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RESEARCH ARTICLE

STUDIES ON THE ARBUSCULAR MYCORRHIZAL FUNGAL DIVERSITY OF SELECTED MEDICINAL PLANT SPECIES FROM KODIKUTHIMALA, MALAPPURAM, KERALA

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ABSTRACT

The present investigation has brought out the AM fungal association in some plant species of Kodikuthimala, Malappuram district Kerala. Totally, 25 plant species belongs to 15 families were analyzed for arbuscular mycorrhizal association. The root samples of all collected plant species showed mycorrhizal infection. The percentage of colonization was varied with plant species and it ranges from 12 (*Commelina benghalensis*) to 79% (*Sida rhombifolia*). Maximum spore population was observed in *Gloriosa superba* (574/100g of soil) and minimum in *Euphorbia hirta* (143/10g of soil). Totally 26 AM fungal species belongs to 13 genera were found. Among this *Glomus* was most dominated. In most of the plants, spores of *Rhizophagus fasciculatus* are seen. Present study confirms the Arbuscular Mycorrhizal association in the collected plant species.

Keywords: AM fungal, Spore population, Colonization, *Glomus, Rhizophagus fasciculatus.*

1. INTRODUCTION

Mycorrhizae, which are a key soil microbial component and known to play an important role in reclamation and revegetation of such, degraded ecosystems (1). They also detoxify certain soil toxins thereby enable seedlings to withstand extreme nutrient absorption capacity of plants (2, 3). Over 80% of terrestrial plants are able to associate symbiotically which mycorrhizal fungi and this usually results in positive plant growth response (4). Mutual nutrient transfer between the fungus and plant provides the plant with phosphate and micronutrients such as copper and zinc and the fungus with carbon- based compounds. The most common form of symbiosis involves arbuscular mycorrhizal (AM) fungi, which form two major structural classes of mycorrhizae with different host plants. In AM fungi, arbuscules are considered the major site of nutrient transfer to the plant (5, 6).

AM Fung can efficiency absorbs mineral nutrients from the soil and delivers them to their host plants in exchange for carbohydrates and it also enhance tolerance of or resistance to root pathogens. Vascular plants host a great variety of fungi. In additions to being susceptible to soil- borne pathogens, plant roots are also colonized by non-pathogenic or mutualistic fungi like arbuscular mycorrhizae (AM), ectomycorrhizae (EM) and dark septate endophytes (DSE). A vast majority of terrestrial plant species are mycorrhizal associations. The AM fungi are associated with most herbaceous plants and with various woody plant families, while the EM fungi are confined chiefly to a limited number of woody plant families. It is now evident that the mycorrhizal fungi have many significant functions in ecosystems (7). Therefore, the present study aims to Enumeration of the arbuscular mycorrhizal fungal species in the rhizosphere soil samples of the plant species in Kodikuthimala, Malapuram district, Kerala.

2. MATERIALS AND METHODS

2.1. Study area

Kodikuthimala is located at 32 km from Malappuram at the Latitude: 10.9802 and Longitude: 76.2917. Kodikuthimala has a watch tower that is popular with tourists visiting this serene place because of the vantage point it offers. British hoisted their flag on this hilltop during survey, thus getting the name Kodikuthimala. This place is noted for its various kinds of medicinal plants and ever flowering springs (Fig. 1). This city has a tropical climate. During most months of the year, there is significant rainfall in Kodikuthimala. There is only a short dry season. The average annual temperature in Kodikuthimala is 27.7°c in a year and the average rainfall is 2500 mm (Table 1).

2.2. Sample collection

Totally 40 plant species belonging to the 28 families were collected from Kodikuthimala, Malappuram, Keralain the period of 2016. Root samples and rhizosphere soil samples of plant species growing in and around areas of Kodikuthimala were collected. The root and soil

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samples were transported to the laboratory immediately after collection.

2.3. Root samples

Root samples, 5-15 cm long, were collected from the plant species during 2016 to 2017. During collection, care was taken to ascertain individual plants for which roots could positively identified as belonging to a particular plant species. For identification and nomenclature of the plant species the following manual was used (8, 9).

