Review Of Research
Vol. 4 | Issue. 6 | March. 2015
Impact Factor : 3.1402 (UIF)
ISSN:-2249-894X Available online at www.lbp.world

ORIGINAL ARTICLE

ARBUSCULAR MYCORRHIZAL FUNGI AND ITS ROLE

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ABSTRACT

The name vesicular-arbuscular mycorrhiza was coined by Dangeard (1900). Peyronel (1924) was the first to give recognition to arbuscular mycorrhizal fungi as *Endogone*. Mosse (1956) was the first to prove experimentally that *Endogone* species could produce arbuscular mycorrhiza. Arbuscular mycorrhizal fungi (AMF) form vesicles in the cortical regions of the host cell. It appears to be a balloon-like structure having oil-content. Arbuscule functions as the storage organ of nutrients which exist for very short duration, varying from species to species. They are also referred as haustoria which are special, short, more or less finger-like hyphae sent into the host cells by the biotrophic fungus.

According to the earlier concept, very few higher plants were considered to have an AM fungal colonization, but now it is almost universally accepted that a large group of higher plants have a mycorrhizal colonization. The fungal component of this symbiotic association is an aseptate mycelial fungus belonging to the family Endogonaceae of class Phycomycetes.

KEY WORDS: Arbuscule functions, family Endogonaceae, mycorrhizal colonization.

INTRODUCTION

Gerdemann and Nicolson (1963) established standard procedure of spore extraction from soil and the family was monographed with segregation of the genus *Endogone* into seven genera (Gerdemann and Trappe, 1974). Since then a number of new taxa has been added and the number of described species has reached to 164, of which 112 are known from India.

Though number of workers has developed keys for the identification of different genera and species, based on the morphological characteristics, Schenck and Perez (1990) has classified 120 species of soil fungi forming vesicular AM colonization on the basis of morphological characters under the genera *Glomus*, *Gigaspora, Acaulospora, Scutellospora, Entrophospora* and *Sclerocystis*. The main features of this key for identification at genera and species level is presence or absence of sporocarps, spore colour, spore cell wall thickness, number of cell wall layers and their thickness, ornamentation of spore wall, shape and number of hyphal attachments on the spore and reaction of spore with Melzer's reagent.

According to AM fungal taxonomy, the AM fungi are included under the class *Glomeromycetes*, in order *Glomales* (Morton & Benny, 1990) and placed in the Phylum *Zygomycota.*

According to existing and well accepted classification (Morton & Benny, 1990) based on the morphological features, 'species tree' of AM fungi has been proposed a new order *Glomerales* containing two suborders i.e. *Glomineae* and *Gigasporineae*, with three families as *Glomaceae, Acaulosporaceae* and *Gigasporaceae.* There are two subfamilies under *Glomaceae* as *Archaeosporaceae* and *Paraglomaceae* with seven genera as *Glomus* under *Glomaceae; Entrophosphora* and *Acaulospora* under *Acaulosporaceae; Gigaspora* and *Scutellospora* under *Gigasporaceae; Archaeospora* under *Archaeosporaceae* and *Paraglomus* under *Paraglomaceae.*

Two ancestral clades of AM fungal species were classified under two new families *Archaeosporaceae* and *Paraglomaceae,* on the basis of ribosomal DNA sequences. Deeply divergent ribosomal DNA sequences showed that each family is phylogenetically distant from each other and from other *glomalean* families, despite similarities in mycorrhizal morphology and fatty acid profiles. (Morton & Redecker, 2001).

Based on SSU rRNA studies it is even concluded that the AM fungi can be separated in a monophyletic clade, which is not related to any zygomycetes group but shares common ancestry with *Ascomycota* and *Basidiomycota.* Therefore, a new fungal phylum based on natural relationships for the AM and related fungi is raised as '*Glomeromycota'* (Schubler, 2001).

Oehl *et al.* (2011) proposed a classification which was based on combined genetic and morphological characters. The genetic characters include partial sequences of β-tubulin, and SSU and LSU rRNA and morphological characters associated with color, shape and thickness, pore closure of subtending hyphae etc. In their classification, they divided the Phylum *Glomeromycota* into three classes namely *Glomeromycetes*, *Archaeosporomycetes* and *Paraglomeromycetes*.

