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Presence Of Arbuscular Mycorrhizal Fungi In The Rhizosphere And Non-Rhizosphere Soil Of Garlic Field. (*Allium Sativum L.*)

Mr. Sagar G. Lokhande** , Dr. Sanjay K. Shinde

Department of Botany, K. R.T. Arts, B.H. Commerce and A.M. Science College, Nashik. Dist. Nashik (M.S.), Savitribai Phule Pune University, Pune, India

Department of Botany, NVP Mandal's Arts, Commerce and Science College, Lasalgaon Dist. Nashik (M.S.),

Savitribai Phule Pune University, Pune, India

Abstract

The soil of the Nashik District offers remarkable opportunities for studying the diversity of arbuscular mycorrhizal fungi. A survey was conducted on arbuscular mycorrhizal fungi from the rhizosphere and non-rhizosphere soil of garlic (Allium sativum) across four different locations in the Niphad and Chandwad talukas of the Nasik district in Maharashtra. The highest number of AM propagules, totaling 446 per 100 grams of soil, along with the greatest root infection rate of 82%, was observed in the Panchakeshwar locality. In contrast, the Rahud locality recorded the lowest number of AM propagules at 174 per 100 grams of soil and a root infection rate of just 50%. The other two localities, Palkhed and Dighwad, exhibited intermediate results. From both the rhizosphere and non-rhizosphere soil of garlic, three genera comprising seventeen species were isolated. The genus Glomus was the most prevalent, featuring ten species. The other genera identified included Acaulospora, which had three to four species, and Scutellospora, which had five species. Notably, the number of AM propagules was higher in the rhizosphere soil compared to the non-rhizosphere soil. Soil analysis was performed to assess various parameters such as pH, electrical conductivity (EC), organic carbon (OC %), phosphorus (P2O5 in Kg/ac), potassium (K2O in Kg/ac), and trace elements including zinc (Zn in ppm), copper (Cu in ppm), iron (Fe in ppm), and manganese (Mn in ppm) from both rhizosphere and non-rhizosphere soil of garlic.

Keywords: Arbuscular Mycorrhizal fungi, Diversity, Garlic (*Allium sativum* L.)

Introduction

Mycorrhizae have been linked to vascular plants since the Paleozoic era 23. Arbuscular mycorrhizae (AM), which represent the most common plant-fungus relationship, consist of approximately 150 species that belong to the order Glomales within Zygomycotina. The arbuscular mycorrhizal (AM) symbiosis forms a partnership between the majority of terrestrial plants and a specific class of fungi (Glomeromycota) that resides in the roots of host plants 18. The fungus benefits from carbohydrates (sugars) and growth factors provided by the plant, while the plant gains numerous advantages, such as enhanced nutrient uptake. These fungi are present in various types of soil, but they thrive particularly well in areas where chemical fertilizers are not applied. They possess the capability to enhance soil fertility. Research has demonstrated that the colonization of roots by AM fungi can boost the productivity of many crop plants, especially in soils experiencing drought stress. Ultimately, AM fungi contribute to improved soil structure by binding soil particles together.

Garlic (Allium sativum L.) is regarded as one of the twenty most significant vegetables, utilized globally in various ways, whether as a raw ingredient for cooking or as a part of both traditional and contemporary medicine. Garlic serves as a popular spice, offering numerous health advantages and containing bioactive compounds. Its medicinal applications have spanned from ancient civilizations to the present day. Garlic products are available in forms such as tablets, capsules, syrup, tinctures, and oil. It can be consumed as raw vegetables (either fresh leaves or dried cloves) or after being processed into oil, extracts, and powder, which results in variations in chemical composition and the content of bioactive compounds across different forms. Garlic is predominantly cultivated across India, with an annual production of 3164.63 tonnes recorded from 2021 to 2022. For millennia, garlic has been utilized in folk medicine and is listed among the medicinal herbs in the Vedas, the sacred texts of India. Hippocrates (460–370 BC), known as the father of modern medicine, recommended garlic for treating ulcers, assisting in the expulsion of the placenta, alleviating respiratory ailments, functioning as a purgative or cleanser, and addressing abdominal growths, particularly those related to the uterus. Theophrastus (371-287 BC), a Greek philosopher, noted that laborers gathering hellebore roots employed garlic to mitigate the toxic effects of the poisonous plant.