2.4. Soil samples

The rhizosphere soils, dug up to a depth of 10 cm, were collected from each plant species after removing the surface of the soil and litter covering. These samples were kept in sterilized bags and were transported to the laboratory immediately after collection for the examination of arbuscular mycorrhizal fungal spore isolation.

2.5. Soil pH

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

2.6. Estimation of arbuscular mycorrhizal colonization in roots

2.6.1. Sample preservation

In the laboratory, the roots were separated from the soil by wet sieving. The roots were washed with water and processed a fresh whenever possible. Otherwise the washed roots were fixed in formaldehyde-acetic acid-ethanol (FAA) solution (90:5:5 V/N) modified method of Phillips and Hayman (10). The soil sample was air dried and stored at 4°C until processed. Each soil samples was used for chemical analysis, spore counts and classification in to various types and multiplication, concentration and separation of AM fungal spore for identification.

2.6.2. Evaluation of AM infection

The root samples were cleared and stained in tryphan blue with a modified version of the Phillips and Hayman's (10) method. Roots were cut in to 1-2 pieces, heated at 90°C 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 0.05% tryphan blue in lacto phenol for 5 minutes and the excess stain was removed with clear lacto phenol.

The pigmented roots were heated at 90°C in 10% KOH for 2 hours, washed with fresh 10% KOH and immersed in an alkaline solution of H_2O_2 for 30 minutes at 25°C until bleached. They were rinsed thoroughly with water to remove the H_2O_2, acidified in dilute HCl and stained as described earlier. In some cases the modified method of Merryweather and Fitter (11) was followed where autoclaving and bleaching with H_2O_2, were omitted. In a few cases, direct observation of unstained, fresh and intact roots (12) was made.

Arbuscular mycorrhizal infection in the roots was assessed following the grid line-intersect method of Giovannetti and Mosse (13). The stained root pieces were spread out evenly on a square plastic Petridish (10.2 x 10 cm). A grid of lines was marked on the bottom of the dish to form 1 cm inch squares. Vertical and horizontal gridlines were scanned under a dissecting microscope and the presence of infection was recorded at each point where the roots intersected a line. Four sets of observation were made, recording 100, 200, 300 and all the root gridline intersects. Each of the three replicates records was made on a fresh rearrangement of the same root sample.

The percentage of AM infection was calculated using the formula:

$$\text{Percentage of infection} = \frac{\text{No. of root segments infected}}{\text{Total No. of root segments observed}} \times 100$$

When sufficient root pieces are not available, the slide method Giovannetti and Mosse (1980) was followed. Root pieces, 1 cm long, were selected at random from a stained sample and mounted on microscope slide groups of 10. Presence of infection was recorded in each of the 10 pieces and present infection was calculated. To observe hyphae, vesicles and arbuscles under light microscope, the root pieces were mounted on glass slides either temporarily in lacto phenol. The cover slip was pressed gently to make the roots flattened and sealed with DPX medium.

2.6.3. Isolation of arbuscular mycorrhizal spores from the soil samples

Spores were recovered from the soil samples by the wet-sieving and decanting method (14). From each soil sample, 100 g of soil was taken and mixed with 1:1 of warm water in a large beaker until all the aggregates dispersed to leave a uniform suspension. Heavier particles were allowed to settle down. To remove organic matter and roots, the suspension was decanted through a 710 µm sieve. The suspension that passed through 710 µm was decanted 425 µm, 250 µm, 150 µm, 75 µm and 45 µm sieves consecutively. The residues in the respective sieve were collected in petridishes with about 10-20 mL water observed under a dissecting microscope for AM fungal spores. The total spore count was calculated by counting the spores. Then the spores were separated using a glass pipette and segregated. The spore were mounted on clear glass slides using lacto phenol or polyvinyl alcohol lacto phenol (PVL), covered with cover slips and sealed with DPX medium.

