Summary and Conclusion
SUMMARY AND CONCLUSION

SUMMARY:

The Foxtail Millet (Setaria italica (L.) Beauv.) growing villages of Raibag taluk of Belgaum district, Karnataka have been selected for VAM association studies. The plants growing under natural condition, possessed VAM spores as a regular component of the soil microflora. In total VAM spore population, Glomus species was dominant in most of the places. It was followed by Acaulospora, Sclerocystis, Entrophospora, Gigaspora and Scutellispora genera. The new genera’s such as Archaeospora and Paraglomus were not found in the present work. In the present investigation highest spore density was observed in acidic soil. Effectiveness of VAM fungi is determined by their ability to colonize the root, produce external hyphae absorb and transport “P” effectively and this was observed in the present work.

The presence of external and internal mycelium in these four selected Foxtail Millet (Setaria italica (L.)Beauv.) varieties, may provide physical channel to food transport and absorption of nutrients from soil to roots and from root to external mycelium through the arbuscules which function as nutrient exchanger.

The mycelial network, which extends from mycorrhizal root and ramifies through the soil, is responsible for both enhancing nutrient absorption for the host and itself - a mechanism by which colonization can spread to other plants. The bi-functional mycelium associated with a mycorrhizal root is partly responsible for the reductions observed in ‘P’ absorption and VAM colonization.

In the present investigation, it was observed that in many cases more than one appressorium is located at an entry point. In most cases, adjacent appressoria probably resulted from the branching of single external hyphae, before or after contact with the root. The results revealed remarkable differences in spore population among the Foxtail Millet growing natural habitat.
Appresorium is produced by hyphae, to penetrate into the host root cortex cells. Arbuscules are finger like projections, in which is active site of ‘P’ and carbohydrate exchange, and vesicles are globular or oval structures, and aids in storage of lipids.

In Growth response studies on all four Foxtail Millet (Setaria italica (L.) Beauv.) varieties inoculated with Glomus fasciculatum, the SiA-326 variety showed increase in plant height, root length, number of rootlets, number of leaves, per cent of root colonization, spore number per 50g soil, shoot-root dry weight and “P” uptake in shoots. This was followed by SiA-2466, PS-4 and HMT-100-1. It increased plant growth, photosynthetic activity of the plant and improved the health and vigor of the seedlings.

In the present study, the enhanced plant growth in Foxtail Millet varieties SiA-326, SiA-2644, PS-4 and HMT-100-1 was recorded after the inoculation of Glomus fasciculatum.

The shoot dry weight was high compared to uninoculated plants. The total photosynthetic area expressed as the number of leaves was significantly enhanced. The “P” content was more pronounced in plants inoculated with Glomus fasciculatum in all four varieties. VAM fungi are known to improve plant growth mainly through increased uptake of ‘P’. It clearly demonstrates that the fungus increases plant growth in phosphate deficient soil.

The present study indicates that, potential benefits could be obtained from the VAM fungi in the production of Foxtail millet plants for their better use in future. It is concluded from the present experiments that the inoculation of Foxtail Millet with VAM, seems to be a great boon to the Botanists/Agriculturists to minimize manure dosage in improving the growth and biomass production.

The interaction experiments revealed that Foxtail Millet (Setaria italica (L.) Beauv) variety SiA-326 treated with Azotobacter plus PSB (Bacillus polymyxa) with AMF, results in the increased shoot height, root length,
number of rootlets, number of leaves, per cent of root colonization, spore number per 50g soil, shoot-root dry weight and per cent uptake of ‘N’ and ‘P’ in inoculated shoots compared to UIC. A positive role of microorganisms in nutrition and growth of Foxtail Millets is established beyond doubt. The tripartite association of mycorrhizal fungi, nitrogen fixing organisms and phosphate solubilizing bacteria, has been a subject of interest in recent days. The combined inoculation of VAM, Azotobacter and Bacillus polymyxa showed increased growth of plant height, root length, number of rootlets, number of leaves, per cent of root colonization, spore number per 50g soil, shoot-root dry weight and uptake of ‘N’ and ‘P’. This might have been attributed by Bacillus polymyxa by enhancing the utility of sparingly insoluble form of ‘P’ in the soil. Similarly, Azotobacter enhanced the utility of ‘N’ in the soil. Hence, an overall enhancement of growth and yield was observed when plants were inoculated with the combination of VAM, Azotobacter and PSB (Bacillus polymyxa).

Increased plant growth with cell elongation and multiplication is due to enhanced nutrient uptake (in the present work P and N) by plants following inoculation of Azotobacter and ‘P’ solubilizing bacteria. In addition the organisms are also known to produce certain growth promoting substances, which influence plant growth.

The physiological promotion characteristics such as N₂ fixation and P-solubilization play a very important role. One or more probable reason may be application of ‘N’ and ‘P’ which appears to encourage the multiplication of the organisms. Therefore, the present study concludes that PSB under specific condition, mobilized unavailable forms of ‘P’ and VAM fungus G.fasciculatum provided soluble nutrients to plants, which improved plant nutrient uptake and growth.

