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# Diversity of arbuscular mycorrhizal fungi in the Fabaceae plants present in Sanjay Gandhi National Park, Borivali, Mumbai, Maharashtra

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The Arbuscular Mycorrhizal Fungal diversity was studied in the 10 selected plants belonging to family Fabaceae present in the Sanjay Gandhi National Park (SGNP) , Borivali , Mumbai , Maharashtra. The plants selected were *Leucaena leucocephala , Butea monosperma , Cassia fistula , Delonix regia , Tamarindus indica , Peltophorum pterocarpum ,Pongamia pinnata,Saraca indica, Acacia catechu, Pithecellobium dulce.* Rhizospheric soil and roots were collected and screened for the presence of arbuscular mycorrhizal fungi. Based on morphological characters of spores, 42 species belonging to seven genera were identified. Maximum spore density, species richness & root colonization were observed in *Delonix regia*. From the trap culture of *Delonix regia*, 11 AM species were recovered. *Glomus* and *Acaulospora* were the dominant genera in all the plants. Root colonization in the plants was in the form of hyphae, arbuscules, vesicles and auxillary cells. Maximum root colonization was also observed in *Delonix regia*.

**Key words:** *Acaulospora*, AM Fungi , Fabaceae, *Glomus*, Sanjay Gandhi National Park

## INTRODUCTION

Arbuscular Mycorrhiza is the mutualistic symbiotic association between most vascular land plant species and fungi of phylum Glomeromycota (Tanwar *et al*., 2011). They are the main component of the soil microbiota in most of the forest ecosystems (Gupta *et al*., 2014). These associations represent a key factor in the below ground dynamics which influence species diversity and plant community structure. Advantages conferred on plants by AM fungi are enormous including increased nutrient uptake especially Phosphorus and hence plant growth, productivity and biomass (Smith and Read, 2008). Sanjay Gandhi National Park ,also known as Krishngiri National Park is present in Mumbai and it is the 'only' protected area in the city.

It is important to study the diversity of these AM fungi to understand their ecological role in this forest. Since there is no report on the species diversity and root colonization of AM fungi from the National Park, this work was undertaken. In this paper, spore density, root colonization and species richness of AM fungi in the plants of family Fabaceae has been described.

## MATERIALS AND METHODS

### *Sampling*

Samples were collected during the month of May, 2019 from the National Park, Borivali, Mumbai. The roots and rhizosphere soils were collected in sterilized plastic bags and transported to the laboratory for analysis.

### *Trap Culture*

Trap Culture was set up to recover intact , fresh and healthy spores by Rodrigues and Muthukumar method (2009). Collected rhizosphere soil were grown in medium size pots (555) with sterilized soil and sand (1:1 ratio) for a period of three and half months using maize as suitable host. After about 45 to 90 days of growth, AM fungal root colonization was checked with 0.05% trypan blue stain. The host plants were maintained for AM sporulation and root colonization.

### *Spore extraction*

Method of Gerdeman and Nicolson (1963) was

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followed for the extraction of spores and Gaur and Adholeya method (1994) method was followed for counting of spores. Taxonomic identification of spores up to species level was made using INVAM (2017) and zor.zut websites.

***Root Colonization***

Root colonization of AM Fungi was studied by method of Philips and Hayman (1970) and percentage of root colonization was calculated by Read *et al*. (1976).

Percentage of mycorrhizal root colonization was calculated using the following formula.

$$\text{Percentage of colonization} = \frac{\text{Number of root segments infected by AM fungi} \times 100}{\text{Total number of segments}}$$

Diversity measures used to describe AM Fungi in SGNP were as follows:
Spore density (SD): The number spores in 20g soil
Species richness (SR): Number of identified AMF species per soil sample

$$\text{IF (Isolation Frequency)} = \frac{\text{The number soil samples in which AMF species occurred}}{\text{The total number of soil}} \text{X100}$$

Simpson's index of dominance: $D = \Sigma$ (ni /N) Shannon –Wiener index of Diversity $H = - \Sigma$ (Pi In Pi) Pi is the relative abundance of each identified species per sampling site and calculated by the following formula, Pi= ni /N, where ni is the spore numbers of a species and N is the total number of identified species per sampling sites.

