RESEARCH ARTICLE

STUDIES ON THE ARBUSCULAR MYCORRHIZAL FUNGAL BIODIVERSITY IN THE PLANT SPECIES OF YELLANAHALLI HILLS, VALLEY VIEW OF NILGIRIS, UDHAGAMANDALAM, TAMIL NADU, INDIA

Santhoshkumar, S.*, N. Nagarajan, R. Prema, R. Kowsaliya, F. Amjath Alikhan and P. Aishwarya
PG and Research Department of Botany Kongunadu Arts and Science College (Autonomous), Coimbatore-641 029, Tamil Nadu, India.

ABSTRACT

The present study investigated that the arbuscular mycorrhizal fungal root colonization and spore population in some medicinal plants at Yellanahalli hills, valley view of Nilgiris, Udhagamandalam, Tamilnadu, India. Root and rhizosphere soil samples were collected during the month of August, 2017 - March, 2018. Soil pH was to be recorded. From the study results revealed that totally 25 plant species belonging to 13 families were recorded root colonization and rhizosphere spore population. A totally 12 Arbuscular mycorrhizal fungal species belonging to 7 genera and 2 different Orders were isolated and identified. The maximum spore population was found in the rhizosphere soil samples of Justicia procumbens (380 /100 g of soil) which belongs to the family Acanthaceae and the lowest spore population was observed in the Crotalarieae juncea (102 / 100 g of soil) belongs to Fabaceae. Among these plant species the highest 81% AM fungal infection was found in roots of Solanum nigrum belongs to the family Solanaceae While the lowest 23 % AM fungal association was found in the root of Verbascum thapsus belongs to Scrophulariaceae.

Keywords: AMF, Spore population, medicinal plants, Yellanahalli hills.

1. INTRODUCTION

As the world population continues to increase, the demands placed on agriculture to supply future food and fiber needs will be one of the greatest challenges facing the agricultural community. In particularly soil is one of the most important along with various microorganisms colonizing the rhizosphere soil surface, mycorrhizae, the mutualistic symbiotic, play an important role in mobilizing phosphorus from the deeper layers of the soil and supplying it to the host plants. Among the mycorrhizae, Arbuscular mycorrhizal (AM) is the most prevalent type (1).

In recently, considerable importance is being given to AM fungi, because of awareness of environmental pollution and health hazards by the use of chemicals. The responsibility of AM fungi and PGPR’s, in improving crop plants growth is well documented (2, 3). Arbuscular Mycorrhizal fungi are also known to several benefits of the hosts by improving the uptake of other nutrients such as nitrogen (4), copper (5), sulphur, potassium and calcium (6) and by limiting uptake of toxic heavy metals such as Zn and Cd from soil (5) and they also increase drought tolerance (7), disease resistance (8). Hence in this present research work, the arbuscular mycorrhizal fungal root colonization and spore population in the rhizosphere soil samples were investigated in Yellanahalli hills, valley view of Nilgiris, Udhagamandalam, Tamilnadu.

2. MATERIALS AND METHODS

2.1. Study area

The present study area of Yellanahalli valley Coonoor (taluk) located in the Nilgiris District of Tamil Nadu State, India. The hill is located 11.404457°N 76.712843°E (Fig. 1). The elevation of valley view ranges 2,400 msl (7,900ft). Near Yellanahalli are another two villages called Ketti and Aruvankadu. The Ketti is located to the south-west of Yellanahalli and is also sometimes referred to as the Switzerland of Southern India due to the year-round climatic conditions. The maximum annual rainfall 991mm and maximum temperature 24.3°C and minimum were 4.8°C.

*Correspondence: Santhoshkumar, S., PG and Research Department of Botany Kongunadu Arts and Science College, Coimbatore, Tamil Nadu, India. E.mail: santhosh.biology@gmail.com

Fig. 1. View of the study area of Yellanahalli hills.
2.2. Sample collection

The present study root and rhizosphere soils samples were collected from 25 plant species during the year August, 2017 to March, 2018. All the 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.

2.3. Estimation of AM fungal root colonization

The fresh root samples were cleared and stained in tryphan blue following method of (9). Root samples of each plant species were washed gently under tap water and cleared in 2.5% KOH, acidified in 5 N HCL and stained in lacto glycerol with 0.05% Trypan blue. The stained roots were examined under a compound microscope (40x–100x). Hundred root segments for each sample were randomly selected for microscopic observation and the degree of colonization was estimated using the slide method (10).

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

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

2.4. AMF spore identification

AM fungal spores were extracted from 100 g rhizosphere soil by wet-sieving and decanting method (11) through a series of 710 to 37μm size sieve filter. For the identification and nomenclature of these AM fungal spore synoptic keys developed by (12, 13, 14) were used. The classification was based upon the color, shape, hyphae, structure, size, and cell wall thickness and spore diameter.