2.6.4. Identification of AM fungi

Based upon microscopic characters, the AM fungal spores were identified. For identification and nomenclature, keys of the following manual authors were used: Raman and Mohankumar (15), Schenk and Perez (16) and Redecker *et al.*, (17). Classification on based on color, size, shape, surface, structure, general nature of the spore contents and hyphal attachment. Photomicrographs were taken with the help of a Magnus Olympus Microscope.

3. RESULTS

AM fungal infection and spore population of 40 plant species belongs to 28 families present in the Table 2 to 4 and pH of the rhizosphere soil samples present in the Table 3 was 4 to 5.8. In the present study, totally 14 AM fungal species belongs to 7 genre were identified. Where the *Glomus* (4) was dominate genus followed by *Gigaspora* (3),*Acaulospora* (2), *Ambispora* (2), *Claroideoglomus* (1), *Rhizophagus* (1) and *Scutellospora* (1). Moreover the *Rhizophagus fasciculatus* was the most frequently abundant species in the study area (Table 4).

Table 1. Temperature and rain fall data of Kodikuthimala, Malappuram, District, during the September 2016 to March 2017.

Year	Month	Temperature(0°C)		Rainfall (mm)	Humidity (%)
		Maximum	Minimum		
2016	September	29.5	24.0	253.2	84
	October	30.6	24.0	280.8	81
	November	31.3	23.6	68.6	77
	December	31.6	22.7	82.7	74
2017	January	31.9	22.9	19.4	67
	February	32.2	23.3	7.8	71
	March	33.1	24.9	1.5	74

Table 2. AM Fungal spore population and root colonization of plants species in Kodikuthimala,

S. No.	Plant name	Family	Habits	Soil pH	Type of colonization	% of root colonization	Spore population/ 100g of soil
1	*Abrus precatorius* L.	Leguminosae	Climber	4.5	HV	58	693
2	*Abutilon indicum* D.gon.	Malvaceae	Shrub	5.5	HA	44	279
3	*Alysicarpus monilifer* (L.) DC.	Fabaceae	Herb	4.2	H A	66	437
4	*Anisomeles malabarica* R.br.	Lamiaceae	Shrub	5.4	HV	36	435
5	*Asparagus racemosus* Willd	Asparagaceae	Climber	4.2	H	27	332
6	*Borreria hispida* (L.) K.Schum.	Rubiaceae	Herb	4.9	HV	35	284
7	*Calotropis procera* (Aiton) W.T.Aiton	Asclepiadaceae	Tree	5.7	H	29	332
8	*Canavalia gladiata*W&A.	Papilionaceae	Climber	4.3	HV	42	354
9	*Cardiospermum halicacabum* L.	Sapindaceae	Climber	5.6	HA	47	372
10	*Chrysopogon zizanioides* (L.) Roberty.	Poaceae	Herb	4.7	HA	56	467
11	*Cissus vitiginea* L.	Vitaceae	Climber	4.1	HV	44	366
12	*Cleome aspera* Koenig ex DC.	Capparidaceae	Herb	4.2	HV	27	241
13	*Cleome monophylla* L.	Capparidaceae	Herb	5.3	HV	22	385
14	*Commelina benghalensis* L.	Commelinaceae	Herb	4.7	H	12	180
15	*Crotalaria pallida* Aiton.	Fabaceae	Shrub	4.1	H	75	274
16	*Euphorbia hirta* L.	Euphorbiaceae	Herb	4.8	HV	13	147
	Evolvulus alsinoides L.	Convolvulaceae			H	26	293