**RESULTS AND DISCUSSION**

The study confirms the presence of arbuscular mycorrhizal colonization in the plants selected for the study. Forty two arbuscular mycorrhizal fungal species belonging to seven genera were recovered from the rhizosphere soil as shown in Table 1. The seven genera were *Glomus, Ambispora Acaulospora, Gigaspora , Diversispora , Dentiscutata and Scutellospora.* Species richness varied from 4 to 11 in the plants. Spore density and Species richness was the maximum in *Delonix regia* where eleven arbuscular mycorrhiza fungal species belonging to three genera ( *Glomus, Acaulospora* and *Dentiscutata*) were recovered from the rhizosphere soil. Minimum spore density of 49.0±12.53/20g soil and species richness ( four species of *Glomus* and *Acaulospora* )were observed in *Tamarindus indica* (Fig.1). From the results in Table 1, the spore density and root colonization are positively correlated. Maximum spore density of 125.33±11.6/20g was found in *Delonix regia*, which showed 100% root colonization. Root colonization showed hyphae, arbuscules,vesicles and auxillary cells. The percentage root colonization varied in the plants from 40-100. Isolation Frequency was highest for *Acaulospora myriocarpa* (80%) followed by *Glomus intraradices* (60%). Isolation Frequency for *Acaulospora morrowiae* and *Glomus mosseae* was 30%. *Acaulospora bireticulata , Acaulospora delicata , Acaulospora rehmii , Glomus multicaule , Glomus macrocarpum , Dentisculata nigra* and *Gigaspora albida* were having Isolation Frequency 20%. Rest of the species have 10% Isolation Frequency ( Fig. 2). Isolated spores of the different AM fungi have been depicted in Fig.3.

Based on isolation frequency, *Glomus* and *Acaulospora* were the predominant genera .The species of *Glomus* identified are *G. intraradices*, *G.diaphanum, G.clarus ,G.aggregatum, G constrictum, G.macrocarpum , G.faciculatum, G.multicaule , G.perpusillum, G.gibbosum, G glomerulatum, G.mosseae, G.minutum, G.etunicatum, G.tenebrosum, G.formosanum, G aureum , G.callosum* and *G.microcarpum.* The species of *Acaulospora* identified are *A myriocarpa, A.bireticulata, A.morrowiae, A.polonica, A.appendicula, A.rehmii, A.delicata.* The high predominance and diversity of members of the genus *Glomus* and *Acaulospora* in Sanjay Gandhi National Park supports earlier reports of a good adaptation of these fungi to a wide range of physical and chemical soil conditions (Nandakwang *et.al*., 2008). Spores of *Glomus* and *Acaulospora* are small sized, so they require less time to sporulate. The soil in SGNP is red laterite which is acidic in nature. D'Souza *et al*. (2013) reported high occurrence of *Glomus* and *Acaulospora* in the acidic soils of mangroves of coastal Goa. Spore production of AMF is known to vary greatly in different ecosystems, and it is influenced by an array of factors such as environment, host and fungus and spore density which tends to increase during root inactivity or senescence (Muthukumar *et al*. 2003). AM fungal colonization is also known to depend on soil moisture and P availability (Khanam *et al.* 2006). Differential sporulation ability of AM fungal species might also influence AM fungal distribution (Barni and Siniscalco, 2000).

