AM FUNGAL DIVERSITY IN THE PLANT COMMUNITY OF VELLIANGIRI HILLS, WESTERN GHATS, COIMBATORE

Muthuraj, K., H. Abdul Kaffoor, A. Venkatachalapathi, K.T. Siva Priya, E. Krishnan and N. Nagarajan*
Department of Botany, Kongunadu Arts and Science College (Autonomous), Coimbatore - 641 029, Tamil Nadu, India

ABSTRACT
The ecological mechanisms of AM fungal diversity ensure successful management for conservation and restoration of natural ecosystems. Here the study contacted to estimate the diversity of AM fungal and their function in Velliangiri hills, Western Ghats, Coimbatore. The community structure of AM fungi, as determined by number of spores present in 100g of soil, varied with sampling time in plant community. And all so the morphological identification was done by microscopic characters. Soil properties like pH, macro and micro nutrient and the climate data were collected for all tree years to know their impact on fungal community. The overall result conform the root colonization and spore population were higher in winter season and also lower in rainy. Totally 30 AM fungal species from 10 genera were identified the important genera were Acaulospora, Ambispora, Claroideoglomus, Funneliformis, Gigaspora, Glomus, Racocetra, Redeckera, Rhizophagus and Scutellospora. Among these five genera, Glomus occurred most frequently. In general, Rhizophagus fasciculatus was found to be most abundant species. Consequently, this result conform the rich diversity in the study area. This symbiotic relationship had important roles in establishment of plant community of this area.

Keywords: Arbuscular Mycorrhizal Fungi, Diversity, Velliangiri hills.

1. INTRODUCTION
There are many groups of fungi can establish associations with roots for facilitate plant growth and increase stress tolerance. Plants associated with mycobiota comprise taxonomically diverse, particularly mycorrhizal symbioses are extensively described due to the important role in improving plant nutrition and stress tolerance (1). AM fungi are integral components of most terrestrial ecosystems, with complex interactions between plants and production of glomalin (AM Fungal hyphal glycoprotein) may play a vital role in soil aggregation (2). The AM Fungal are essential for the function of ecosystems by the influence in plant diversity patterns in a variety of ecosystems. Where the mycelial network of AM fungi extends greatly increases the surface area for the uptake of immobile nutrients and they build up the macroporous structure in soil that allows penetration of water and air and thereby prevents erosion. They have great potential in the restoration of disturbed land and low fertility soil (3).

Mycorrhizal fungi usually enhance overall plant performance such as seed germination, early plant establishment, crucial steps in plant cycles and increased reproductive output (4). Moreover, the importance of mycorrhiza and the possibilities of its practical application strengthen the need for identification and cultivation of mycorrhizal fungi of natural plants (5). There is not enough focus on the mycorrhizal association with medicinal plants. Their species in different ecosystems are affected by edaphic factors, so it is necessary to investigate the spatial distribution and colonization of AM fungi in medicinal plants (6). Hence, in the present study contacted to estimate the diversity of AM fungal and their function in Velliangiri hills of Western Ghats.

2. MATERIALS AND METHODS
2.1. Study area
The Velliangiri hills from a major hill range in Western Ghats and a part of Nilgiri Biosphere Reserve of southern Western Ghats of Coimbatore district at a distance of 40 km. The geographical position between the longitude 6°-40’ and 7°-10’ and E latitude 10°-55’ and 11°N with the altitudinal range having the altitude 1840 ms above msl. The boundary of Velliangiri hills is Palghat district of Kerala at western side, Nilgiri mountains at northern side, Siruvani hills at the south and plains of Coimbatore district of eastern side (Fig. 1 & 2).

2.2. Sample collection
Root samples and rhizosphere soil samples of 25 plant species growing in area of Velliangiri hills were collected in all three different seasons in the period of January, 2013 to December, 2015. For identification and nomenclature of the plant species...
the following manual was used (7). The root and soil samples were transported to the laboratory immediately after collection. The roots were fixed in formaldehyde-acetic acidethanol (FAA) solution for further process (8). The soil sample was air dried and stored at 40°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.

2.3. Soil analysis and climate data

The soil factors, texture, macro and micro nutrients were estimated by the following methods such as soil pH, EC (9), OC (10), available N, available P (11) and available K and the micro nutrient (Zn, Cu, Fe and Mn) (12). The climate date of the study area was collected from the Tamil Nadu Agricultural University, Coimbatore, India.