17			Herb	4.7			
18	*Gloriosa superba* L.	Lilliaceae	Climber	5.6	HV	48	574
19	*Hemidesmus indicus* (L.) R.Br.	Asclepiadaceae	Climber	4.8	H	25	329
20	*Hybanthus enneaspermus* (L.) F.Muell.	Violaceae	Herb	5.2	H	24	381
21	*Hyptis suaveolens* (L.) Poit.	Lamiaceae	Shrub	5.8	HV	47	472
22	*Indigofera uniflora* Roxb.	Fabaceae	Herb	4.4	HA	55	382
23	*Kyllinga alba* Nees.	Cyperaceae	Herb	4.9	-	-	180
24	*Lindernia ciliata* (Colsm.) Pennell.	Scrophulariaceae	Herb	5.4	H	14	173
25	*Lindernia parviflora* (Roxb.) Haines.	Scrophulariaceae	Herb	5.6	HV	15	285
26	*Mimosa pudica* L.	Mimosaceae	Herb	5.4	HV	33	247
27	*Mukia maderaspatana* (L.) Roem	Cucurbitaceae	Climber	4.8	HV	62	542
28	*Ocimum gratissimum* Linn.	Lamiaceae	Shrub	5.2	HV	45	473
29	*Oldenlandia biflora* L.	Rubiaceae	Herb	5.8	HV	34	312
30	*Passiflora foetida* L.	Passifloraceae	Climber	4.6	H	27	189
31	*Phyllanthus maderaspatensis* L.	Euphorbiaceae	Herb	5.8	H	21	473
32	*Plectranthus barbatus* Andrews.	Lamiaceae	Herb	4.7	HV	48	389
33	*Rauwolfia serpentina* (L.) Benth. ex Kurz	Apocynaceae	Herb	4.2	HV	31	431
34	*Sida rhombifolia* L.	Malvaceae	Shrub	5.5	HV	79	573
35	*Solanum xanthocarpum* Schrad. & H. Wendl.	Solanaceae	Herb	5.4	H	32	412
36	*Spillanthes calva* DC.	Asteraceae	Herb	5.2	HV	32	352
37	*Stachytarpheta jamaicensis* (L.) Vahl.	Verbenaceae	Sub-shrub	5.4	H	26	441
38	*Stachytarpheta urticifolia* (Salisb.) Sims.	Verbenaceae	Shrub	5.8	H	18	249
39	*Wattakaka volubilis* (L. fil.) Stapf.	Asclepiadaceae	Climber	4.6	HV	34	285
40	*Ziziphus oenoplia* (L.) Miller.	Rhamnaceae	Climber	5.1	HV	39	378

H- hyphae, A- Arbuscules, V- Vescicle, + - Present, - - Absent

Table 3. Distribution of AM fungal spores different plant species.

S. No.	Plant name	Family	AM Fugal species
1	*Abrus precatorius* L.	Leguminosae	*Acaulospora alpine, Gigaspora albida, Glomus arborense, Rhizophagus fasciculatus*
2	*Abutilon indicum* D.gon.	Malvaceae	*Acaulospora tuberculata, Funneliformis coronatum, Glomus canadense, Rhizophagus fasciculatus*
3	*Alysicarpus monilifer* (L.) DC.	Fabaceae	*Acaulospora alpine, Claroideoglomus claroideum, Glomus albidum, Rhizophagus fasciculatus, Scutellospora striata*
4	*Anisomeles malabarica* R.br.	Lamiaceae	*Acaulospora foveat, Dentiscutata erythropus, Gigaspora ramisporophora, Scutellispora* spp
5	*Asparagus racemosus* Willd	Asparagaceae	*Archaeospora trappei, Dentiscutata erythropus, Glomus canadense, Rhizophagus fasciculatus*
6	*Borreria hispida* (L.) K.Schum.	Rubiaceae	*Acaulospora tuberculata, Claroideoglomus claroideum, Gigaspora albida, Scutellospora striata*
7	*Calotropis procera* (Aiton) W.T.Aiton	Asclepiadaceae	*Archaeospora trappei, Diversispora arenaria, Gigaspora decipiens, Glomus multicaule*
8	*Canavalia gladiata*W&A.	Papilionaceae	*Archaeospora trappei, Diversispora arenaria, Gigaspora decipiens, Rhizophagus fasciculatus*