**Table 1:** Spore density, Species richness, Root colonization & Mycorrhizal Spore types

| Name of the Plant | Spore Density/20 gm soil | Species Richness | Root colonization | | | | Mycorrhizal Spore types and auxillary cells if any |
|---|---|---|---|---|---|---|---|
| | | | H | A | V | % | |
| *Leucaena leucocephala* | 53.33± 4.50 | 4 | ++ | -- | ++ | 60 | *Acaulospora sp , A myriocarpa , Am. gerdemannii , G. intraradices,* |
| *Butea monosperma* | 78.66± 10.5 | 9 | ++ | -- | +++ | 80 | *A .myriocarpa , A. bireticulata , A. morrowiae, A. polonica , Di. spurca , G. diaphanum , G. clarus ,G. aggregatum , Gi. decipiens.* |
| *Cassia fistula* | 56.66± 7.09 | 10 | ++ | -- | +++ | 80 | *A. myriocarpa , A. morrowiae, Ambispora species, , G. constrictum , Dentiscutata erythropa , G. macrocarpum , G fasciculatum , G. multicaule , G perpusillum ,* Spore in spore syndrome |
| *Delonix regia* | 125.33± 11.6 | 11 | ++ | ++ | +++ | 100 | *A. myriocarpa , A. bireticulata , A. rehmii , A. appendicula , Acaulospora sp. , Dentiscutata nigra , G. glomerulatum , G. intraradices , G. gibbosum , G. mosseae , Glomus* Sporocarp , Auxillary cells |
| *Tamarindus indica* | 49.0± 12.53 | 4 | ++ | ++ | ++ | 60 | *A myriocarpa , G coremoides , G mosseae , Glomus* sporocarp, Auxillary cells |
| *Peltophorum pterocarpum* | 105.66± 4.33 | 6 | ++ | ++ | +++ | 90 | *A delicata , G intraradices , G mosseae , G minutum , G etunicatum , Scutellospora sp ,* |
| *Pongamia pinnata* | 80.0±7.0 | 7 | ++ | -- | ++ | 60 | *A. myriocarpa , A. rehmii , A. laevis, G. formosanum, Dentiscutata nigra , G. intraradices, G. tenebrosum* |
| *Saraca indica* | 65.0±9.84 | 7 | ++ | -- | + | 40 | *A. myriocarpa , Acaulospora sp., G. intraradices, G. aureum,G. callosum, Gi. albida ,* Sporocarp *of Sclerocystis* Auxillary cells |
| *Acacia catechu* | 87.33± 23.0 | 5 | ++ | -- | +++ | 60 | *A. myriocarpa , A. morrowiae , Diversispora sp.,G. intraradices , G. microcarpum* |
| *Pithecellobium dulce* | 71.66± 9.29 | 5 | ++ | ++ | ++ | 50 | *A. scrobiculata, A. delicata , G. macrocarpum, Gi. Albida, Glomus multicaule* |

(+ Average, ++ Moderate, +++Good, — Absent); H= Hypha , V = Vesicles , A= Arbuscules Legend: *A= Acaulospora*, *Am= Ambispora, De = Dentiscutata, Di = Diversispora , G= Glomus, Gi= Gigaspora, S= Scutellospora*

In our study, we found a positive correlation between spore density and species richness (*Delonix regia* spore density 125.33±11.6 and species richness 11). Similar results were obtained by D'Souza and Rodrigues (2013) in six sites in the study of biodiversity of mangroves of Goa . Root colonization showed hyphae, arbuscules, vesicles and auxillary cells. There was a positive correlation between spore density and root colonization also. Similar results were obtained by Birhane *et al.* (2017). *Gigaspora* and *Scutellospora* do not form vesicles ( Smith and Read , 2008). The presence of auxillary cells confirms presence of *Gigaspora*.sps and the type of auxillary cells were of echinulate type . Shannon weiner index was found to be 3.9 and Simpson's diversity index of AM fungal genera in the area was 0.67 which indicates good diversity of AM fungi in the area. No host specificity was observed in the plants with respect to mycorrhizal fungi.

Hence the above study proved that there is good amount of AM Fungal diversity in the plants of Fabaceae family present in the National park. *Delonix regia* showed highest spore density and root colonization out of the ten tree species screened.