Furthermore, garlic plays a significant role in enhancing nutrient levels. It regulates iron metabolism and boosts the absorption of zinc and iron from food. Garlic has the potential to prevent tuberculosis, eradicate food poisoning bacteria, and protect infant formula. In his renowned medical work, Materia Medica, Dioscorides recommended garlic for its ability to thin mucus and alleviate coughing, eliminate worms, provide protection against dog and viper bites, stimulate menstrual flow, and treat ulcers, leprosy, and toothaches. This review aims to offer comprehensive insights that can assist researchers in drug development, ultimately benefiting pharmaceutical companies. In this review, we intend to investigate various elements, including the origin and distribution, taxonomy, morphology, chemical constituents, nutritional value, pharmacological activities, health benefits, and potential side effects, providing a thorough analysis of these components.

The current study focuses on both qualitative and quantitative evaluations, as well as certain physicochemical characteristics of the rhizosphere and non-rhizosphere soil of tomatoes. These characteristics include pH, electrical conductivity (EC), organic carbon (OC, %), phosphorus pentoxide (P2O5 in Kg/ac), potassium oxide (K2O in Kg/ac), and the concentrations of zinc (Zn in ppm), copper (Cu in ppm), iron (Fe in ppm), and manganese (Mn in ppm).

Material & Methods

In 2023, we gathered rhizosphere and non-rhizosphere soil samples of garlic from Niphad and Chandwad taluka in the Nasik district. We conducted sampling from four distinct localities every 30 days over a period of two months. The selected localities included Panchakeshwar, Palkhed, Dighwad, and Rahud. From each location, we collected between 4 to 8 samples. Fresh soil samples were transported to the laboratory. Fine roots were preserved in a solution of formalin acetic acid alcohol (90:5:5) after being thoroughly washed to assess root infection. Soil samples were air-dried in the shade for subsequent spore counting at laboratory temperature. Roots were autoclaved for 15 to 20 minutes in a 10% KOH solution, cleared in distilled water, neutralized with 2% HCl, and stained with 0.05% trypan blue in lactophenol. The percentage of root infection was determined using the 15 methods.

100 g of air-dried soil mixture was placed into a beaker containing 1000 ml of tap water. The root soil mixture was thoroughly mixed with a glass rod for 30 seconds. After allowing the soil particles and organic debris to settle, the remaining soil-root-hyphae-spore suspension was carefully poured through a series of 250, 200, 150, 100, and 50 µm sieves. The extracts were washed off the sieves onto Whatman filter paper. Using a trinocular research microscope, spores, aggregates, and sporocarps were collected using a needle. 5-10 spores were added to each drop of PVLG. The mounting medium was permitted to set for 5–10 minutes before placing a cover slip on top.

Results and Discussion

The data collected primarily originated from the active growth phase and flowering stage of the plants. The rhizosphere soil from Panchakeshwar exhibited the highest count of AM propagules, totaling 424 per 100 g of soil, while Palkhed recorded the lowest at 174 spores per 100 g of soil. A similar pattern was noted in the non-rhizosphere soil, with counts of 374 and 123 spores per 100 g of soil from Panchakeshwar and Palkhed, respectively. Intermediate results were observed from Dighwad and Rahud. A comparable trend was noted in the percentage of root infection, with 82% infection in plants from Panchakeshwar, 50% in those from Palkhed, and smaller variations in the plants from the other two locations. Additionally, there was an increase in the number of AM propagules and percentage infection as the plants aged, indicating the rhizosphere effect. Three genera—*Glomus*, *Acaulospora*, and *Scutellospora*—were identified in association with the roots of Garlic plants. Characteristic of tropical soils, the genus *Glomus* was predominant, comprising ten species, while *Scutellospora* included five species and Acaulospora had two species. *Glomus constrictum*, *G. fasciculatum*, *G. globiferum*, and *G. tenebrosum* were present in all four locations. The same applies to *Acaulospora elegans*, *Scutellospora heterogama*, and *Scutellospora minuta*. Notably, *Scutellospora gregaria* was found exclusively in one locality.