9	*Cardiospermum halicacabum* L.	Sapindaceae	*Archaeospora trappei, Claroideoglomus claroideum, Glomus ambisporum*
10	*Chrysopogon zizanioides* (L.) Roberty.	Poaceae	*Claroideoglomus claroideum, Dentiscutata erythropus, Glomus 11canadense*
11	*Cissus vitiginea* L.	Vitaceae	*Acaulospora alpine, Dentiscutata erythropus, Glomus ambisporum, Rhizophagus fasciculatus, Scutellospora savannicola*
12	*Cleome aspera* Koenig ex DC.	Cleomaceae	*Acaulospora tuberculata, Diversispora arenaria, Glomus albidum, Glomus globiferum, Rhizophagus fasciculatus*
13	*Cleome monophylla* L.	Cleomaceae	*Acaulospora foveat, Diversispora arenaria, Gigaspora decipiens*, *Glomus multicaule*, *Scutellospora striata*
14	*Commelina benghalensis* L.	Commelinaceae	*Ambispora callosa, Diversispora celata, Glomus ambisporum, Rhizophagus fasciculatus, Scutellospora savannicola*
15	*Crotalaria pallida* Aiton.	Fabaceae	*Acaulospora undulate, Diversispora celata, Glomus albidum, Glomus globiferum*
16	*Euphorbia hirta* L.	Euphorbiaceae	*Acaulospora alpine, Entrophospora infrequens, Glomus ambisporum, Pacispora scintillans, Rhizophagus fasciculatus*
17	*Evolvulus alsinoides* L.	Convolvulaceae	*Acaulospora foveat, Diversispora arenaria, Gigaspora decipiens*, *Glomus multicaule, Rhizophagus fasciculatus*
18	*Gloriosa superba* L.	Lilliaceae	*Acaulospora foveat, Claroideoglomus claroideum, Glomus ambisporum, Rhizophagus fasciculatus*
19	*Hemidesmus indicus* (L.) R.Br.	Asclepiadaceae	*Acaulospora alpine, Dentiscutata erythropus, Glomus albidum, Glomus globiferum*
20	*Hybanthus enneaspermus* (L.) F.Muell.	Violaceae	*Ambispora callosa, Diversispora arenaria, Glomus albidum, Glomus arborense*
21	*Hyptis suaveolens* (L.) Poit.	Lamiaceae	*Acaulospora undulate, Diversispora celata, Gigaspora albida, Rhizophagus fasciculatus, Scutellospora savannicola*
22	*Indigofera uniflora* Roxb.	Fabaceae	*Ambispora callosa, Diversispora arenaria, Gigaspora albida, Glomus arborense*
23	*Kyllinga alba* Nees.	Cyperaceae	*Acaulospora tuberculata, Entrophospora infrequens, Glomus albidum, Rhizophagus fasciculatus*
24	*Lindernia ciliata* (Colsm.) Pennell.	Linderniaceae	*Ambispora callosa, Claroideoglomus claroideum, Gigaspora ramisporophora*
25	*Lindernia parviflora* (Roxb.) Haines.	Linderniaceae	*Acaulospora alpine, Diversispora celata, Glomus albidum, Glomus arborense*
26	*Mimosa pudica* L.	Mimosaceae	*Acaulospora tuberculata, Claroideoglomus claroideum, Glomus globiferum, Scutellispora* spp
27	*Mukia maderaspatana* (L.) Roem	Cucurbitaceae	*Claroideoglomus claroideum, Funneliformis coronatum, Glomus ambisporum*
28	*Ocimum gratissimum* Linn.	Lamiaceae	*Acaulospora alpine, Dentiscutata erythropus, Glomus albidum, Rhizophagus fasciculatus*
29	*Oldenlandia biflora* L.	Rubiaceae	*Acaulospora undulate, Diversispora arenaria, Gigaspora albida, Glomus ambisporum, Rhizophagus fasciculatu, Scutellospora savannicola*
30	*Passiflora foetida* L.	Passifloraceae	*Acaulospora undulate, Claroideoglomus claroideum, Glomus albidum, Rhizophagus fasciculatus, Scutellospora savannicola*
31	*Phyllanthus maderaspatensis* L.	Euphorbiaceae	*Ambispora callosa, Claroideoglomus claroideum, Glomus albidum, Pacispora scintillans, Rhizophagus fasciculatus*
32	*Plectranthus barbatus* Andrews.	Lamiaceae	*Archaeospora trappei, Gigaspora albida, Gigaspora decipiens, Glomus globiferum, Rhizophagus fasciculatus*
33	*Rauwolfia serpentina* (L.)	Apocynaceae	*Claroideoglomus claroideum, Diversispora arenaria, Glomus canadense, Glomus multicaule*

