu, India. Root and rhizosphere soil samples were collected during the month of August, 2017-March, 2018 from the surface to 30 cm depth as well as pH were also recorded. Totally 32 plant species belonging to 21 families and 30 genera were identified. The present result showed arbuscular mycorrhizal spore population in the rhizosphere soil and root colonization of all the plant species. A total of 20 AM fungal species belonging to 7 genera and 2 different orders were recorded from the rhizosphere soil samples of this study region. The Glomus was dominant had seen in rhizosphere soil samples in all the medicinal plant species. The maximum spore population was found in the rhizosphere soil samples of Phyllanthus amarus (440 /100 g soil) which belongs to the family Euphorbiaceae and the lowest spore population was observed in the Tephrosia purpurea (110 /100g soil) belongs to Fabaceae. family. The highest 87% AM fungal infection was found in roots of Plumbago zeylanica belongs to the family Plumbaginaceae. While the lowest 24% AM fungal association was found in the root of Striga angustifolia belongs to the family Scrophulariaceae.

Keywords: Arbuscular mycorrhizal fungi, Medicinal plants, Kondrangi hills.

1. INTRODUCTION
Fungi constitute a megadiverse kingdom. There are at least 1.5 million, but probably as many as 3–5 million species, of which only about 100,000 have been described formally. Fungi play an important role in the rhizosphere; one among them Arbuscular Mycorrhizal symbiotic association with plant and enhances the absorption of water and nutrients, especially in phosphorous. It also increases the tolerance of plants to biotic and abiotic stresses, as pathogens, drought and high salinity (1). Besides that, the Arbuscular Mycorrhizal plays a critical role in the functional and successional processes of plant communities as soil formation, management and nutrient cycling (2, 3).

In the present study area of kondrangi hills located at eastern region of Dindugul district, a rich diversity of medicinal plants scattered over the hills and hillocks. Publish information on the AM fungal association in the medicinal plants at kondrangi hills is not available till date. Hence, the present research to investigate the diversity of arbuscular mycorrhizal fungi in the rhizosphere soil samples and root colonization of medicinal plants species were collected from the kondrangi hills, Eastern Ghats of Dindugul district, Tamil Nadu India.
2.2. Sample collection

In this present study, root and rhizosphere soil samples of 32 plant species were collected for the duration of August, 2017- March, 2018. The collected soil and root samples were placed in the polyethylene bags, labeled 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 in study species.

2.3. Estimation of AM fungal root colonization

The root samples were cleared and stained in tryphan blue with a modified version of following method by Philips and Hayman’s (4). The collected roots samples were cut into 1-2 cm pieces, heated at 90ºC in 10% KOH for about 1 hour. For thicker and older roots, the duration was increased. The root segments were rinsed in water and acidified with dilute HCl. The root pieces were stained with 0.05% tryphan blue in lacto phenol for 5 minutes and the excess stain was removed with clear lacto phenol.

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

\[
\text{Percentage of colonization} = \frac{\text{No. of root segments colonized}}{\text{Total no of root segments of observed}} \times 100
\]

2.4. Identification of AM fungi

The present study isolation and identification of AM fungal spores based upon their morphological characters such as spore size, color, hyphal attachment, cell wall layer characters, were identified in addition with nomenclature, keys of the following manual authors were used: Raman and Mohankumar (5); Schenk and Perez (6) and Schubler and Walker (7). The Photomicrographs were taken with the help of a Magnus Olympus Microscope.

2.5. 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.