2.4. Evaluation of AM infection

The root samples were cleared and stained in tryphan blue with a modified version of the Phillips and Hayman’s (8) method, in some cases, the modified method of Merryweather and Fitter (13) and Arias et al. (14). Arbuscular mycorrhizal infection in the roots was assessed following the grid line-intersect and the slide methods of Giovannetti and Mosse (15).

2.5. Isolation of Arbuscular Mycorrhizal Spores from the soil samples

Spores were recovered from the soil samples by the wet sieving and decanting method (16). 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 (17), Schenk and Perez (18), Redecker et al. (19) and Schubler and Walker (20). 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

The study purpose was to isolate the diversity and function of AM Fungi associated with some medicinal plants located in Velliangiri hills. The infection and spread of AM fungal genera as influenced by as climatic and edaphic factors. The results relate to influence of soil properties and climatic variations on the AM fungal associations in medicinal plant. As well as the monthly rain fall, temperature and relative humidity of Velliangiri hills from January, 2013 to December, 2015 were presenting in Table 1. The soils were sandy loam, non-calcareous and black in nature (Table 2). The soil physical factors such as soil pH, electric conductivity and organic carbon were reported in the Table 2. The soil pH was recorded 7.19 to 7.1 in the all seasons of three years, whereas electric conductivity was recorded in between 0.39 to 0.34 d sm-2. Likely, the organic carbon was noted in between 0.86 to 0.81 % in the vegetation zones in all seasons of tree years. Whereas, the detailed records of the macro and micro nutrients were given in the Table 3.

Totally in Velliangiri hills, 30 AM fungal species in the 10 genera were isolated and identified (Table 4). The important genera were identified as Acaulospora, Ambispora, Claroideoglomus, Funneliformis, Gigaspora, Glomus, Racocetra, Redeckera, Rhizophagus, and Scutellospora. Among these five genera, Glomus occurred most frequently. In general, Rhizophagus fasciculatus was found to be most abundant species. In winter season, Crotalaria barbata (47%), Plectranthus fruticosus (88%) and Crotalaria albida (66%) were noted higher percentage of root colonization and Begonia malabarica (12%), Abutilon hirtum (8%) Piper longum and Begonia malabarica (8%) were found as lower infected plant roots. In summer, the higher root infection were found in Crotalaria albida (63%), Plectranthus fruticosus (91%), Abutilon hirtum and Corchorus trilocularis (73%), and also the lower colonization were found in Impatiens goughii (6%) and Piper longum (7%). Where in rainy season, the high colonization were found in Pogostemon mollis (51%), Anaphalis aristata (11%) and Plectranthus fruticosus (57%) where the lower infection found in Biophytyum polyphyllum and Begonia malabarica (6%), and Andrographis alata (5%).

In winter season, the highest spore populations were found in Crotalaria barbata (647), Sida acuta (784) and Plectranthus fruticosus (795), of the examined years 2013 to 2015, whereas also the lower spore population in Impatiens goughii (145), Cleome gynandra (189) and Piper longum (184). In summer, the higher population noted in Crotalaria barbata (758), Pogostemon speciosus (498) and Impatiens goughii (637) as well as the lowest population found in Impatiens goughii (128), Anaphalis aristata (120) and Piper longum (159).
### Table 1. Climatic factor of Velliangiri hills, Western Ghats during 2013 to 2015.

