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STATUS AND DIVERSITY OF ARBUSCULAR MYCORRHIZAL FUNGI IN FOREST OF NAGPUR, MAHARASHTRA, INDIA.

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ABSTRACT:

Microbes are important components of Earths biota and contribute to the maintenance of natural ecosystems function. Arbuscular Mycorrhizal Fungi (AMF)are ubiquitous in natural ecosystems and form mutualistic association with majority of terrestrial plant species and forest trees. AMF are receiving worldwide attention because they play crucial role in plant productivity and plant community ecology. Lot of research has proven that AMF have beneficial effects on soil and plant health and play a pivotal role in restoration and re-establishment of degraded ecosystem. So there is a need to evaluate, quantify, identify and multiply the indigenous AMF population. However, before we can effectively utilize the fungi in afforestation programs we need to understand their ecology and distribution in naturally occurring plants of the area. Existing literature shows that little attention has been given to improve forest tree seedlings by application of AM fungi in Nagpur district, Maharashtra, India. A qualitative and quantitative survey of species distribution of AM fungi and mycorrhizal colonization was carried out in forest reserve of Nagpur district. Results indicate that forests of Nagpur contained high AM fungal diversity. The percent root colonization also showed variation depending upon the plant species and ecological conditions .Based on above research findings , attempt is being made for subsequent indigenous inoculum production for further utilization of mycorrhizal technology in afforestation programs and reclamation of wastelands, polluted soils, degraded sites in Nagpur district.

Keywords: Mycorrhiza, Arbuscular Mycorrhiza,biodiversity, forestation.

INTRODUCTION:

Plant and soil health are dependent upon the interactions of biological ,physical and chemical components of the soil .Arbuscular Mycorrhizal Fungi (AMF) are considered to be the most common and ubiquitous underground endophytic fungi serving as a crucial link within the plant and soil continuum and are treated as main functional component in the belowground ecosystem(Gupta et al. 2014) Arbuscular mycorrhizal fungi (AMF) belonging to phylum Glomeromycota symbiotically associate with the plant roots and are the main component of the soil microbiota in most of the forest ecosystem. They are obligate plant root symbionts and form considerable part of the combined biomass of the soil microflora. They improve plant growth by increasing the absorption and translocation of mineral nutrients especially Phosphorus and tolerance to biotic and abiotic stresses. The plant provides the fungus with organic carbon which has been estimated to represent about 20% of photoassimilates (Smith and Read, 2008). Lot of work has been done in the past few decades to show that this association is beneficial to plants in many ways ((Khade et al., 2010). The extramatricalhyphalnetwork of AM fungi take up nutrients from the soil and translocate them to the internal mycelium where they are released into the root cells (Abdel Latef and He Chaoxing 2011). Suppressed uptake of heavy metals in a few mycorrhizal plants have been reported thereby protecting the plant from toxic effects of high concentration of heavy metals. It also improves the plant water relations and provide protection to plant against soil toxins. The extramatrical hypha of Arbuscular mycorrhiza can improve soil structure by binding the soil particles into more stable aggregates. Mycorrhizae have a potential to biologically suppress the root pathogens. The plants earlier inoculated with VAM fungi have been shown to exhibit increased resistance to several root pathogens like *Phytopthora* sp. *Macrophomina* sp., *Aphanomyces* sp., *Fusarium* sp., *Verticillium* sp., *Rhizotoniasp*, *Botryosphaeria* (Naqvi and Naqvi 2004). These fungi also provide resistance to plants against nematodes. AM fungi are also reported to have an important implication in reforestation of wastelands (Naqvi 2012, 2014). Potential for increasing the growth of various reforestation crops by mycorrhizal inoculation and management in semi-arid and tropical zones is well recognized (Martinez & Johnson 2010). AM fungi may also be an alternative to rising fertilizer costs because of their potential in increasing the crop yields (Gosling et al. 2010). These associations represent a key factor in the below ground dynamics which influence species diversity and plant community structure. They form the basis in many conservation priority approaches such as reserve selection procedures, afforestation /reforestation drives. Studies on occurrence and distribution of AMF flora in any forest ecosystem and their in situ maintenance is of prime importance in proper management of resources. Many factors such as dominant vegetation type, climate and edaphic properties influence the abundance and distribution of AMF in natural habit. AMF are recently reported to show low endemism (Davison *et al.*, 2015) and their biogeography is largely determined by local environmental conditions. AMF have been reported to have declined due to farming practices such as mono-cropping and tillage etc. or excessive usage of chemical fertilizers and pesticides. Data available for natural ecosystems also supports the change in environment caused by heavy metal pollution, elevated CO2 concentration, climate warming and invasive species affect the AMF community composition in the given area. Factors which contribute to environmental change such as loss of natural habitats, pollution, invasive species, anthropogenic activities and global warming are highlighted to be the main cause of global biodiversity loss.