2.5. Soil pH

The pH of the rhizosphere 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 research, revealed that AM fungal colonization and spore population totally 25 plant species belongs to 13 families and pH of rhizosphere soil samples ranges between 4.8 to 6.6 were recorded from the study region. The detailed information about the plant species and their family habit, parts used and medicinal uses presented in (Table-1, 2; Fig.2).

In this study, analysis of life forms indicates that 72% of them are herbs and 28% of them are shrubs (Fig. 3). As far as the plant part used is concerned, it was noted that the local people especially in Badagas employed almost all part of plant used as ethnomedicine. The leaf is most predominantly used 44 % followed by whole plant 32%, seed 8 %, flower 8%, fruit 4% and root 4% (Fig.4) respectively. Based on the present study, it has been found that the Badagas tribal community of Yellanahalli hills is rich in ethnobiological knowledge and this knowledge is being transmitted from one generation to another generation. These traditional medicines are the primary health care resources for the Badagas tribes to protect their health.

Our present study findings that AM fungal colonization, the highest percent root colonization 81% was observed in the root samples from the plant species Solanum nigrum. A least number of 23% AM fungal infection was observed in Verbascum thapsus. The maximum spore population was noted in Justicia procumbens (380/100 g of soil) belongs to the family Acanthaceae and minimum spore population was recorded in Crotalaria juncea (102/100 g of soil) belongs to Fabaceae (Fig. 5 and 6).

The Plant species like Agapanthus africanus 27% (Amaryllidaceae), Helichrysum arenarium 28% (Asteraceae). Verbascum thapsus 23% (Scrophulariaceae), Rumex nepalensis 29% (Polygonaceae), Cestrum aurantiacum 30% (Solaceae), showed 20 and less than 30% of infection. The Plant species Agertia adenophora 33% (Asteraceae), Dahlia imperialis 35% (Asteraceae), Plectranthus rugosus 31% (Lamiaceae), showed 30 and less than 40% of AM fungal infection. The Plant species like Anaphalis aristata 45% (Asteraceae), Crotalaria juncea 49% (Fabaceae), Erigeron karvinkianus 48% and Helichrysum bracteatum 45% both belongs to the family Asteraceae 48 %. Euphorbia rothiana 47% (Euphorbiaceae), Leucas suffruticosa 42% (Lamiaceae), Phytolacca octandra 44% (Phytolaccaceae), showed 40 and less than 50% of infection. The Asteraceae member Parthenium hysterophor 55%, Tricholepis ampliculais 59% and Fabaceae member Ulex europaeus 60% showed 50 and less than 60% infection. The Plant species like Diplazium esculentum 61% (Athyriaceae), Hypochaeris radicata 66% (Asteraceae), Ipomoea carnea 69% (Convolvulaceae), showed 60 and less than 70% of infection. The Plant species like Bidens trichoserma 71% (Asteraceae), Solanum nigrum 81% (Solanaceae), Vinca major 77% (Apocynaceae) showed 70 and less than (90%) of infection.
| S. No | Plant Species | Family           | Habit  | Parts Used | Medicinal uses                                    |
|-------|---------------|------------------|--------|------------|---------------------------------------------------|
| 1     | *Agapanthus africanus* (L.) Hoffmanns. | Amaryllidaceae   | Herb   | Whole plant | Allergy, fever, impotence, skin diseases           |
| 2     | *Ageratina adenophora* (Spreng.) King & H.Rob | Asteraceae       | Shrub   | Leaves     | Itching, menus scanty,                             |
| 3     | *Anaphalis aristata* (D C.) | Asteraceae       | Herb   | Whole Plant | Stomach Problems                                  |
| 4     | *Bidens trichosperma* (Michx.) Britton | Asteraceae       | Herb   | Flowers     | Skin diseases and Itching                          |
| 5     | *Cestrum aurantiacum* Lindl. | Solanaceae       | Shrub   | Leaves     | Epilepsy                                          |
| 6     | *Crotalaria juncea* L. | Fabaceae         | Herb   | Whole plant | Swelling and Ulcers                               |
| 7     | *Dahlia imperialis* Roezl ex Ortgies | Asteraceae       | Herb   | Flower      | Skin treatments,                                   |
| 8     | *Diplazium esculentum* (Retz.)Sw. | Athyriaceae      | Herb   | Leaves     | Fever cold, cough                                 |
| 9     | *Erigeron karvinskianus* D C. | Asteraceae       | Herb   | Leaves     | Bee attractive Plant and Skin diseases            |
| 10    | *Euphorbia rothiana* Spreng. | Euphorbiaceae    | Shrub   | Leaves     | cough, Abscesses, ulcer                           |
| 11    | *Helichrysum aurantiacum* Boiss.& A.Huet | Asteraceae       | Herb   | Fruits     | Gall bladder disorders,                            |
| 12    | *Helichrysum bracteatum* (Vent).Haw | Asteraceae       | Herb   | Seeds      | Chest complaints                                  |
| 13    | *Hypocharis radicata* L. | Asteraceae       | Herb   | Whole plant | Cough and cold                                    |
| 14    | *Ipomoea carnea* Jace. | Convolvulaceae   | Shrub   | Leaves     | Diabetic, Cancer,                                 |
| 15    | *Justicia procumbens* L. | Acanthaceae      | Herb   | Leaves     | Diuretic, Asthma, Cough                           |
| 16    | *Leucas suffruticosa* Benth. | Lamiaceae        | Herb   | Whole plant | Scorpion bites, Reduce fever                      |
| 17    | *Parthenium hysterophorus* L. | Asteraceae       | Herb   | Roots      | Rheumatic pain, Diarrhea                          |
| 18    | *Phytolacca octandra* L. | Phytolaccaceae   | Shrub   | Whole plant | Impotency and also in down fever.                 |
| 19    | *Plectranthus rugosus* Wall.ex Benth | Lamiaceae        | Shrub   | Leaves     | Cough and Cold,                                   |
| 20    | *Rumex nepalensis* Spreng. | Polygonaceae     | Herb   | Leaves     | Skin sores                                        |
| 21    | *Solanum nigrum* L. | Solanaceae       | Herb   | Whole plant | Nonetheless and Locales                           |
| 22    | *Tricholepis amplexicaulis* C.B. Clark | Asteraceae       | Herb   | Whole plant | Skin disease, Cough and Urinary troubles          |
| 23    | *Ulex europaeus* L. | Fabaceae         | Shrub   | Seeds      | Blood problems                                    |
| 24    | *Verbascum thapsus* L. | Scrophularaceae  | Herb   | Leaves     | Respiratory, problems and ear pain, eczema        |
| 25    | *Vinca major* L. | Apocynaceae      | Shrub   | Leaves     | Stomach problems, Cerebral stimulant              |
Table 2. AM fungal Colonization and spore Population of some Plant species in Yellanahalli, Valley view during, 2017-2018.