| Month      | Rain fall (mm) | Temperature °C | Relative humidity (%) |
|------------|----------------|----------------|-----------------------|
|            | 2013 | 2014 | 2015 | MAX | MIN | MAX | MIN | MAX | MIN | MAX | MIN | 7.22 HOURS | 2013 | 2014 | 2015 |
| JANUARY    | 0    | 14   | 0    | 31.6 | 19.0 | 29.4 | 17.9 | 30.1 | 19.5 | 86  | 61  | 86           |
| FEBRUARY   | 99.8 | 9.2  | 0    | 31.9 | 20.7 | 31.4 | 18.5 | 32.2 | 20   | 82  | 55  | 80           |
| MARCH      | 0    | 17.0 | 3.7  | 34.2 | 22.8 | 34.5 | 20.5 | 34.5 | 23.1 | 80  | 50  | 80           |
| APRIL      | 46.8 | 52.7 | 62.7 | 35.9 | 24.5 | 35.2 | 23.8 | 32.7 | 24   | 86  | 54  | 83           |
| MAY        | 14.8 | 66.5 | 195.8 | 33.4 | 24.5 | 34.0 | 23.2 | 32.3 | 23.5 | 82  | 55  | 91           |
| JUNE       | 54.5 | 42.8 | 46.9 | 30.6 | 23.3 | 31.6 | 22.9 | 32.3 | 23.7 | 80  | 56  | 82           |
| JULY       | 21.9 | 68.5 | 5.1  | 30.1 | 23.2 | 30.1 | 22.2 | 32.2 | 22.9 | 79  | 55  | 85           |
| AUGUST     | 27.3 | 30.1 | 28.1 | 31.3 | 22.6 | 30.1 | 22.2 | 32.3 | 23.2 | 86  | 62  | 86           |
| SEPTEMBER  | 46.5 | 68.0 | 66.2 | 31.2 | 22.6 | 31.6 | 21.8 | 33   | 23.8 | 85  | 63  | 83           |
| OCTOBER    | 140.12 | 146.0 | 65.2 | 31.5 | 21.7 | 30.6 | 21.4 | 31.6 | 23.3 | 88  | 72  | 87           |
| NOVEMBER   | 57.9 | 118.0 | 191.3 | 29.8 | 22.3 | 29.2 | 20.2 | 28.6 | 22   | 89  | 73  | 93           |
| DECEMBER   | 24.8 | 41.4 | 24.1 | 29.2 | 19.8 | 29.4 | 17.9 | 29.0 | 21.5 | 88  | 77  | 90           |

### Table 2. Soil type, texture and Physical factor of Velliangiri hills, Western Ghats during 2013 to 2015.

| Years  | Seasons | PH  | EC  | OC  | Soil type               | laim          |
|--------|---------|-----|-----|-----|-------------------------|---------------|
| 2013   | Winter  | 7.14| 0.38| 0.85| Sandy loam              | Non-calcareous, Black |
|        | Summer  | 7.11| 0.38| 0.85| Sandy loam              | Non-calcareous, Black |
|        | Rainy   | 7.19| 0.39| 0.84| Sandy loam              | Non-calcareous, Black |
|        | Winter  | 7.13| 0.38| 0.86| Sandy loam              | Non-calcareous, Black |
| 2014   | Summer  | 7.12| 0.38| 0.85| Sandy loam              | Non-calcareous, Black |
|        | Rainy   | 7.18| 0.39| 0.83| Sandy loam              | Non-calcareous, Black |
|        | Winter  | 7.12| 0.36| 0.82| Sandy loam              | Non-calcareous, Black |
| 2015   | Summer  | 7.1 | 0.34| 0.81| Sandy loam              | Non-calcareous, Black |
|        | Rainy   | 7.17| 0.39| 0.83| Sandy loam              | Non-calcareous, Black |

### Table 3. Soil macro and micro nutrients of Velliangiri hills, Western Ghats during 2013 to 2015.

| Years  | Seasons | Available N (kg ha⁻¹) | Available P (kg ha⁻¹) | Available K (kg ha⁻¹) | DTPA-Zn (ppm) | DTPA-Cu (ppm) | DTPA-Fe (ppm) | DTPA-Mn (ppm) |
|--------|---------|-----------------------|-----------------------|-----------------------|---------------|--------------|--------------|--------------|
| 2013   | Winter  | 224                   | 16.1                  | 555                   | 0.98          | 1.26         | 7.58         | 13.37        |
|        | Summer  | 225                   | 16.0                  | 553                   | 0.97          | 1.23         | 7.55         | 13.30        |
|        | Rainy   | 222                   | 16.1                  | 551                   | 0.97          | 1.20         | 7.46         | 13.24        |
|        | Winter  | 234                   | 16.2                  | 544                   | 0.92          | 1.39         | 7.91         | 12.48        |
| 2014   | Summer  | 232                   | 16.3                  | 524                   | 0.91          | 1.37         | 7.90         | 12.45        |
|        | Rainy   | 230                   | 16.2                  | 510                   | 0.92          | 1.37         | 7.90         | 12.23        |
|        | Winter  | 226                   | 16.2                  | 536                   | 1.1           | 1.40         | 7.52         | 14.96        |
| 2015   | Summer  | 226                   | 15.3                  | 531                   | 1.09          | 1.47         | 7.50         | 14.95        |
|        | Rainy   | 223                   | 15.2                  | 528                   | 1.12          | 1.35         | 7.46         | 14.93        |