Table1: Number of species of AM fungi isolated from rhizosphere soil of garlic from Four localities

Name of genus	L1	L2	L3	L4
Acaulospora	3	3	4	5
Entrophospora	2	0	4	5
Glomus	4	3	3	0
Gigaspora	5	3	5	2
Scutellospora	4	1	3	2
Total	**19**	**10**	**19**	**14**

L1=Panchakeshwar, L2=Palkhed, L3=Dighwad, L4=Rahud

The analysis of rhizosphere and non-rhizosphere soil across all localities was conducted (Table 3). The pH and electrical conductivity (EC) levels in both rhizosphere and non-rhizosphere soils remained nearly unchanged. The organic carbon (OC) content was also nearly identical in both types of soil. The evident uptake of phosphate and its transfer to the roots is indicated by the decreased phosphate levels in the rhizosphere soil. Similar findings were reported by 21. Other minerals, including potassium, zinc, copper, iron, and manganese, showed little variation between rhizosphere and non-rhizosphere soils, with a slight decrease noted in the rhizosphere soil 7, suggesting that these elements are either utilized by AM fungi or transported to the roots. Arbuscular mycorrhizal (AM) fungi are found in most soils and are typically not regarded as host-specific. Nevertheless, the sizes of their populations and the composition of species can vary significantly, influenced by plant traits and various environmental factors such as temperature, soil pH, moisture levels, phosphorus and nitrogen concentrations, heavy metal presence 5, the existence of other microorganisms, fertilizer application, and soil salinity 3, 4. It was concluded that AM fungi have adapted to crop plants and their environments, managing the indigenous fungal populations in agricultural practices to boost the presence of effective native fungi.

Table-2: Arbuscular Mycorrhizal fungi reported from rhizosphere and Non-rhizosphere soil of Garlic

S.N.	Name of Genus and species	L1	L2	L3	L4
1	*Acaulospora appendicula* Spain, Sieverding and Schenck	+	+	-	+
2	*Acaulospora foveata* Trappe and Janos	-	+	+	-
3	*Acaulospora laevis* Gerdemann and Trappe	+	+	+	+
4	*Acaulospora nicolsonii* Walker, Reed and Sanders	+	-	-	-
5	*Acaulospora scrobiculata* Trappe,	+	+	+	+
6	*Acaulospora spinosa* Walker and Trappe	-	+	+	-
7	*Acaulospora splendida* Sieverding, Chaverri and Rojas	+	+	+	-
8	*Entrophospora colombiana* Spain and Schenck	+	+	+	-

9	*Entrophospora infrequens*(Hall) Ames and Schneider	-	+	+	+
10	*Glomus aggregatum* Schenck and Smith Emend. Koske	-	+	-	+
11	*Glomus australe* (Berkeley) Berch	+	+	-	+
12	*Glomus delhiense* Mukerji, Bhattacharjee, Tewari	+	+	-	+
13	*Glomus deserticola* Trappe, Bloss and Menge	+	-	+	-
14	*Glomus diaphanum* Morton and Walker	_-	+	+	-
15	*Glomus dimorphicum* Boyetchko and Tewari	+	-	+	+
16	*Glomus fasciculatum* (Thaxter) Gerdemann and Trappe emend. Walker and Koske	-	+	+	+
17	*Glomus fecundisporum* Schenck and Smith	+	-	+	+
18	*Glomus fistulosum* Skou and Jakobsen	+	+	+	-
19	*Glomus formosanum* Wu and Chen	+	+	+	-
20	*Glomus fragilistratum* Skou and Jakobsen	-	+	+	-
21	*Glomus hoi* Berch and Trappe	+	-	+	+
22	*Glomus hyderabadensis* Swaruparani, Kunwar, Prasad and Manoharachary	-	+	_	+
23	*Glomus mosseae* (Nicolson and Gerdemann) Gerdemann and Trappe	+	+	-	+
24	*Glomus versiforme* (Karsten) Berch	+	+	+	-
25	*Gigaspora albida* Schenck and Smith	-	+	-	+
26	*Gigaspora candida* Bhattacharjee, Mukerji, Tewari and Skoropad	+	+	-	+
27	*Gigaspora margarita* Becker and Hall	-	+	-	+
28	*Gigaspora ramisporophora* Spain, Sieverding and Schenck	+	+	+	_
29	*Scutellospora arenicola* Koske and Halvorson	+	+	+	+
30	*Scutellospora biornata* Spain, Sieverding and Toro	-	-	+	+
31	*Scutellospora fulgida* Koske and Walker	-	+	-	+
32	*Scutellospora minuta* Walker and Sanders	-	+	+	+
33	*Scutellospora pellucida* (Nicolson and Schenck) Walker and Sanders	-	+	-	_

