

## Role of Mycorrhizae in Agriculture and Forestry

It is a commonly accepted fact now that the growth of many plants can be significantly increased if there is a mycorrhizal association. Mycorrhizal associations are very significant with respect to their utilisations as biofertilisers.

1. Mycorrhiza attach itself with plant roots and then expand to the surrounding soil too. Due to this expanded hyphae much more soil area comes under the nutritive zone of the plant and the surface area of roots is increased by 10 to 1000 folds.

2. Elements like phosphorus, zinc, copper, calcium, magnesium, iron and manganese do not move in soil or combine with other elements into compounds so that the plant can directly absorb. Mycorrhizal fungi exude acids to break down rock or element which are tightly bound in the soil and bring those minerals to the plant in an usable form. Phosphorus which is often an limiting factor for plant growth becomes available by the action of arbuscular mycorrhizal fungi (AMF).

3. N<sub>2</sub>-fixing bacteria need phosphorus for effective N<sub>2</sub> fixation. Mycorrhizal fungi being skilled in extracting phosphorus helps the N<sub>2</sub> fixing bacteria to grow on the root surface and rhizosphere

Mycorrhizal fungi assist nutrient uptake by plants from dilute solutions by two mechanisms. Hyphae extending into the soil from the root may play as an avenging role, since the active transport systems in the cell membrane of fungi are capable of concentrating solutes against steep concentration gradient. The nutrients thus concentrated are then released by the hyphae and taken up by the associated root cells. Also, nutrients concentrated by the fungus and held in the vicinity of the root may serve as reservoirs for future utilisation. Such reservoirs are of great importance to plant growth in places where soil nutrient concentrations show seasonal fluctuations.

4. VAM helps plants in their water uptake too. Due to microscopic nature of the mycorrhizal hyphae they are able to harvest water from soil pores too small for plant roots to enter. This, along with the increased nutrition greatly increases the plants ability to survive in a dry period without watering. Association of VAM is very important where water stress cycle is present. It has been seen that *Glomus fasciculatus* closes the pores of wheat plants during the lower pressure of leaf xylem pressure potential (LXPP) and increases its drought tolerance.

5. The mycorrhizal association helps in the formation of dichotomous branching and profuse root growth, thus enhances plant growth too.

6. Mycorrhiza protects plant roots from other infections basically by covering the roots and preventing other microbes to enter the roots. Mycorrhizae discourage the growth of harmful organisms in the rhizosphere and kill them by releasing antibiotics and anti fungal components in the soil. Infection by *Pythium* and *Phytophthora* can be checked by this process. Mycorrhizal growth also activates plant defence mechanisms, as observed in orchids, where such association leads to the synthesis of phytoalexins- orchinol and hirsinol. Both these compounds act as a barrier to protect infection by other pathogens.

7. Mycobionts of mycorrhizal association release hormones that induces the roots to remain physiologically active for longer period than other non-mycorrhizal plant roots.

8. Gloating, also known as super glue, is a sticky substance produced only by AMF. It aggregates soil particles together thus increasing the pores and making the movement of air, water and roots through the soil easier. This also protects the soil from air and water erosion and gives soil its exclusive quality known as tilth. Glomatin coats the surface of the fungal spores and hyphae when they persist in the soil. During formation of new mycorrhizal association these glomatin covering is shed into the soil where they can stay for even years depending on the condition. Glomatin is 30-40% carbon in nature and makes up to 27% of soil carbon stock.

9. Mycorrhizal fungi are found to prevent the invasion of non-mycorrhizal plants on land where they have established symbiosis. Recent research shows that a diffuse blue factor known as **myc**

**factor** is released by VAM. This factor activates the nodulation factor inducible gene. This same gene is involved in the establishment of symbiosis with N<sub>2</sub> fixing rhizobial bacteria. Molecules similar to Nod factors have been isolated from VAM fungi and are shown to induce the nodulation gene, lateral root formation and enhanced mycorrhizal formation. VAM also controls the bacterial population and diversity in the rhizosphere by affecting the composition and amount of root exudates.

10. Studies have shown that arbuscular mycorrhizal fungi have the ability to suppress the negative consequences of aggressive agricultural weeds which reduce the crop productivity. Weeds like *Chenopodium album* and *Echinochloa crus-galli* population decreases with AMF presence in the rhizosphere.

11. Plants normally transports as much as 80% of its sugar produced down to the roots. But, it is not entirely used by the mycorrhizae. Experimental studies suggest that mycorrhizal fungi mediated the transfer of the excess sugar to the vast diverse population of soil organisms in the area.

Thus, it can be concluded that mycorrhizal association have a lot of use and significance in agriculture and is a component necessary for sustainable agriculture. They are also used as biofertilisers for agricultural and horticultural crops. Nowadays the AM technologies have been developed also to provide good quality of AM fungi.

Mycorrhizae is essentially required for forest ecosystem. The establishment of ectomycorrhizal fungi with the roots is considered as essential for restoration of harsh sites and plant colonisation of new soils in glacial moraines, fresh volcanic deposits and mine soils. These fungi also detoxify soils contaminated with heavy metals.

Ectomycorrhizal fungi (EMF) are essential in forest food webs. The hyphae and exudates of EMF form a major link between above formed procedures and soil food webs while providing photosynthates to rhizosphere consumers like bacteria, Protozoa, arthropods and micro fungi.

Mycorrhiza plays an important role in cultivated forest too. It's requirement is felt highly in Oak and Pine forestry. The hyphae strands extended into the soil store extra nutrition and water. They are very quick and efficient in absorbing and retaining N<sub>2</sub>, P, K and Ca. They can also protect plants from soil acidity.

It is now a world wide practice to use mycorrhizal association during plantation of man made forests. In India it is used during plantation of *Pinus*, *Eucalyptus*, *Fagus* and *Sallyx*. In nursery it is seen that seedlings grown in mycorrhizal soil shows 45% better growth than the non-mycorrhizal seedlings.

VAM normally inhibit cereal plants and increase the cereal production by supplying nutrition easily. *Glomus*, *Gigaspora* and *Endogone* are found largely in the agricultural fields of Bihar, Orissa, UP, Himachal Pradesh, Punjab, West Bengal, Haryana etc. it is seen that the Kharif (June-Sept) cereals create more endomycorrhizal association than the Rabi (Oct-May) cereals, and produce more yields. This association not only increases growth, but biomass, N-P-K ratio, number of leaves and yield also increases.