### Table 4. AM fungal Species from Velliangiri hills Western Ghats with species code.

| S. No. | AM fungal Species                  | Synonym                  | Species code |
|--------|------------------------------------|--------------------------|--------------|
| 1.     | Acaulospora denticulate             | Acaulospora denticulate  | ADTC         |
| 2.     | Acaulospora foveata                 | Acaulospora foveata      | AFVT         |
| 3.     | Acaulospora mellea                  | Acaulospora mellea       | AMLL         |
| 4.     | Acaulospora nicolsonii              | Acaulospora nicolsonii   | ANCS         |
| 5.     | Acaulospora sporocarpa              | Acaulospora sporocarpa   | ASPC         |
| 6.     | Ambispora appendicula               | Ambispora appendicula    | AAPD         |
Table 5. AM fungal root colonization and spore population in the plant species of Velliangiri hills Western Ghats during 2013.

| S. No. | Plant name | Family | Type of Colonization | % Root colonization | Spore population/100g of soil |
|--------|------------|--------|----------------------|---------------------|-------------------------------|
|        |            |        |                      |                     |                               |
| 1       | *Abutilon hirtum* (Lam.) Sweet. | Malvaceae | + + -               | 47 62 23           | 376 312 189                   |
| 2       | *Anaphalis aristata* (DC.) DC. | Compositae | + + +               | 12 36 11           | 271 189 123                   |
| 3       | *Andrographis alata* (Vahl) Nees. | Acanthaceae | + + -               | 12 24 -            | 274 253 132                   |
| 4       | *Andrographis affinis* Nees. | Acanthaceae | + - -               | 27 -               | 210 168 115                   |
| 5       | *Begonia malabarica* Lam. Begoniaceae | + + + | 12 20 - | 183 138 110 |
| 6       | *Begonia trichocarpa* Dalzell | Begoniaceae | + - - | 10 - | 234 172 121 |
| 7       | *Biophytum polyphyllum* Munro | Oxalidaceae | + - + | 23 - - | 222 332 129 |
| 8       | *Biophytum sensitivum* (L.) DC. | Oxalidaceae | + + - | 16 12 - | 321 214 164 |
| 9       | *Cleome gynandra* L. | Cleomaceae | + + + | - 17 - | 241 254 130 |
| 10      | *Cleome monophylla* L. | Cleomaceae | + + - | - 14 - | 256 189 112 |
| 11      | *Corchorus trilocularis* L. | Malvaceae | + - + | 36 53 25 | 473 481 243 |
| 12      | *Crotalaria albida* Roth & Arn. | Leguminosae | + + - | 42 63 32 | 564 742 184 |
| 13      | *Crotalaria barbata* Wight & Arn. | Leguminosae | + - - | 53 57 28 | 647 758 213 |
| 14      | *Hibiscus calyphyllus* Cav. | Malvaceae | + - + | 47 62 32 | 474 529 143 |
| 15      | *Hibiscus hispidissimus* Griff. | Malvaceae | + + - | 38 46 29 | 546 435 179 |
| 16      | *Impatiens crenata* Bedd. Balsaminaceae | + + - | - 10 - | 243 156 124 |
Table 6. AM fungal root colonization and spore population in the plant species of Velliangiri hills Western Ghats during 2014.