	Benth. ex Kurz		
34	*Sida rhombifolia* L.	Malvaceae	*Acaulospora foveat, Entrophospora infrequens, Glomus albidum, Glomus multicaule, Rhizophagus fasciculatus*
35	*Solanum xanthocarpum* Schrad. & H. Wendl.	Solanaceae	*Acaulospora undulate, Claroideoglomus claroideum, Glomus ambisporum, Rhizophagus fasciculatus*
36	*Spillanthes calva* DC.	Asteraceae	*Archaeospora trappei, Claroideoglomus claroideum, Glomus albidum*
37	*Stachytarpheta jamaicensis* (L.) Vahl.	Verbenaceae	*Acaulospora undulate, Funneliformis coronatum, Glomus arborense*
38	*Stachytarpheta urticifolia* (Salisb.) Sims.	Verbenaceae	*Claroideoglomus claroideum, Funneliformis coronatum, Gigaspora ramisporophora, Rhizophagus fasciculatus*
39	*Wattakaka volubilis* (L. fil.) Stapf.	Asclepiadaceae	*Archaeospora trappei, Entrophospora infrequens, Glomus arborense, Rhizophagus fasciculatus*
40	*Ziziphus oenoplia* (L.) Miller.	Rhamnaceae	*Ambispora callosa, Dentiscutata erythropus, Glomus arborense,*

Table 4. AM fungal spore species diversity, Kodikuthimala, Malappuram District.

S. No.	Genus Name	Species Name
1	*Acaulospora*	*alpine, foveat, tuberculata, undulate*
2	*Ambispora*	*callosa*
3	*Archaeospora*	*trappei*
4	*Claroideoglomus*	*claroideum*
5	*Dentiscutata*	*erythropus*
6	*Diversispora*	*arenaria, celata*
7	*Entrophospora*	*infrequens*
8	*Funneliformis*	*coronatum*
9	*Gigaspora*	*albida, decipiens, ramisporophora*
10	*Glomus*	*albidum, ambisporum, arborense, canadense, globiferum, multicaule,*
11	*Pacispora*	*scintillans*
12	*Rhizophagus*	*fasciculatus*
13	*Scutellispora*	*savannicola, striata, spp*

Fig. 1. The map showing the study area.

The total number of 40 plant species belongs to 28 families were examined for AM fungal spore populations and colonization (Table 3 and 4). Of these, maximum spore population was recorded in the plant species of *Gloriosa superba* (574/100g of soil) belongs to the family Liliaceae and minimum spore population was noticed in the plant species of *Euphorbia hirta* belongs to Euphorbiaceae. The highest AM fungal infection was found in the roots of *Sida rhombifloia* (79%) belongs to Malvaceae and minimum infection was occurred in the plant species *Commelina benghalensis* (12%) belongs to Commelinaceae.

The plant species like *Cleome aspera* (27%) and *Cleome monophylla* belongs to the family Cleomaceae, *Euphorbia hirta* (13%), Euphorbiaceae, *Evolvulus alsinoides* (26%), Convolvulaceae, *Hybanthus enneaspermus* (24%), Violaceae, *Lindernia ciliate*(14%), *L.parviflora* (15%), Linderniaceae, *Phylllanthus maderaspatensis* (21%), Euphorbiaceae, *Stachytarpheta jamaicensis* (26%), *S.*

urticifolia, Verbenaceae, *Passiflora foetida* (27%), Passifloraceae, *Hemidesmus indicus* (25%), Apocynaceae, *Asparagus racemosus* (27%), *Calotropis procera* (29%), Asparagaceae, *Stachytarpheta urticifolia* (18%), Verbenaceae, showed 10 to less than 30% of AM fungal infection.