3. RESULTS AND DISCUSSION

In the present result reveals that totally 32 medicinal plant species belongs to 21 families were examined AM fungal colonization and spore population at kondrangi hills, Dindugul district, Tamilnadu (Fig. 2,3). The collected and identification of the plant species for their respective family, habit, plant parts used and therapeutic uses are presented (Table.1, 2; Fig. 4,5). The present findings that the rhizosphere soil samples of kondrangi hills, the maximum spore population was observed in the plant species of Phyllanthus amarus (440/100g of soil) belongs to Euphorbiaceae and minimum was observed in Tephrosia purpurea (110/100g of soil) belongs to Fabaceae. In the present investigation the highest AM fungal infection was recorded in Plumbago zeylanica 87%belongs to Plumbaginaceae and minimum was noticed in Striga angustifolia 24% belongs to Scrophulariaceae. The plant species like Portulaca oleracea 36% (Portulacaceae) Heliotropium scarbrum 35% (Boranginaceae), Meremiea tridenta 40% (Convolvulaceae), Evolulus alsinoides 33% and Ipomea pesti-gridis 28% belongs to (Convolvulaceae), Justicia tranubariensis 32% (Acanthaceae), Plecranthus barbatus 40% (Lamiaceae), Striga angustifolia 24% (scrophulariaceae) and the two members of Euphorbiaceae Euphorbia hirta 28%, Phyllanthus amarus 39% showed 20 to 40 % of infection. Logaprabha and Tamilselvi (2015) observed that some of the plants which were previously reported to be-non-mycorrhizal, were found to possess the mycorrhizal association. The level of AM infection markedly differed with various plants. The plant species Cynodon dactylon belongs to Poaceae member showed AM fungal colonization Sampath kumar et al. (2007). The similar findings were noticed in the present study of other species Cymbopogan citratus belongs to Poaceae member. The results was observed in the present research clearly indicated that the plants species belonging to the family Poaceae showed Arbuscular mycorrhizal fungal colonization. In this, study revealed that the rhizosphere soil samples of all the plant species the genus Glomus was predominant than other and Gigaspora occupied the second position. The present study also concluded that there is a high incidence of AM fungi in the study area. All the plant species studied were colonized by AM fungi.
Table 1. Identification of Plant species and their medicinal uses of Kondrangi hills, Dindugul district, Tamilnadu.

| S.No. | PLANT SPECIES                      | FAMILY       | PART USED | MEDICINAL USES                      |
|-------|-----------------------------------|--------------|-----------|-------------------------------------|
| 1     | Cleome monophylla L.              | Capparidaceae| Whole plant| Ulcer, Swelling                     |
| 2     | Portulaca oleracea L.             | portulacaceae| Whole plant| Heart attack, digestive problem     |
| 3     | Corchorus aestuans L.             | Tiliaceae    | Whole plant| Headache, flavouring                |
| 4     | Cissus quadrangularis L.          | Vitceae      | Stem      | Diabetes, allergies, asthma         |
| 5     | Indigofera villosa L.             | Fabaceae     | Leaf      | Snake bite, swelling, ulcer         |
| 6     | Tephrosia purpurea sensu Baker    | Fabaceae     | Whole plant| Ulcer, asthma, tumors               |
| 7     | Mollugo pentaphylla L.            | Aizoaceae    | Leaf      | Stomach pain, antacancer            |
| 8     | Borreria ocymoides (Burm.f.) DC.  | Rubiaceae    | Whole plant| Headache, wounds, eczema            |
| 9     | Oldenlandia aspera L.             | Rubiaceae    | Leaf and root| Tuberculosis, asthma, snake bites  |
| 10    | Oldenlandia umbellata Steud.      | Rubiaceae    | Whole plant| Asthma, snake bites                 |
| 11    | Plumbago zeylanica L.             | Plumbaginaceae| Whole plant| Dysentery, leucoderma, piles        |
| 12    | Pergularia daemia (Forssk.) chiov.| Asclepiadaceae| Whole plant| Leprosy, haemorrhoids, ulcer        |
| 13    | Heliotropium scabrum Retz.        | Boranginaceae| Whole plant| Blood loss, yaws, skin ulcer        |
| 14    | Merremia tridenta (L.) Hallier f. | Convolvulaceae| Whole plant| Dysentery, snake bites              |
| 15    | Evolulus alsinoides (Linn.) Linn. | Convolvulaceae| Whole plant| Syphilis, scrofula, snake bites     |
| 16    | Ipomoea pesti-gridis L.           | Convolvulaceae| Leaf      | Pimples, tumours, headache          |
| 17    | Didymocarpus tomentosa Wight      | Gesneriaceae | Leaf      | Fever, skin allergy, kidney stone   |
| 18    | Sesamum orientale L.              | Pedieaceae   | Whole plant| Diarrhoea, dysentery                |
| 19    | Barleria prionitis L.             | Acanthaceae  | Whole plant| Fever, rheumatism, jaundice         |
| 20    | Andrographis echionides (L.)      | Acanthaceae  | Whole plant| Fever, stomach-ache, dysentery      |
| 21    | Justicia trangubariensis L.f.     | Acanthaceae  | Whole plant| Fever, stomach pain                 |
| 22    | Plentranthes barbatus Andrews     | Lamiaceae    | Leaf, root| Blood pressure, digestion           |
| 23    | Leucas aspera(Willd.) Link        | Lamninaeae   | Leaf      | Fever, skin diseases                |
| 24    | Striga angustifolia (D. Don)C J Saldanha | Scrophulariaceae | Leaf and stem| Healing process, dye skins blue-black |
| 25    | Allmania nodiflora (L)R.Br.ex Wight | Amaranthaceae| Whole plant| Fever, cold, snake bites            |
| 26    | Aerva javanica (Buirm.f.) juss.ex Schult. | Amaranthaceae | Whole plant| Headache, toothache                |
| 27    | Euphorbia hirta L.                | Euphorbiaceae| Whole plant| Asthma, Fever, cold                 |
| 28    | Phyllanthus amarus Schumach & Thonn. | Euphorbiaceae| Whole plant| Jaundice, stomach pain              |
| 29    | Phyllanthus maderaspatenesis L.   | Euphorbiaceae| Whole plant| Skin, rheumatism, jaundice          |
| 30    | Gloriosa superba L.               | Liliaceae    | Whole plant| Cancer, ulcer, piles                |
| 31    | Typhonium trilobatum. schott.     | Araceae      | Tuber     | Piles, stomach pain, ulcer          |
| 32    | Cymbopogan citrates(DC) stapf,    | Poaceae      | Leaf and root| Achy joints, fever, cold           |
Table 2. AM fungal root colonization and spore population in the plant species of Kondrangi hills, Ottanchantram, Dindugul district, during August, 2017-March, 2018.

