DOI:10.26524/krj268

Kong. Res. J. 5(2): 34-40, 2018
Publisher: Kongunadu Arts and Science College, Coimbatore.

http://krjscience.com

RESEARCH ARTICLE

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. MATERIALS AND METHODS

2.1. Study area

The present research area of Kondarangi hills Keeranur is situated at Eastern Ghats of Ottanchattram (Taulk), Dindugul district, Tamilnadu, India. The altitude ranges between 10.627988°N 77.730901°E. The hill elevation 1165.86 meters (3825 Feet) m. s. l. (Fig. 1). The maximum temperature was recorded in the month of May 33^{0}C. The maximum annual rainfall ranges 800 mm. The main activity of the local people is agriculture. They depend upon wells for irrigating the lands.

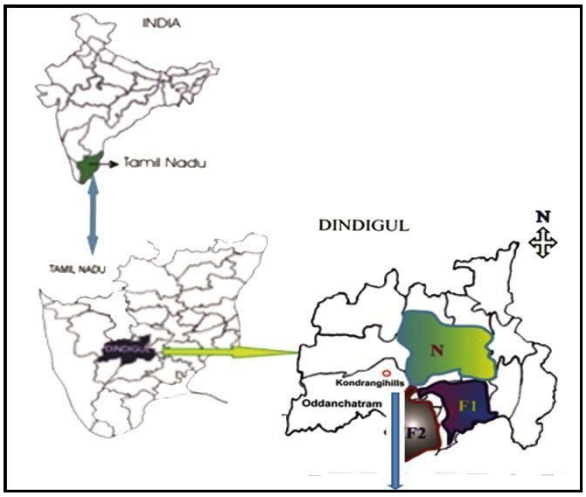

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Fig.1. View of the study area of Kondrangi hills, Dindugul district.

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 attachement, 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), *Evolvulus alsinoides* 33% and *Ipomea pesti-gridis* 28% belongs to (Convolvulaceae), *Justicia tranubariensis* 32% (Acanthaceae), *Plectranthus barbatus* 40% (Lamiaceae), *Striga angustifolia* 24% (scrophularaceae) 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	Snakebites,swelling,ulcer
6	*Tephrosia purpurea* sensu Baker	Fabaceae	Whole plant	Ulcer,asthma,tumors
7	*Mollugo pentaphylla* L.	Aizoaceae	Leaf	Stomach pain, anticancer
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	*Merremiea tridenta*(L.)Hallier f.	Convolvulaceae	Whole plant	Dysentery, snake bites
15	*Evolvulus 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.	Pedileaceae	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	Laminaceae	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* (Burm.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
			Hyphae	Arbuscule	Vesicle		
1.	*Cleome monophylla* L.	5.1	+	-	+	375	45
2.	*Portulaca oleracea* L.	4.8	+	+	--	260	36
3.	*Corchorus aestuans* L.	6.8	+	-	+	403	60
4.	*Cissus quadrangularis* L.	5.3	+	+	-	180	55
5.	*Indigofera villosa* L.	6.4	+	-	+	340	53
6.	*Tephrosia purpurea* Sensu Baker	5.5	+	+	-	110	70
7.	*Mollugo pentaphylla* L.	4.8	+	-	+	303	66
8.	*Borreria ocymoides* (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.	*Meremiea 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 prionitis* L.	5.4	+	-	+	247	63
20.	*Andrographis echionides* (L.) Nees.	5.7	+	+	-	380	59
21.	*Justicia trangubariensis* L. f.	5.9	+	-	+	430	32
22.	*Plentranthes barbatus* Andrews	5.1	+	-	+	399	40
23.	*Leucas aspera*(Willd.) 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. arborences*, *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*

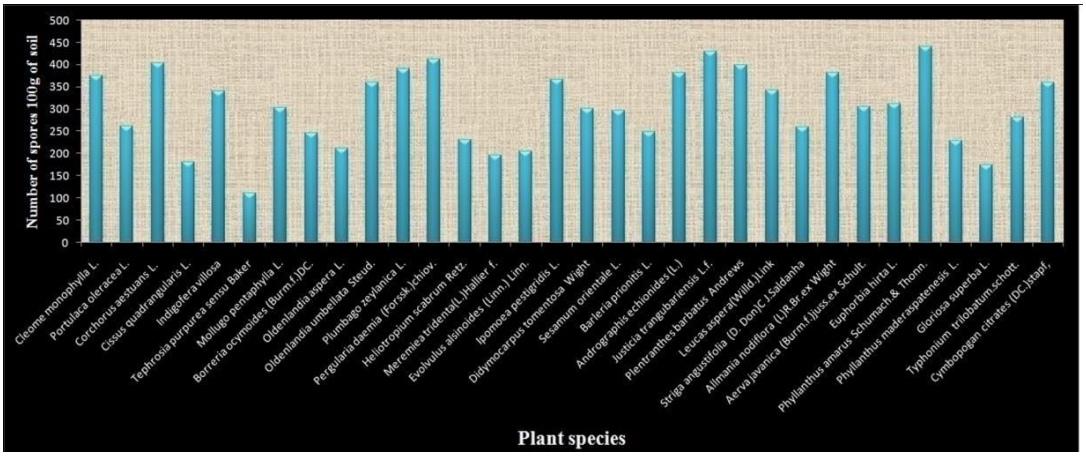

Fig. 2. Isolation of AM fungal spores in the rhizosphere soil samples of different plant species collected from the Kondrangi hills.