| S. No | Plant Species                     | Family          | pH  | Types of infection | Spore Population (100g/soil) | (%) of root colonization |
|-------|-----------------------------------|-----------------|-----|--------------------|-------------------------------|-------------------------|
| 1.    | *Agapanthus africanus* (L.) Hoffmanns. | Amaryllidaceae  | 5.1 | +                  | 220                           | 27                      |
| 2.    | *Ageratina adenophora* (Spreng.) King & H.Rob | Asteraceae      | 4.8 | +                  | 108                           | 33                      |
| 3.    | *Anaphalis aristata* (D.C.)         | Asteraceae      | 6.1 | +                  | 110                           | 45                      |
| 4.    | *Bidens trichosperma* (Michx.) Britton | Asteraceae      | 5.3 | +                  | 226                           | 71                      |
| 5.    | *Cestrum aurantiacum* Lindl.        | Solanaceae      | 6.4 | +                  | 177                           | 30                      |
| 6.    | *Crotalaria juncea* L.              | Fabaceae        | 5.5 | +                  | 102                           | 49                      |
| 7.    | *Dahlia imperialis* Roezl ex Ortgies | Asteraceae      | 4.8 | +                  | 310                           | 35                      |
| 8.    | *Diplazium esculentum* (Retz.)Sw.   | Athyraceae      | 5.2 | +                  | 265                           | 61                      |
| 9.    | *Erigeron karvinskianus* D.C.       | Asteraceae      | 5.9 | +                  | 238                           | 48                      |
| 10.   | *Euphorbia rothiana* Spreng.        | Euphorbiaceae   | 6.0 | +                  | 224                           | 47                      |
| 11.   | *Helichrysum aurantiacum* Boiss.& A.Huet | Asteraceae     | 5.3 | +                  | 188                           | 28                      |
| 12.   | *Helichrysum bracteatum* (Vent).Haw | Asteraceae      | 5.6 | +                  | 134                           | 45                      |
| 13.   | *Hypocharis radicata* L.            | Asteraceae      | 5.8 | +                  | 199                           | 66                      |
| 14.   | *Ipomoea carnea* Jace.              | Convolvulaceae  | 5.1 | +                  | 256                           | 69                      |
| 15.   | *Justicia procumbens* L.            | Acanthaceae     | 6.3 | +                  | 380                           | 67                      |
| 16.   | *Leucas suffruticosa* Benth.        | Lamiaceae       | 6.6 | +                  | 320                           | 42                      |
| 17.   | *Parthenium hysterophorus* L.       | Asteraceae      | 5.6 | +                  | 277                           | 55                      |
| 18.   | *Phytolacca octandra* L.            | Phytolaccaceae  | 5.8 | +                  | 219                           | 44                      |
| 19.   | *Plectranthus rugosus* Wall.ex Benth | Lamiaceae       | 5.4 | +                  | 173                           | 31                      |
| 20.   | *Rumex nepalensis* Spreng.          | Polygonaceae    | 5.7 | +                  | 342                           | 29                      |
| 21.   | *Solanum nigrum* L.                 | Solanaceae      | 5.9 | +                  | 287                           | 81                      |
| 22.   | *Tricholepis amplexicaulis* C.B. Clark | Asteraceae     | 5.1 | +                  | 202                           | 59                      |
| 23.   | *Ulex europaeus* L.                 | Fabaceae        | 5.0 | +                  | 258                           | 60                      |
| 24.   | *Verbascum thapsus* L.              | Scrophulariaceae | 6.4 | +                  | 293                           | 23                      |
| 25.   | *Vinca major* L.                    | Apocynaceae     | 6.2 | +                  | 328                           | 77                      |
Table 3. AM fungal genera and species were isolated from the rhizosphere soil samples in Yellanahalli hills Valley view of Nilgiri’s.