In fertilizer effect experiment (P₂O₅) on the Foxtail Millet (Setaria italica (L.) Beauv.) variety SiA-326 inoculated with Glomus fasciculatum, we can conclude that 75% recommended dose give more response as compared to
other recommended doses of super phosphate like 25%, 50% and 100%. Many microorganisms can bring the insoluble organic compounds into soluble form. In such case VAM fungi clearly increase the absorbing root area due to change in morphology of the feeder roots. The data obtained in the present study offer positive response, which was influenced by different levels of single superphosphate inoculated with *Glomus fasciculatum* on Foxtail Millet (var SiA-326).

The per cent of mycorrhizal root colonization and spore count was significantly increased with ‘P’ levels upto 75% recommended doses (RD) in Foxtail Millet var SiA-326. However, further increase in ‘P’ dose significantly decreased both percent of root colonization and spore number in Foxtail Millet (var SiA-326). The better development of AM in the host root was seen at lower ‘P’ dose (25% and 50%). At higher ‘P’ concentration, the permeability of plasma membrane decreased due to higher amount of phospholipids in the membrane. This in turn, reduced the exudation of photosynthates and aminoacids in plant roots, which are essential for the mycorrhizal development. The reduced concentrations of soluble carbohydrates in the mycorrhizal roots at high ‘P’ dose resulted in the decreased AM development. Present investigation showed the decreased number of chlamydospores and percent of root colonization with increased level of superphosphate treatments. The availability of mycorrhizal roots to utilize the organic form of ‘P’ was attributed to higher acid and alkaline phosphate activities in the mycorrhizal soil. In general, inoculum of the respective efficient AM fungi in Foxtail Millet var SiA-326 supplemented with 75% recommended ‘P’ fertilizer would save 25% of ‘P’ fertilizer.

The Foxtail Millet (*Setaria italica* (L.) Beauv.) SiA-326 variety inoculated with *Glomus fasciculatum* showed higher content of chlorophyll, proteins, and phenol content except proline. The enzyme activity like acid phosphatase activity and phenylalanine ammonia lyase activity was higher over UIC plants. VAM treated Foxtail Millet (*Setaria italica*) SiA-326 variety
showed more content of chlorophyll in leaves, more protein content in root, lesser production of proline in roots and more content of phenols in roots as compared to UIC plants. Rapid accumulation of proline is a metabolic consequence of water deficit plants. Mycorrhizal plants have been shown to have a lower concentration of proline in both the root and the shoot implying a lowered physiological water stress. The Foxtail Millet (*Setaria italica*) SiA-326 variety treated with *Glomus fasciculatum* showed higher content of Acid Phosphatase activity as compared to UIC plants. PAL (Phenylalanine ammonia Lyase) activity was higher in mycorrhiza treated Foxtail Millet (*Setaria italica*) SiA-326 variety compared with UIC plants.

**CONCLUSION:**

❖ The screening of villages of Raybag Taluk for VAM fungi is new to the region.

❖ In the present investigation, the *Glomus* was predominated. This was followed by *Acaulospora, Sclerocystis, Entrophosphora, Gigapora* and *Scutelllospor*a species. There was no occurrence of new genera like *Archaespora* and *Paraglomus*.

❖ Foxtail Millet showed the positive response to the VAM colonization.

❖ The growth response experiments revealed that *Glomus fasciculatum* gave more response to biomass production like Plant height, root length, number of rootlets, number of leaves, per cent root colonization, number of spores per 50g soil, root and shoot dry weight and ‘P’ uptake in shoots. The VAM treated four varieties of *Setaria italica* plants shows more growth compared to UIC plants.

❖ The Foxtail Millet variety SiA-326 showed best response, which was followed by SiA-2644, PS-4 and HMT-100-1.

❖ The Interaction of VAM (*Glomus fasciculatum*) with *Azotobacter* and PSB (phosphate solubilizing bacteria) combination, showed best response on Foxtail Millet variety SiA-326. Biomass production such as plant
height, root length, number of rootlets, number of leaves, per cent root colonization, number of spores per 50g soil, root and shoot fresh weight, ‘N’ and ‘P’ uptake in shoots was increased. The VAM treated plants were dominant over UIC plants. Hence tripartite inoculation technology will be useful in successful biomass (yield) production of Foxtail Millet (L.) Beauv.).

❖ VAM (*Glomus fasciculatum*) with *Azotobacter* gave best response of ‘N’ uptake and it was dominant over UIC.

❖ VAM (*Glomus fasciculatum*) with PSB gave better response for uptake of ‘P’ and it was dominant over UIC.

❖ The superphosphate fertilizer effect with VAM (*Glomus fasciculatum*) at 75% recommended dosage, gave better result on Foxtail Millet variety SiA-326 in terms of plant height, root length, number of rootlets, number of leaves, per cent root colonization, number of spores per 50g soil, root and shoot dry weight and ‘P’ uptake in shoots. The VAM treated plants were dominant over UIC.

❖ The effect of VAM (*Glomus fasciculatum*) on Foxtail Millet variety SiA-326 resulted in biochemical changes such as higher content of chlorophyll, protein and phenol. But proline content was less. The acid phosphatase and phenylalanine ammonia lyase (PAL) activity was high. The VAM treated plants were dominant over UIC except in the case of proline.

❖ It is expected that the results of this research would provide baseline data for the sustainable agriculture and identify the factors to conserve the natural resources.

❖ Overall experiments revealed that a VAM fungus would reduce chemical fertilizers.

❖ The beauty of VAM is, it is eco-friendly and has excellent performance in natural condition without adverse effect.