| S. No. | Plant name                     | Family                | Type of Colonization | % Root colonization | Spore population/100g of soil |
|--------|--------------------------------|-----------------------|----------------------|---------------------|-----------------------------|
|        |                                |                       | H        | V        | A        | W | S | R | W | S | R |
| 1      | _Abutilon hirtum_ (Lam.) Sweet.| Malvaceae             | +        | +        | +        | 32 | 46 | 18 | 265 | 483 | 192 |
| 2      | _Anaphalis aristata_ (DC.) DC. | Compositae            | +        | +        | -        | 12 | 24 | 19 | 325 | 271 | 163 |
| 3      | _Andrographis alata_ (Vahl) Nees.| Acanthaceae           | +        | +        | +        | 16 | 27 | 12 | 271 | 234 | 123 |
| 4      | _Andrographis affinis_ Nees. | Acanthaceae           | +        | -        | -        | 18 | 22 | 20 | 292 | 189 | 136 |
| 5      | _Begonia malabarica_ Lam. | Begoniaceae            | +        | +        | -        | 17 | 13 | 14 | 324 | 214 | 222 |
| 6      | _Begonia trichocarpa_ Dalzell | Begoniaceae           | +        | -        | +        | 24 | 22 | 21 | 345 | 258 | 140 |
| 7      | _Biophytum polypyllum_ Munro | Oxalidaceae           | +        | -        | -        | 12 | 7  | 5  | 281 | 178 | 124 |
| 8      | _Biophytum sensitivum_ (L.) DC. | Oxalidaceae           | +        | +        | -        | 8  | 9  | -  | 299 | 189 | 142 |
| 9      | _Cleome gynandra_ L. | Cleomaceae             | +        | +        | +        | 14 | 12 | 8  | 189 | 256 | 182 |
| 10     | _Cleome monophylla_ L. | Cleomaceae             | +        | +        | -        | 12 | 7  | 8  | 201 | 173 | 122 |
| 11     | _Corchorus trilocularis_ L. | Malvaceae             | +        | -        | +        | 45 | 84 | 22 | 372 | 478 | 123 |
| 12     | _Crotalaria albida_ Roth | Leguminosae            | +        | +        | -        | 78 | 89 | 49 | 760 | 485 | 270 |
| 13     | _Crotalaria barbata_ Wight & Arn. | Leguminosae           | +        | -        | -        | 88 | 91 | 57 | 768 | 389 | 213 |
| 14     | _Hibiscus calyphyllus_ Cav. | Malvaceae             | +        | -        | +        | 56 | 62 | 39 | 580 | 482 | 294 |
| 15     | _Hibiscus hispidissimus_ Griff. | Malvaceae             | +        | +        | +        | 63 | 41 | 29 | 440 | 341 | 289 |
| 16     | _Impatiens crenata_ Bedd. Balsaminaceae | +        | +        | +        | 12 | 15 | 10 | 264 | 189 | 134 |
| 17     | _Impatiens goughii_ Wight Balsaminaceae | +        | +        | +        | 11 | 8  | 5  | 284 | 149 | 111 |
| 18     | _Piper longum_ L. | Piperaceae             | +        | +        | -        | 10 | 11 | -  | 210 | 120 | 115 |
| 19     | _Plectranthus bishopianus_ Gamble | Lamiaceae             | +        | +        | +        | 43 | 29 | 17 | 243 | 178 | 142 |
| 20     | _Plectranthus fruticosus_ L’Hér. | Lamiaceae             | +        | +        | -        | 52 | 37 | 26 | 273 | 159 | 123 |
| 21     | _Pogostemon benghalensis_ Kuntze | Lamiaceae             | +        | +        | -        | 67 | 48 | 29 | 658 | 493 | 184 |
| 22     | _Pogostemon mollis_ Benth. | Lamiaceae             | +        | -        | +        | 58 | 39 | 22 | 597 | 498 | 281 |
| 23     | _Pogostemon speciosus_ Benth. | Lamiaceae             | +        | +        | +        | 66 | 38 | 22 | 784 | 479 | 260 |

H- Hyphal, V- Vesides, A- Arbuscules; W-Winter; S – Summer; R – Rainy
Table 7. AM fungal root colonization and spore population in the plant species of Vellangiri hills Western Ghats during 2015.