| S. No | Plant Species                        | pH   | Types of infection | Spore Population (100g/soil) | (%) of root colonization |
|-------|--------------------------------------|------|--------------------|-------------------------------|--------------------------|
| 1.    | Cleome monophylla L.                 | 5.1  | + - +              | 375                           | 45                       |
| 2.    | Portulaca oleracea L.                | 4.8  | + + -              | 260                           | 36                       |
| 3.    | Corchorus aescuans L.                | 6.8  | + - +              | 403                           | 60                       |
| 4.    | Cissus quadrangularis L.             | 5.3  | + + -              | 180                           | 55                       |
| 5.    | Indigofera villosa L.                | 5.5  | + - +              | 340                           | 53                       |
| 6.    | Tephrosia purpurea Sensu Baker       | 5.5  | + + -              | 110                           | 70                       |
| 7.    | Mollugo pentaphylla L.               | 4.8  | + - +              | 303                           | 66                       |
| 8.    | Borreria ocyoides (Burm.f.) DC.      | 5.2  | + + -              | 245                           | 46                       |
| 9.    | Oldenlandia aspera L.                | 5.9  | + - +              | 210                           | 54                       |
| 10.   | Oldenlandia umbellata Steud.         | 6.0  | + + -              | 359                           | 77                       |
| 11.   | Plumbago zeylanica L.                | 5.3  | + - +              | 390                           | 87                       |
| 12.   | Pergularia daemia (Forssk.) Chiov.   | 5.6  | + + -              | 412                           | 68                       |
| 13.   | Heliotropium scabrum Retz.           | 5.8  | + - +              | 231                           | 35                       |
| 14.   | Meremia tridenta (L.) Hallier f.     | 5.1  | + + -              | 195                           | 40                       |
| 15.   | Evolvulus alsinoides (Linn.) Linn.   | 6.3  | + - +              | 204                           | 33                       |
| 16.   | Ipomoea pestigridis L.               | 6.6  | + + -              | 365                           | 28                       |
| 17.   | Didymocarpus tomentosa Wight         | 4.5  | + - +              | 301                           | 50                       |
| 18.   | Sesamum orientale L.                 | 5.8  | + + -              | 297                           | 48                       |
| 19.   | Barleria priionitis L.               | 5.4  | + - +              | 247                           | 63                       |
| 20.   | Andrographis echinoides (L.) Nees.   | 5.7  | + + -              | 380                           | 59                       |
| 21.   | Justicia trangubariensis L. f.       | 5.9  | + - +              | 430                           | 32                       |
| 22.   | Pleranthes barbatus Andrews          | 5.1  | + - +              | 399                           | 40                       |
| 23.   | Leucas aspera(Wildl.) Link           | 5.0  | + - +              | 341                           | 69                       |
| 24.   | Striga angustifolia (D. Don) C.J.Saldanha | 6.4 | + + -              | 258                           | 24                       |
| 25.   | Allmania nodiflora (L)R.Br.ex Wight  | 6.2  | + - +              | 382                           | 57                       |
| 26.   | Aerva javanica (Burm.f.) juss. ex Schult. | 5.8 | + + -              | 304                           | 44                       |
| 27.   | Euphorbia hirta L.                   | 5.3  | + + -              | 312                           | 28                       |
| 28.   | Phyllanthus amarus Schumach & Thonn. | 5.5  | + - +              | 440                           | 39                       |
| 29.   | Phyllanthus maderaspatenesis L.      | 6.2  | + - +              | 228                           | 71                       |
| 30.   | Gloriosa superba L.                  | 6.5  | + + -              | 174                           | 42                       |
| 31.   | Typhonium trilobatum schott.         | 5.8  | + + -              | 280                           | 58                       |
| 32.   | Cymbopogan citrates (DC.) Stapf      | 5.6  | + + -              | 360                           | 61                       |
Table. 3. AM fungal genera and species were isolated from the rhizosphere soil samples of Kondrangi hills.

