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Eco-Friendly Cultivation of Onion (Allium Cepa L.) Using Vesicular-Arbuscular Mycorrhizal (Vam) Fungi

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ABSTRACT
The use of vesicular-arbuscular mycorrhizae (VAM) fungi in sustainable agriculture is gaining traction due to their ability to enhance nutrient uptake, plant growth, and resilience while reducing chemical inputs. This study investigated the role of VAM fungi in the eco-friendly cultivation of onion (Allium cepa L.). Seeds were grown in sterile soil with and without AMF inoculation, and growth parameters were observed over 80 days. The inoculated plants demonstrated significant improvements in biomass, chlorophyll content, and overall yield. The findings highlight the potential of VAM fungi as a natural growth enhancer, offering a cost-effective and environmentally sustainable alternative to conventional fertilization methods.

Keywords: Allium cepa, VAM fungi, sustainable agriculture, mycorrhizae, biofertilizer, plant physiology

1. INTRODUCTION

Onion (Allium cepa L.) is one of the main vegetable crops worldwide with respect to its production and economical value. Onion cropping systems usually make use of large amounts of inputs, and high-yielding crops widely rely on chemical control of diseases and large use of fertilizers (Bosch-Serra and Currah 2002). In the last decades, a number of risks and negative consequences of the use of synthetic chemicals in agriculture have been identified (Lorbeer et al. 2002). Therefore, agricultural systems involving more sustainable ways of productions like organic and low-input agricultural systems gained interest (Lammerts van Bueren, 2003). In organic and low-input agricultural systems, crop yield is more in balance with other considerations like sustainability of the agro-ecosystem, management of biodiversity, and reduced impact on environment (Rossing et al. 2007). In this context, the search for a broader crop genetic background by combining or introducing new genetic variation enhances possibilities for more sustainable agricultural systems (Stuthman, 2002). Furthermore, another biological interaction that has received increasing attention in sustainable agriculture is the symbiosis between crops and arbuscular mycorrhizal fungi (AMF). Arbuscular mycorrhizal fungi usually improve the performance of their host plant species under sub-optimal growing conditions (Van der Heijden et al. 2008), with benefits such us improved uptake of phosphorus and protection against diseases (Gosling et al. 2006). Plant genetic variation that could allow a better exploitation of the interaction with AMF by

the host has been described for various crops, including onion (Powell et al. 1982). Genetic variation for benefit from the mycorrhizal symbiosis opens opportunities for breeding. However, the practical exploitation of this variation in plant breeding is still in its infancy.

Modern agriculture faces the dual challenge of increasing crop productivity while minimizing environmental impact. Vesicular-arbuscular mycorrhizae (VAM), a type of arbuscular mycorrhizal fungi (AMF), form mutualistic associations with the roots of most terrestrial plants, facilitating nutrient uptake, particularly phosphorus. Their application in sustainable agriculture offers a promising avenue to reduce dependency on synthetic fertilizers and improve soil health (Smith & Read, 1997).

Onion (Allium cepa L.), a globally significant vegetable crop, is sensitive to nutrient availability. Integrating VAM fungi in its cultivation could enhance growth, yield, and quality attributes while aligning with eco-friendly agricultural practices. This study aimed to evaluate the effect of VAM fungi on onion seed germination, growth physiology, and yield.

2. MATERIAL AND METHODS

Mycorrhizae are fungal symbionts forming mutualistic relationship with plant roots. In the present study surface sterilized seeds of onion were sown in earthen pots filled with sterile soil. Half the pots were inoculated with 30 AMF spores of the Glomus species and 10 grams of maize root inoculated with the species of genus Glomus. Another half represented controls with no AMF inoculation. Inoculation was done twice 3 days before sowing the seeds and on the onset of germination. Potted plants were regularly watered. After germination, the inoculated plants along with their controls were sampled at 20, 40, 60 and 80 days of growth. The observed data seems to predict that there is a net increase in the above and below ground growth of the plant with each 20 days interval after germination. The present study seems interesting since it pertains the work on modified stem vis a vis mycorrhizal relationship of a modified stem than normal root. The Chlorophyll content besides morphological growth parameters and fresh and dry weight content of onion plant are shown to present in higher levels in the mycorrhiza infected as compared to the non-inoculated ones.

The analysis of the possibilities to enhance the benefit from arbuscular mycorrhizal fungi (AMF) in onion in this investigation.

3. RESULT AND CONCLUSION

The observed data seems to predict that there is a net increase in the above and below ground growth of the plant with each 20 days interval after germination. The present study seems interesting since it pertains the work on modified stem vis a vis mycorrhizal relationship of a modified stem than normal root. The Chlorophyll content besides morphological growth parameters and fresh and dry weight content of onion plant are shown to present in higher levels in the mycorrhiza infected as compared to the non-inoculated ones.