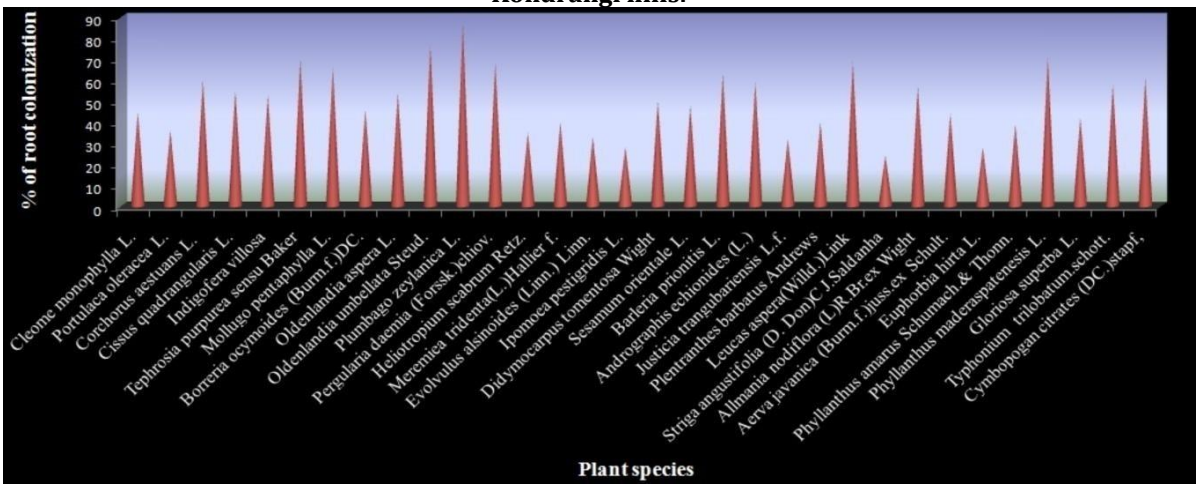

Fig. 3. AM fungal colonization in the root samples of from the plant species in Kondrangi hills.

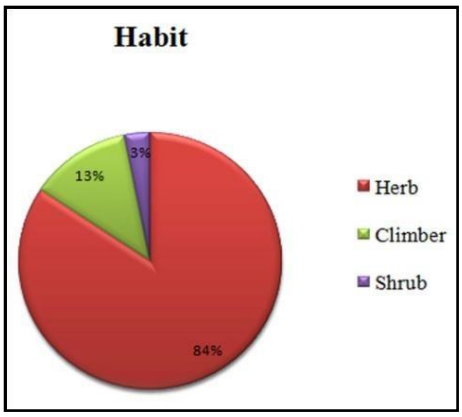

Fig. 4. Habit of the plant species

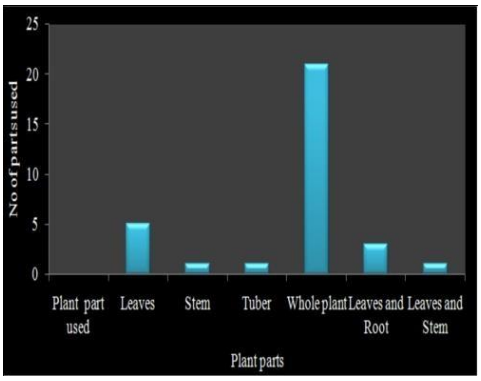

Fig. 5. Plant part used in collected plant species

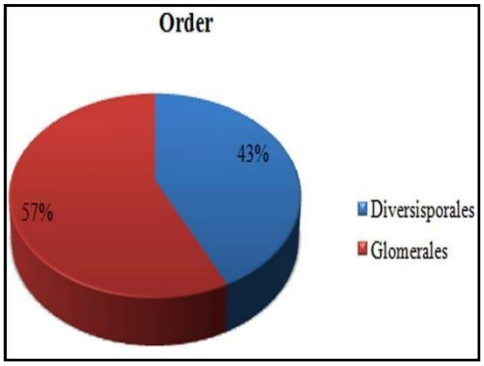

Fig. 6. Order wise distribution AM fungal species

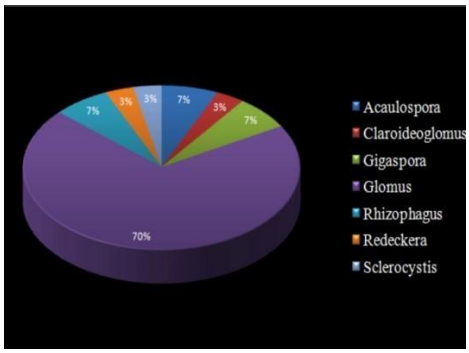

Fig.7. Dominant AM fungal species in rhizosphere soil samples

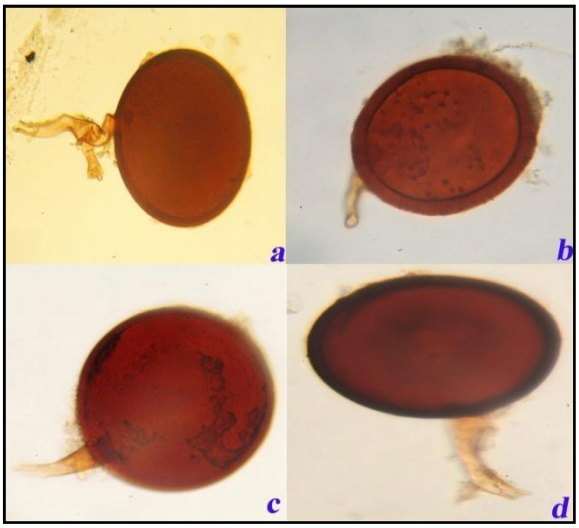

Fig. 8. Isolation and identification AM fungal species from the rhizosphere soil samples in collected plant species

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, Gl.hoi, Gl.albidum*, *Gl*. *arborences*, *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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