| S. No | AM fungal genera | Order           | Family            | Species                                      |
|-------|------------------|-----------------|-------------------|----------------------------------------------|
| 1     | *Acaulospora*    | Diversisporales | Acaulosporaceae   | *levies*                                     |
| 2     | *Claroideoglomus*| Glomerales      | Claroideoglomeraceae | *etunicatum*                                 |
| 3     | *Gigaspora*      | Diversisporales | Gigasporaceae     | *candida* and *decipiens*                     |
| 4     | *Glomus*         | Glomerales      | Glomeraceae       | *Gl.hoi, Gl.albidum, Gl. arborescences, Gl. austral, Gl. citricola, Gl. delhience, Gl. dimorphicum, Gl. favisporum, Gl. microcarpum, Gl. glomerulatum, Gl. heterosporum, Gl. macrocarpum, Gl. multisubstensum,* |
| 5     | *Rhizophagus*    | Glomerales      | Glomeraceae       | *fasciculatus*                               |
| 6     | *Sclerocystis*   | Glomerales      | Glomeraceae       | *pachycaulis*                                |
| 7     | *Redeckera*      | Diversisporales | Gigasporaceae     | *fulvum*                                     |

Fig. 2. Isolation of AM fungal spores in the rhizosphere soil samples of different plant species collected from the Kondrangi hills.

Fig. 3. AM fungal colonization in the root samples of from the plant species in Kondrangi hills.
The present study reveals that *Glomus* is the dominant AM fungal genus which seems to be dominant in the root regions of the plant species. Similar findings are in conformity that the genus *Glomus* was predominance in arid and semi-arid areas (10-13). Natalia et al. (14) reported that mycorrhizae are key components of natural ecosystems because of their essential role in sustain vegetation cover. The present study revealed that the *Allmania nodiflora* belongs to Amaranthaceae member showed 57% of arbuscular mycorrhizal colonization was observed. The present studies believed to be non mycorrhizal plants were found to be associated with AM fungi.

As far as the rhizosphere soil samples of Kondrangi hills, totally 20 AM fungal species belong to 7 genera and 2 different order (Fig. 6,7) were isolated and identified. Of these 1 species of *Acaulospora*, *Aca. levies*, 1 species of *Claroideoglomus etunicatum*, 2 species of *Gigaspora*, *Gig.* candida and *Gig.* decipiens, 13 species of *Glomus*, *G.hoi*, *Gl.albidum*, *Gl. arborescens*, *Gl. austral*, *Gl. citricola*, *Gl. delhience*, *Gl. dimorphicum*, *Gl. favisporum*, *Gl. microcarpum*, *Gl. glomerulatum*, *Gl. heterosporum*, *Gl. macrocarpum*, *Gl. multisubstensum*, 1 Species of *Sclerocystis*, *Scl. pachycaulis*, 1 Species of *Redekera fulvum*, 1 Species of *Rhizophagus fasciculatus* were observed (Table. 3; Fig. 8). Santhoshkumar and Nagarajan (15) reported that AM fungal association in the Rhizosphere soil of some Pteridophytic plant species in Valparai Hills, Western Ghats of Tamilnadu. Totally 34 AM fungal spore species was identified six genera from 12 plant species belongs to 7 families. Of these AM fungal spores of the genus *Glomus* was recorded as the most population,
followed by *Aculospora, Gigaspora, Scutellispora, Sclerocystis* and *Entrophospora* respectively.

4. CONCLUSION

The AM colonization and spore population in 32 medicinal plants species were investigated in kondrangi hills, Dindugul district, Tamilnadu. From the present findings of the research work, conclude that root colonization and spore population was abundant in all the plant species, however the genus *Glomus* was the dominant seen in all the rhizosphere soil. In this mutualistic association significance on medicinal plants, improving plant growth and also increasing secondary metabolite production, especially in agricultural crops.

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