| S. No. | Plant name                          | Family       | Type of Colonization | % Root colonization | Spore population/100g of soil |
|--------|-------------------------------------|--------------|----------------------|---------------------|-------------------------------|
| 1      | Abutilon hirtum (Lam.) Sweet.       | Malvaceae    | H V A                 | W S R               |                               |
| 2      | Anaphalis aristata (DC.) DC.        | Compositae   | + + +                 | 64 73 39            | 584 396 259                   |
| 3      | Andrographis alata (Vahl) Nees.     | Acanthaceae  | + + +                 | 24 28 17            | 369 240 189                   |
| 4      | Andrographis affinis Nees.          | Acanthaceae  | + - -                 | 32 25 15            | 463 273 168                   |
| 5      | Begonia malabarica Lam. Begoniaceae | Begoniaceae  | + + +                 | 10 8 -              | 231 169 123                   |
| 6      | Begonia trichocarpa Dalzell          | Begoniaceae  | + - -                 | - 5 -               | 184 159 133                   |
| 7      | Biophytum polyphyllum Munro         | Oxalidaceae  | + - -                 | 8 14 6              | 213 159 112                   |
| 8      | Biophytum sensitivum (L.) DC.       | Oxalidaceae  | + + +                 | 12 14 8             | 243 260 127                   |
| 9      | Cleome gynandra L.                  | Cleomaceae   | + + +                 | 23 12 11            | 372 231 157                   |
| 10     | Cleome monophylla L.                | Cleomaceae   | + + -                 | 21 22 13            | 543 274 189                   |
| 11     | Corchorus trilocularis L.           | Malvaceae    | + - +                 | 47 52 25            | 473 243 163                   |
| 12     | Crotalaria albida Roth              | Leguminosae  | + + -                 | 64 59 23            | 537 498 362                   |
| 13     | Crotalaria barbata Wight & Arn.     | Leguminosae  | + - -                 | 87 91 46            | 758 637 341                   |
| 14     | Hibiscus calyphyllus Cav.           | Malvaceae    | + + +                 | 53 42 28            | 576 453 236                   |
| 15     | Hibiscus hispidissimus Griff.       | Malvaceae    | + - -                 | 66 43 35            | 564 376 132                   |
| 16     | Impatiens crenata Bedd. Balsaminaceae | Malvaceae   | + + -                 | 14 12 10            | 321 243 124                   |
| 17     | Impatiens goughii Wight Balsaminaceae | Malvaceae   | + - +                 | 11 9 -              | 246 194 153                   |
| 18     | Piper longum L.                     | Piperaceae   | + + -                 | 9 8 9               | 233 179 145                   |
| 19     | Plectranthus bishopianus Gamble     | Lamiaceae    | + - +                 | 48 51 37            | 597 463 251                   |
| 20     | Plectranthus fruticosus L'Hér.      | Lamiaceae    | + - +                 | 61 59 24            | 574 632 220                   |
| 21     | Pogostemon benghalensis Kuntze      | Lamiaceae    | + - -                 | 41 73 28            | 689 473 197                   |
| 22     | Pogostemon mollis Benth. Lamiaceae  | Lamiaceae    | + + +                 | 52 63 31            | 489 372 186                   |
| 23     | Pogostemon speciosus Benth.         | Lamiaceae    | + - +                 | 62 53 36            | 754 359 190                   |
| 24     | Pogostemon vestitus Benth.          | Lamiaceae    | + + +                 | 42 49 21            | 479 352 189                   |
| 25     | Sida acuta Burm.f.                  | Malvaceae    | + - +                 | 57 62 70            | 795 473 255                   |

H- Hyphal, V- Vesicles, A- Arbuscules; W-Winter; S – Summer; R – Rainy
In rainy season, *Corchorus trilocularis* (243), *Crotalaria barbata* (294) and *Impatiens crenata* (362) were found higher spore population, at the same time *Begonia malabarica* (110), *Biophytum polyphyllum* (111) and *Begonia malabarica*, (112) were have minimum population in the study period. The overall aspirations the rainy season were influenced the spore population due to the lagging of rain water. Where, in the winter and summer seasons have more favor for the AM fungal. In Velliangiri hills, highest AM diversity was recorded which may be due to its location, which experiences optimum rainfall and temperature that are conducive for AM population (Table 5-7).

4. DISCUSSION

The AM fungi are major components of soil biota that can determine the productivity of ecosystems (21). The rhizosphere of the mycorrhizal
plant can be referred to as the mycorrhizosphere. Mycorrhizosphere comprises both the root and hyphae influence zones. Hence, the mycorrhizosphere provide a critical link between plants, other microorganisms and the soil (22). The number of mycorrhizal fungal individuals found in a given habitat is likely to depend on a range of factors that includes plant community composition and age, soil chemical, physical and biological properties, and climate, meaning that considerable variability can be expected this requires more effort to quantify intra specific diversity of mycorrhizal fungi (23). The present study contacts an experiment on mycorrhizal fungal community from the Velliangiri hills. In the study site 10 AM fungal genera were identified, among these Glomus has been the most dominant genus in this region, where also the Rhizophagus fasciculatus was the most dominant AM fungal species. Some other finding supported that the relatively higher frequency of Glomus species (24, 25). These species have good relation with edaphic factors of this area.