| S. No | AM fungal genera | Order          | Family            | Species                                      |
|-------|------------------|----------------|-------------------|----------------------------------------------|
| 1     | Acaulospora      | Diversisporales | Acaulosporaceae   | levies and thomii                            |
| 2     | Claroideoglomus  | Glomerales      | Claroideoglomeraceae | etunicatum                                   |
| 3     | Gigaspora        | Diversisporales | Gigasporaceae     | candida                                      |
| 4     | Glomus           | Glomerales      | Glomeraceae       | Glomus hoi, G. invermeyanum, G. macrocarpum, G. magnicaule, G. multicaulis, |
| 5     | Racocetra        | Diversisporales | Gigasporaceae     | verrucosa                                    |
| 6     | Rhizophagus      | Glomerales      | Glomeraceae       | fasciculatus                                 |
| 7     | Sclerocystis     | Glomerales      | Glomeraceae       | pachycaulis                                  |

Fig. 2. Identification of collected plant species at Yellanahalli hills, Nilgiris.

a) Agapanthus africanus (L.) Hoffmanns. b) Bidens trichosperma (Michx.) Britton c) Dahlia imperialis Roezl ex Ortgies d) Hypochaeris radicata L.

Fig. 4. Plant Parts Used.

Fig. 5. AM fungal spore population in the plant species of Yellanahalli hills.

Fig. 6. Percentage of root colonization in the plant species of Collected plant families.
Claroideoglomus, Cla. etunicatum, 1 species of Gigaspora, Gig. candida, 5 species of Glomus, Gl. hoi, Gl. invermayanum, Gl. macrocarpum, Gl. magnicaule, Gl. multicaulis, 1 species of Racocetra, Rac. verrucosa, 1 species of Rhizophagus, Rhiz. fasciculatus, 1 species of Sclerocystis, Scl. pachycaulis. The genus Glomus was dominant and the name of the species were present in (Table. 3, Fig. 8, 9). Santhoshkumar and Nagarajan (15) reported that arbuscular mycorrhizal fungal association in the rhizosphere soil and root colonization of some medicinal plant Species in Sirumalai Hills Eastern Ghats of Dindugul District, Tamilnadu and they were reported totally 39 AM fungal species belonging to six genera were isolated and identified. The genus Glomus were found dominate followed by Acaulospora, Sclerocystis, Entrophospora and Gigaspora. Priyadarshini et al. (16) also reported that occurrence of VAM fungi in Kalasalingam University campus. They were isolated totally 26 species of vesicular arbuscular mycorrhizal fungal spores from the rhizosphere soil samples of the plant species belonging to 14 families was reported.

4. CONCLUSION

Based on this result, concluded that arbuscular mycorrhizal fungal root colonization and spore population were observed in the plant species of Yellanahalli hills. The symbiotic association of these arbuscular mycorrhizal fungal species Glomus was more abundant in all rhizosphere soil of the plant species. Further studies need for the tissue culture technique using mycorrhizal inoculation for ensuring enhanced the plant growth especially in agricultural crops.

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