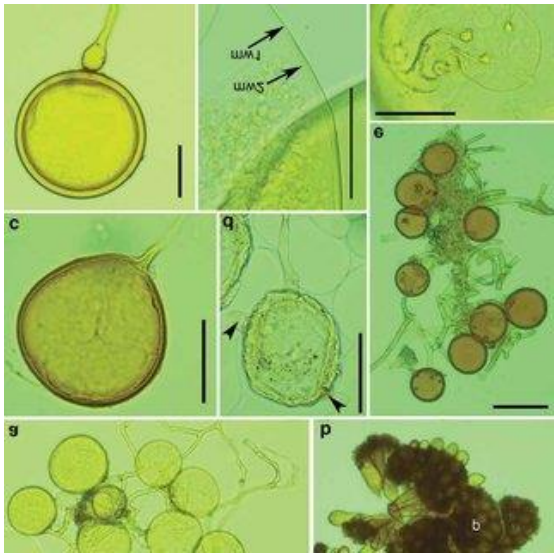

Fig: Arbuscular mycorrhizal spores isolated from the soils

Table 1. Physiochemical analysis of the used soil.

Total $CaCo_3$	**Organic matter (%)**	**Particle size distribution (%)**				**Texture**
		Corse sand	**Fine sand**	**Silt**	**Clay**	
(a) Mechanical analysis						
1.25	0.30	4.35	78.5	12.5	3.05	Sandy

pH 1:2.5	EC dS m^{-1}	Soluble ion (meq/L)							Available nutrients		
		Cations				Anions			µg g^{-1}		
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}	SO_4^{--}	N	P	K
(b) Chemical analysis											
7.92	3.1	11.7	3.47	13.06	1.77	0.69	11.4	17.91	85	25	125

Treatments			
Biofertilizers			
	N	**P**	**K**
Control	107.3	5.3	183.2
VAM	135.3	9.2	291.2

The effect of inoculation with arbuscular mycorrhizal fungi (VAM) on onion plants was studied in pot experiment. Results showed that, inoculation gave significant increases in N, P, K and S concentrations in plants rhizosphere soil at the sampling periods of 60 and 90 days from planting.

Highest values of nutrient concentrations were found in soils inoculated with VAM . Mycorrhizal spores number and VAM infection percentages in plants roots greatly affected by VAM inoculation after 60 days from planting. Dry weight of onion bulbs shoots as well as NPK contents significantly affected by VAM inoculations than the control plants.

Fig: Effect of VAM on the Bulb yield and growth of Allium cepa L.

In conclusion, mycorrhizal colonization improved onion seedling survival and establishment and increased its growth and development which led to producing greater bulb and higher yield. Plants inoculated by VAM were more tolerant to longer irrigation interval and produced comparable yield with weekly irrigation interval. In conclusion, mycorrhizal colonization improved onion seedling survival and establishment and increased its growth and development which led to producing greater bulb and higher yield. Plants inoculated by G. versiforme and G . intraradices were more tolerant to longer irrigation interval and produced comparable yield with regular irrigation interval.

It was observed that about 30% increase in chlorophyll content of A. cepa leaves under VAM application.

Table: 2. Effect of VAM application on biochemical parameters and elemental composition of A. cepa (% to control plants).

Parameter		
	Control	**VAM**
Yield	132	143
Dry matter	95	115
Total sugar	87	98
Flavonoids	69	96
Ascorbic acid	88	97

The data presented in Table 2 indicates that the VAM application showed a higher beneficial effect than control on yield, monosaccharides, flavonoids, and ascorbic acid levels of A. cepa. The inoculation of VAM species consortia usually provides higher beneficial effects than the control, thus showing interesting utilization prospects within Allium crop systems.

4. SUMMARY AND CONCLUSION:

Mycorrhizal colonization improved onion seedling survival and establishment and increased its growth and development which led to producing greater bulb and higher yield. The application of VAM to Allium cepa commonly grown as vegetables leads to significant enhancement of yield, physiological and quality indicators. Mycorrhizae are symbiotic associations, formed between plants and soil fungi that play an essential role in sustainable crop production and soil fertility. Interest in Vesicular Arbuscular Mycorrhiza (VAM) fungi inocula propagation for agriculture is increasing due to their role in promotion of plant health, soil fertility, and soil aggregates stability in the developing economies. The impact of VAM to plant growth, factors contributing to VAM utilization and associations to plant growth. The management and strategic applications of VAM to enhance growth of crops most especially in Onion with an understanding of exploiting VAM benefits towards sustainable agricultural development is very important. Therefore, the benefits of the symbiosis for nutrient uptake by plants in restoration, management and sustainability in agro-ecosystem is very important but a more complete understanding of how to manage VAM for optimum plant growth and development is urgently needed. Commercial use of vesicular-arbuscular mycorrhizae (VAM) may be an alternative to rising agricultural energy and fertilizer costs. Vesicular-arbuscular mycorrhizae may be able to increase crop yields while reducing fertilizer and energy inputs. Since mycorrhizal fungi are naturally present in most soils, their unique fertilizer abilities are already being utilized by most crop plants. Commercial uses of VA mycorrhizal fungi are therefore currently restricted to situations where the natural populations of VAM fungi have been destroyed or damaged such as in fumigated or chemically treated areas, greenhouses, and disturbed areas such as coal spoils, strip mines, waste areas, or road beds. Methods for determining what soils are most likely to benefit from applications of VAM fungi are available. The potential for employing VAM fungi on a wide scale in agriculture is dependent on the development of crop growth-promoting strains of VAM which are superior to native soil populations of VAM fungi.

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