The present study clearly demonstrated for the first time that plant species from Velliangiri hills are revealed that both AM fungal spore population and percentage of root colonization, which may affected by edaphoclimatic factors such as effect of various climatic, physical and chemical properties of soils. The huge distinction takes place in the spore population within the plant species have in this study, this may be attributed to the variation in edaphic and climatic factors. Numerous biotic and abiotic factors influence into the structure of mycorrhizal fungal communities. Similarly, Kulkarni (26) also proposed by the influence of edaphic factors and host compatibility, climate and soil microorganisms on mycorrization. The soil study revealed that AM Fungal communities are influence by habitat and soil type. In addition, the soil properties are related to microbiological activity and triggering the distribution of AM Fungi. These results contribute to a better understanding of the ecological factors that can shape AM fungal communities, an important soil microbial group that affects multiple ecosystem functions. The pH of study area was very fine (7.19 to 7.1) and this got good relationship of AM population of the study area. The other factors like organic carbon, electric conductivity and micro and macro nutrients.

The present study have higher spore population in winter followed by summer, where rainy season got lower spore population, this may be a variation in moisture and temperature. There is an optimum soil and environmental conditions are required for the AM fungi development and infectiveness (27). Here, many species were recorded in lower colonization of the samplings in the test sites. This has been influenced on plant growth and community structure, due to the important relationship between biodiversity and their potential to control on plant diversity and productivity (28). Where also AM fungal colonization increase intra specific plant competition by different magnification among them. There the influence of mycorrhizal community appears to extant level of plant populations and communities. Fungal may profit from additional nutrient and water availability at relatively low energy cost compared to non-mycorrhizal. Mycorrhizal alien plant species may obtain a competitive advantage compared to non-mycorrhizal alien plant species (24).

5. CONCLUSION

However, despite the importance of AMF to terrestrial ecosystems, little is known about the effects of environmental changes on AMF abundance, activity and the impact of these changes on the ecosystem services. Therefore, it is important to gain a clearer understanding of the effects of environmental changes on the AM fungal species to guide conservation and restoration efforts. The symbiosis has long been a focus for invasion biologists, we do not know of any study combining plant mycorrhizal status with other plant functional traits. Therefore, we encourage the consideration of mycorrhizal status and related mycorrhizal plant traits in future analyses of alien plant invasion success.

REFERENCES

1. Qin, Y., X. Pan, C. Kubícek, I. Druzhinina, K. Chenthama, J. Labbe and Z. Yuan, (2017). Diverse plant-associated pleosporalean fungi from saline areas: ecological tolerance and nitrogen-status dependent effects on plant growth. Front. Microbiol. 8: 158.

2. Burrows, R.L. (2014). Glomalin production and infectivity of Arbuscular-Mycorrhizal fungi in response to grassland plant diversity. Amer. J. Plant. Sci. 5(1): 103-111.

3. Soka, G. and M. Ritchie, (2014). Arbuscular mycorrhizal symbiosis and ecosystem processes: Prospects for future research in tropical soils. Open J. Eco. 4: 11-22.

4. Varga, S. 2015. Effects of arbuscular mycorrhizal fungi and maternal plant sex on seed germination and early plant establishment. Amer. J. Bot. 102(3): 358-366.