AM fungi are found distributed worldwide. They are mainly found in the soil in the form of chlamydospores, zygospores and azygospores. A chlamydospore may, however, look like a zygospore when it possesses two hyphal attachments or when a hyphal attachment is totally absent (Thaxter, 1922; Lange and Lund, 1954). They were also found associated with wide range of plant community, such as Bryophytes, Pteridophytes, Gymnosperms and Angiosperms, reported from nearly all the geographical regions i.e. nutrient deficient soils, sand dunes and deserts, industrial wastes, sodic soils, polluted land sites, sewage, iron ore mines, forests, open woodlands, scrub, savanna, grasslands and coal mining sites (Gerdemann, 1968).

Economically important plant species associated with mycorrhiza are reported by many workers. Even in the forestry, plantations, tree species have been found associated with mycorrhiza. It is well established that vesicular-arbuscular mycorrhiza can increase phosphate uptake and growth in a number of agricultural crops, especially in soils low in available phosphorus (Baylis, 1970; Mosse, 1973; Gerdemann, 1975; Tinker, 1975). Since then AM fungi has remained an important tool in modern agriculture for the solubilization of insoluble forms of phosphorus available in the agricultural fields. With the beginning of modern research facilities, the active role of AM fungi in biological control of root pathogens, enhancement of biological nitrogen fixation, uptake of other micro-elements, hormone production and drought resistance in plants is well known. Some of the other benefits of AM fungi could be harnessed to improve plant growth and productivity. It can be summarised into following points:

1. Improves the rooting system.
2. Improves the uptake of immobilized mineral ions including phosphorus.
3. Improves the overall nutrient cycle.
4. Enhance plant tolerance to stresses of biotic as well as abiotic nature.
5. Improves soil structure.
6. Enhance survival rate of micropropagated plants.
7. Enhance the quality of resistance in plants against fungal pathogens.
8. Early flowering and fruiting in horticultural crops.
9. Improves uniform yield.
10. In nurseries, it improves the rooting of cuttings and tolerance of plants to transplantation shock.
11. In agriculture it helps in increase in plant growth and biomass production.
12. Enhance plant community diversity and also helps the plant to withstand the sites deficient in nutrition.
13. Enhance transport of water in plants under normal and stressed conditions.
14. Helps to accommodate higher levels of sugars in plants under drought conditions and thereby helps to withstand drought stress.
15. It increases the level of soluble proteins, which contribute to drought tolerance.
16. Improves osmo-regulation in tissues of AM fungal colonized plants.
17. Improves the enhancement of primary and secondary metabolites in plants.

Since AM fungi are an obligate symbiotic organism, they are not able to grow on artificial mediums. Even though little success has been made in growing the fungi in symbiotic association on artificial medium, still these cannot be implemented for industrial production. Though, there are a number of methods developed for mass multiplication of AM fungi 'Soil Culture technique' is the only one that finds maximum practical utility. Selection of AM fungi for mass multiplication for a particular locality requires the survey of the local populations of AM fungi. The growth of AM fungi is also affected by the local micro-flora, physico-chemical parameters of the soil and type of vegetation.

Thaper and Khan (1973) confirmed the occurrence of AM association in the tropics form India. They reported the endomycorrhizal association in conifers and broad-leaved trees in India. Mishra and Sharma (1979) found endomycorrhizal association in 12 tree species of north-eastern region of Himalaya. Kharbuli and Mishra (1982) reported the presence of mycorrhiza in 15 tree species out of 18 screened.

Work on mycorrhizal studies has been carried out on grasses growing in saline soils of Mumbai for the occurrence and frequency of AM fungi in different seasons to determine the best host for AM fungi colonization and further research work was carried on effect of AM fungi on native vegetable crops of Maharashtra (Kanade, 1994, 1999). Survey of AM fungal spore population was also carried out on soils from different localities adjoining Mumbai where screened for native AM fungi and reported highest number of chlamydospores in the rhizospheric soil of *Dipcadi saxorum* Blatter, an endemic species, growing on open rocky forest plateau in Sanjay Gandhi National Park, Borivali (Mulani and Prabhu, 2002).

CONCLUSION

According to the earlier concept, very few higher plants were considered to have an AM fungal colonization, but now it is almost universally accepted that a large group of higher plants have a mycorrhizal colonization.

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