Despite the universal presence of AM fungi in most soils an infection in many plant species, information on mycorrhizal association is very limited and there is no work in this respect in Nagpur. Before AM fungi can be utilized effectively in large scale forestry programs and sustainable agricultural systems, we need to understand their ecology and distribution in naturally occurring plants of the area. A systematic survey of the forest reserve of Nagpur was undertaken to assess the population and diversity of AM fungi in such soil and to study the intensity of AM association in the roots of the different trees growing in vicinity .Present study is an attempt to find the status of AM fungi in Nagpur District and explore the possibility of utilization of mycorrhizal technology and subsequent production of inoculums of AM fungi in Nagpur.

METHOD AND MATERIAL:

A) Study Area

Site was located in Gorewada forest area**.** It extends over to 1885 hectares of reserve forests, in outskirts of Nagpur city. Gorewada International Biopark is located at 7 km from zero mile along the Nagpur Katol Road. Land is well drained and form catchment area of Gorewada Lake. Physiography of the area is undulation with slope. Soil is shallow, well-drained, clayey soils. Vegetation pattern is dry deciduous .The annual average rainfall of the area is 900 mm and the annual mean temperature varies from 10C minimum to 45C maximum.

B) Selected Plants

Following plants were selected from the site .

Phoenix sylvestris, Azadirachtaindica, Cassia siamea, Erythrina, Pongamiapinnata, Leucaenaleucocephala, Acacia catechu, Dendrocalamus, Delonixregia, Acacia nilotica, Pithecellobium, Dalbergiasissoo, Buteamonosperma, Hardwickia.

On each sampling occasion variation in air temperature and relative humidity was noted.

C) Soil Sampling

Soil from rhizosphere of different trees growing under natural conditions was collected over a period of 2 years and were analyzed for Arbuscular Mycorrhizal spore counts. These soil samples were also used for analysis of soil ecological factors. The roots of the selected plants were also used for studying the colonization of the endophyte into the root tissue.

D) AM Fungal spore isolation:-

AM Fungal spores were extracted using wet sieving and decanting method (Gerdemann & Nicolson 1963). Spores were counted under Stereozoom microscope. An average of 5 readings was taken. Different spores isolated from soil were also photographed to study spore taxonomy.

E) AM Fungi in roots:-

Percent mycorrhizal colonization in roots- The cleaned roots were cut into 1cm long pieces and stained with Trypan Blue (Phillips and Hayman 1970). Minimum of 100 root segments were observed and colonization by AM fungi was calculated using the following formula -

$$\text{Percent root colonization}(\%) = \frac{\text{Total number of root segments colonized}}{\text{Total number of root segments studied}} \times 100$$

RESULT & DISCUSSION:

Lot of diversity and variation in spore density was recorded at the site (Table1 &Fig2). All the plants exhibited mycorrhizal association (Fig1). The spore count varied from 11 spores / 10 grams (*Pithocellobium* sp.) to 129 spores / 10 grams (*Cassia Siamea*) (Table 1). Percentage of root colonization varied from 7.6 % (*Phoenix sylvestris*) to 100 % (*Pithecellobium*)(Table1).Diversity and functioning of AMF communities have traditionally been based on root colonization estimation and AM spore count. Spore population dynamics is regulated by various biotic and abiotic factors which include host species, cropping pattern, crop rotation, crop management practices, use of fertilizers ,nutrients.AM spore population and root colonization pattern changes with seasonal variation and host plant phenology. Wide variation in percent colonization, density of AM fungal spores may be the result of variable host susceptibility, soiltype, root morphology and mycorrhizal dependency of different host plants and other edapho-climatic factors. The AM fungal colonization and subsequent spore production depend on the type of host as well as on the duration of infection of these symbiotic organisms. Generally with increase in the growth period after infection, the host root colonization increase. The higher colonization in *Pithecellobium* may be due to the effectiveness of AM fungal spores developed in root morphology of this host. Highest percent of mycorrhizal infection in *Pithecellobium* may be attributed to the root exudates of these plants which might have stimulated the germination of mycorrhizal spores and increased the infection (Azaizeh *et al.*1995). Although these fungi are not host specific, host and fungal genotypes and soil abiotic as well as biotic variables have been shown to influence the nature of symbiosis (Oehl *et al.* 2010). Climatic and edaphic factors can substantially influence AM association and its population. Several environmental factors such as soil moisture, temperature, pH, nutrients especially N & P, organic matter and changes in plant community composition can influence the composition of AM fungal species. Variation in AM spore population, percentage of root infection and intensity of infection may be dependent on host plant, different soil factors. It is now well established that AM fungi are sensitive to environmental conditions especially edaphic factors (Curaqueo *et al.*, 2011). Edaphic factors can affect spore germination, colonization of host root and ability of the AM fungus to influence the growth and physiology of the host plant (Gaidashova *et al.*, 2010). In addition to the sensitivity of soil type and soil temperature, some other external factors like soil pH, nutrient levels affect the behavior of AM fungi (Gosling *et al.*, 2010).The presence of hypha, vesicles, arbuscules is evidence of AM associations. Generally, arbuscules die within 15 days of their formation and are therefore sometimes not found in older roots. Vesicles are considered as storage organs produced in the older regions of roots. The lack of correlation between root colonization and spore number could be attributed to dormancy of AM spores.

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Figure 1:Endomycorrhizal colonization in plants of Gorewada Forest, Nagpur

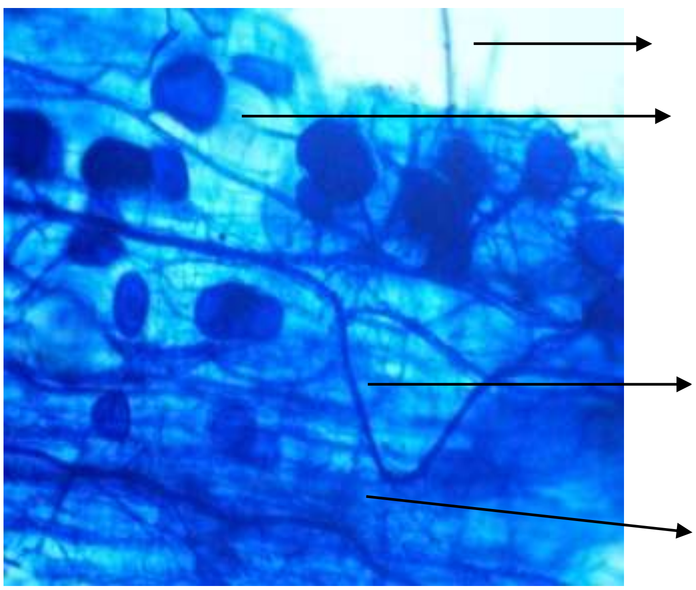

Table 1: Variation in AM fungal spores and percent colonization in different trees of Gorewada forest, Nagpur

Sr. No	Name of the Plant	Spores / 10g	% Roots Colonized	Hyphae	Vesicles	Arbuscules
01	***Phoenix sylvestris***	56	7.6	+	-	-
02	***Azadirachtaindica***	171	61.1	+	+	+
03	***Cassia siamea***	129	83.3	+	+	-
04	***Erythrinasp***	18	26.6	+	-	-
05	***Pongamia pinnata***	125	18.1	+	-	-
06	***Leucanea leucocephala***	53	28.5	+	-	+
07	***Acacia catechu***	49	13.6	+	-	-
08	***Dendrocalamusstrictus***	51	50	+	+	-
09	***Delonix regia***	68	12	+	-	-
10	***Pithecellobium sp***	11	100	+	+	+
11	***Dalbergia sissoo***	94	62.5	+	+	-
12	***Cassia fistula***	45	31.25	+	-	-
13	***Buteamonosperma***	93	57.6	+	+	-
14	***Hardwickia binnata***	20	17.6	+	-	+
15	***Acacia nilotica***	37	27.7	+	-	-

Figure 2: Spore Diversity in Gorewada Forest