5. Songachan, L.S. and H. Kayang, (2012). Diversity and distribution of arbuscular mycorrhizal fungi in Solanum species growing in natural condition. Agric. Res. 1(3): 258-264.
6. Wang, B. and Y.L. Qui, (2006). Phylogenetic distribution and evolution of mycorrhizas in land plants. Mycorrhiza. 16(5): 299-363.
7. Gamble, J.S. (1957). Flora of the Presidency of Madras. Reprint Edition. Vol. 1. Calcutta, p. 91.
8. Phillips, J.M. and D.S. Hayman, (1970). Improved procedures for clearing roots and staining parasitic and vesicular-arbuscular mycorrhizal fungi for rapid assessment of infection. Trans. Br. Mycol. Soc. 55: 158-161.
9. Jackson, M.L. (1973). Soil Chemical Analysis, Prentice Hall of India Pvt. Ltd., New Delhi, pp. 38-56.
10. Walkley, A. and C.A. Black, (1934). An examination of the Degtjareff method for determining soil organic matter and proposed modification of the chromic acid titration method. Soil Sci. 37: 29-39.
11. Olsen, S.R., C.V. Cole, F.S. Wantanable and L.A. Dean, (1954). Estimation of available phosphorus in soil by extraction with Sodium bicarbonate. United State Dept. of Agric. CIRC., Washington, D.C. 939.
12. Lindsay, W.L. and W.A. Norvell, (1978). Development of DTPA soil test for zinc, iron, manganese and copper. Soil Sci. Society Amer. J. 42: 421-428.
13. Merryweather, J.W. and J.H. Fitter, (1991). A modified methods for elucidating the structure of the fungal partner in a vesicular arbuscular mycorrhiza. Mycol. Res. 95: 1435-1437.
14. Arias, I., M.J. Sainz, C.A. Grace and D.S. Hayman, (1987). Direct observation of vesicular arbuscular mycorrhizal infection in fresh unstained roots. Trans. Brit. Mycol. Soc. 89: 128-131.
15. Giovannetti, M. and B. Mosse, (1980). An evaluation of techniques for measuring vesicular arbuscular mycorrhizal infection in roots. New Phytol. 84: 489-500.
16. Gerdemann, J.W. and T.H. Nicolson, (1963). Spores of mycorrhizal Endogone species extracted from soil by wet sieving and decanting. Trans. Brit. Mycol. Soc. 46: 235-244.
17. Raman, N. and V. Mohankumar, (1988). Techniques in mycorrhizal research. University of Madras, Madras, p. 279.
18. Schenck, N.C. and Y. Perez, (1990). Manual for the identification of VA mycorrhizal fungi. Synergistic publications, Gainsvillse, USA. p. 286.
19. Redecker, D., A. Schubler, H. Stockinger, S.L. Sturmer, J.B. Morton and C. Walker, (2013). An evidence based consensus for the classification of arbuscular mycorrhizal fungi (Glomeromycota). Mycorrhiza. 23: 515-531.
20. Schubler, A. and C. Walker, (2010). The Glomeromycota- A species list with new families and new genera. The Royal Botanic Garden Kew.
21. Alguacil, M.D.M., M.P. Torres, A. Montesinos-Navarro and A. Roldan, (2016). Soil characteristics driving arbuscular mycorrhizal fungal communities in semiarid Mediterranean soils. Appl. Environ. Microbiol. 82: 3348-3356.
22. Asmelash, F., T. Bekele and E. Birhane, (2016). The potential role of arbuscular mycorrhizal fungi in the restoration of degraded lands. Front. Microbiol. 7: 1095. DOI: 10.3389/fmicb.2016.01095.
23. Johnson D., F. Martin, J.W.G. Cairney and I.C. Anderson, (2012). The importance of individuals: Intraspecific diversity of mycorrhizal plants and fungi in ecosystems. New Phyto. 194: 614-628.
24. Husna Budi, S.W., I. Mansur and D.C. Kusmana, (2015). Diversity of arbuscular mycorrhizal fungi in the growth habitat of kayu kuku (Pericopsis mooniana Thw.) in Southeast Sulawesi. Pakistan J. Biol. Sci. 18: 1-10.
25. Kulkarni, P. (2014). Effect of agroedaphic conditions on the association, diversity and distribution of am fungi associated with indigenous weed flora. Indian J. Sci. Res. 4(1): 53-59.
26. Vyas, D. and R.K. Gupta, (2014). Effect of edaphic factors on the diversity of VAM fungi. Trop. Plant Res. 1(1): 14-25.
27. Menzel, A., S. Hempel, S. Klotz, M. Moora, P. Pysek, M.C. Rillig, M. Zobel and I. Kuhn, (2017). Mycorrhizal status helps explain invasion success of alien plant species. Ecology. 98(1): 92-102.
28. Nandakwang, P., S. Elliott, S. Youpensuk, B. Dell, N. Teamuromong and S. Lumyong, (2008). Arbuscular mycorrhizal status of indigenous tree species used to restore seasonally dry tropical forest in northern Thailand. Res. J. Microbiol. 3: 51-61.