The other plant species like *Borreria hispida* (35%), Rubiaceae,*Oldenlandia biflora* (34%), Rubiaceae, *Wattakaka volubilis* (34%), Asclepiadaceae, *Zizypus oenoplia* (39%), Rhambaceae, *Mimosa pudica* (33%), Mimosoideae, *Rauwolfia serpentina* (31%), Apocynaceae, *Solanum xanthocarpum* (32%), Solanaceae,*Anisomeles malabarica* (36%), Lamiaceae showed 30 to less than 40% of infection.

The other species *Hyptis suaveolens* (47%) Lamiaceae, *Indigofera uniflora* (55%), Fabaceae,*Plectrantus barbatus* (48%), Lamiaceae, *Cardiospermum halicacabum* (47%), Sapindaceae, *Cissus vitiginea* (44%), Vitaceae, *Ocimum gratissimum* (45%), Lamiaceae, *Canavalia gladiate* (42%), Papilionoideae, Cucurbitacae, *Chrysopogon zizanioides* (56%), Poaceae*, Abutilon indicum* (44%), Malvaceae showed 40 to less than 60% of AM fungal infection. The rest of the species like *Alysicarpus monilifer* (66%), *Crotalaria pallida* (75%), both the species belongs to Fabaceae, *Sida rhombifolia* (79%), Malvaceae, *Mukia madraspatana* (62%), Cucurbitaceae, *Abrus precatorius* (66%), Fabaceae showed 60 to less than 80% of AM fungal infection.

In the present study, all the plants were examined form the study area have significantly influenced by AM fungal. Where, the plants were successfully surveyed by these fungal through their contribution in the plant community.

4. DISCUSSION

Vesicular-arbuscular mycorrhizal (VAM) association with plants is widely distributed and it is geographically ubiquitous. In the present investigation all tree species were found to have mycorrhizal association. Microscopic observation of root segments revealed the presence of AM fungal structures ramified by extra-matrical hyphae and intracellular infestation of angular thick-walled hyphae. AM fungi have a potential importance in the recovery of disturbed lands and can be used in wasteland or semi-arid land could be improved by incorporating AM fungi. The variation in the intensity of root colonization and sporulation due to varieties and AM fungi recorded in the present study must be on the basis of host-symbiont specificity. In the present investigation, there was a change in AM spore number and infection in all the plant species. Others have also reported similar changes in different constituents of microbial population (18, 19). Priya (20) showed that the activity of soil mycorrhizal population was greatly affected by soil pH, temperature and moisture.

In the present study the Cyperaceae family *Kyllinga alba* not infected by Arbuscular mycorrhizal infection. In contrast *Cyperus conglomerathus, Cyperus rotundus* both the species were found to be mycorrhizal (21). These findings are quite in line with the findings of Muthukumar and Udaiyan (22), Harikumar (23), Silva *et al.,* (24). The probability of mycorrhizal colonization increases with the increase of soil pH because the availability of nutrients decreased with increasing pH (25). Chaudhry *et al.* (21) find out the AM fungal infection in the Poaceae members, particularly *Cympopogon jwarancusa* in an aromatic grass showed highest number of AMF species. The present study also revealed that the Poaceae member *Chrysopogon zizanoides* showed 56% of AM fungal infection. Most of the plant species in tropical rain forests and the members of Leguminosae sub families Papilonaceae and Mimosaceae form AM symbiosis (26). The same result was obtained in the present findings.

The present investigation of the AM fungal diversity in this study area, the tractability and ecological importance of mycorrhizal systems makes them ideal models to test and develop biodiversity in this study area. Consequently, recent studies have focused on the different functions of AM Fungal and their roles in ecosystem functioning. Hence, there is a new need of ecological concepts in AM Fungal community to increasing productivity and fitness of plants in ecosystems.

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