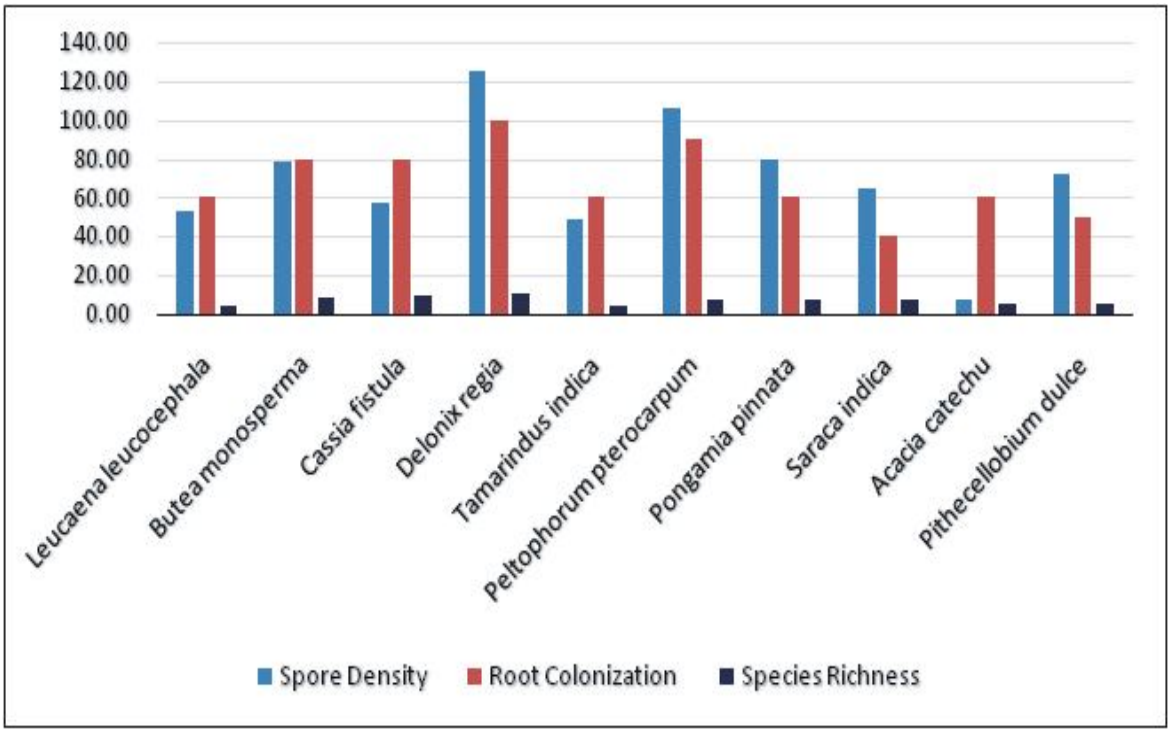


**Fig. 1 :** Spore density, root colonization and species richness of AM fungi

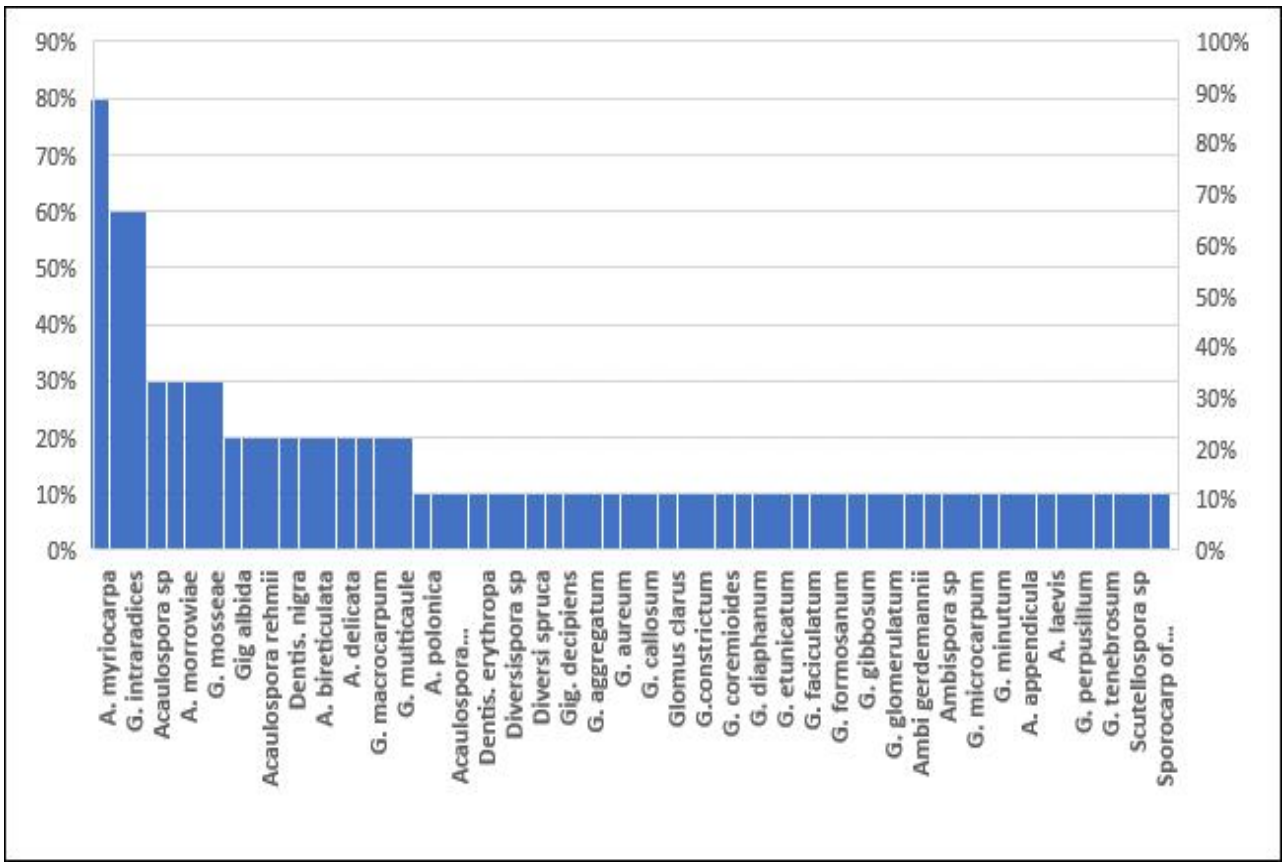


**Fig. 2 :** Isolation Frequency of Mycorrhizal species

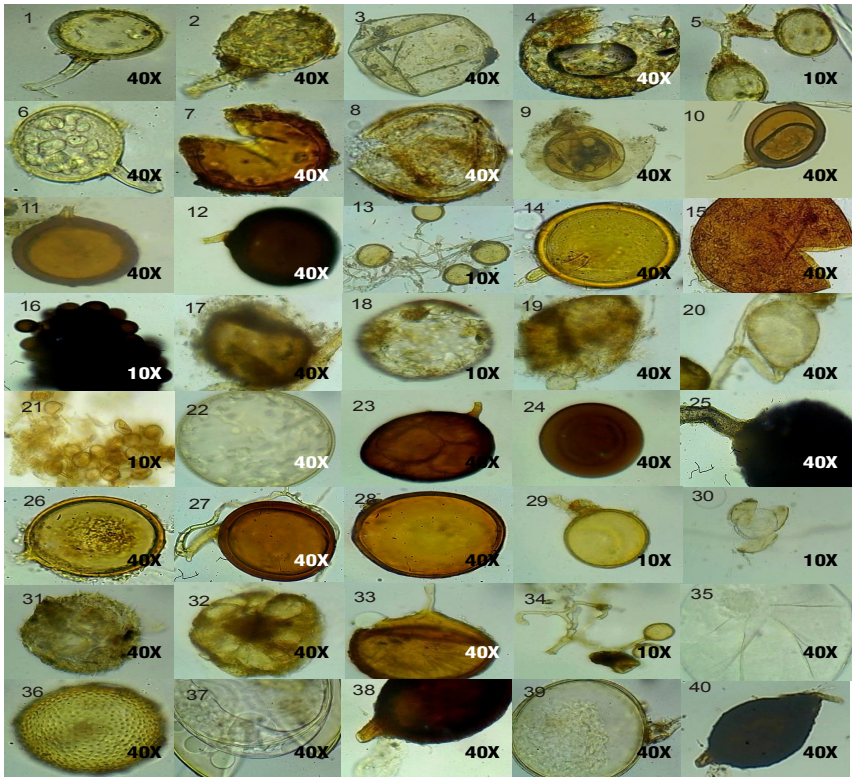

**Fig. 3 :**1.*Glomus intraradices* 2. *Ambispora gerdemannii* 3. *Acaulospora sp* 4. *Acaulospora myriocarpa* ( from *Leucaena leucocephala*) 5. *Glomus aggregatum* 6. *Glomus clarus* 7. *Acaulospora morrowiae* 8. *Diversispora spurca* from *Butea monosperma*) 9. Spore in spore syndrome 10. *Glomus constrictum* 11. *Glomus perpusillum* 12. *Glomus macrocarpum* ( from *Cassia fistula* ) 13. *Glomus intraradices* 14. *Glomus gibbosum* 15. *Acaulospora rehmii* 16. *Glomus glomerulatum* (from *Delonix regia*) 17. *Glomus coremoides* 18. *Glomus myriocarpa* 19. *Glomus sporocarp* 20. *Glomus mosseae* ( from *Tamarindus indica* ) 21. *Glomus intraradices* 22. *Acaulospora delicata* 23. *Glomus minutum* 24. *Scutellospra sp* (from *Peltophorum pterocarpum*) 25. *Glomus tenebrosum*, 26. *Glomus intraradices* 27. *Glomus formosanum* 28. *Acaulospora laevis*(from *Pongamia pinnata*) 29. *Glomus intraradices* 30. *Gigaspora albida* 31. *Glomus callosum* 32. *Sporocarp of Sclerocystis* ( from *Saraca indica*) 33. *Glomus microcarpum* 34. *Glomus intraradices* 35. *Diversispora celata* (from *Acacia catechu*) 36. *Acaulospora scrobiculata* 37. *Acaulospora delicata* 38. *Glomus macrocarpum* 39. *Gigaspora albida* 40. *Glomus multicaule* ( from *Pithecellobium dulce)*

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