+ = Present - = Absent L1= Panchakeshwar, L2 = Palkhed , L3 = Dighwad , L4 = Rahud

Locality	Collection of samples after	No. of propagules /100 g		% Root Infection
		Rhizosphere soil	% Root Infection	
Panchakeshwar	30 days	424	374	70
	60 days	446	382	82
Palkhed	30 days	274	266	61
	60 days	296	284	70
Dighwad	30 days	174	123	50
	60 days	228	186	62
Rahud	30 days	340	302	65
	60 days	376	325	72

Conclusion

The findings of the study reveal a notable prevalence of arbuscular mycorrhizal fungi (AMF) associations among the weed species in the studied region. All the weed species selected, except for those belonging to the Brassicaceae family, were observed to be colonized by AMF. The research pinpointed three genera—Glomus, Sclerocystis, and Acaulospora—through spore analysis conducted at the sampled locations. The dominance of the Glomus genus is linked to a phosphorus (P) deficiency in the area, which also has a neutral pH; conversely, Acaulospora is known to flourish in slightly acidic conditions. Additionally, the study recorded the presence of vesicles, arbuscules, external hyphae, and internal hyphae. These findings imply to the agricultural community that regions with reduced microflora might face mineral deficiencies, while mycorrhizal associations could improve nutrient efficiency. The effects on plant communities may differ, potentially resulting in either positive or negative outcomes.

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Reference

[1] Abbott, L.K. and A.D. Robson. 1991. Factors influencing the occurrence of vesicular– arbuscular mycorrhizas. Agric. Ecosyst. Environ., 35: 121–150. https://doi.org/10.1016/0167- 8809(91)90048-3

[2] Agwa, H.E. and Y.M. Al-Sodany. 2003. Arbuscularmycorrhizal fungi (Glomales) in AMF in wheat and Maize crops of Malakand Division of North west Frontier Province. Pak. J. Bot., 42(2): 1301-1312.

[3] Auge, R.M., 2001. Water relations, drought and vesicular-arbuscular mycorrhiza symbiosis. Mycorrhiza. 11: 3-42. https://doi.org/10.1007/ s005720100097

[4] Auge, R.M., 2004. Arbuscular mycorrhizae and soil / plant water relations. Can. J. Soil Sci., 84: 373–381. https://doi.org/10.4141/S04-002

[5] Bhale, U.N., V.S. Sawant and P.P. Sarwade. 2011. Arbuscular Mycorrhizas of some plants growing in Marathwada Region of Maharashtra. Kavaka., 39: 33-36.

[6] Birhane, E., K.M. Gebremedihin, T. Tadesse, M. Hailemariam and N. Solomon. 2017. Exclosures restored the density and root colonization of arbuscular mycorrhizal fungi in Tigray, Northern Ethiopia. Ecol. Proces., 6: 33. https:// doi.org/10.1186/s13717-017-0101-9 Black, C.A., 1965. Methods of soil analysis. Part I, American Society of Agronomy. Madison, Wisconsin, USA. pp. 1572. https://doi. org/10.2134/agronmonogr9.1

[7] Chen, X., Z. Fang and J. Tang. 2001. Investigation on host plants of VesicularArbuscular Mycorrhiza fungi (VAMF) within weed community in agricultural slope land in red soil area, southeastern China. Biodiver. Sci., 9: 122- 128.

[8] Datta, P. and M. Kulkarni. 2012. Arbuscular Mycorrhizal Fungal Diversity in Sugarcane Rhizosphere in Relation with Soil Properties. Not. Sci. Biol., 4(1): 66-74. https://doi. org/10.15835/nsb416567

[9] Dobo, B., F. Asefa and Z. Asfaw. 2016. Diversity and Abundance of Arbuscular Mycorrhizal Fungi Under Different Plant and Soil Properties in Sidama, Southern Ethiopia. Adv. Biosci. Bioeng., 4(3): 16-24. https://doi. org/10.11648/j.abb.20160403.11

[10]Dodd, J.C., 2000. The role of arbuscular mycorrhizal fungi in agro- and natural ecosystems, Outlook. Agric., 29: 55-62. https://doi. org/10.5367/000000000101293059

[11]Entry,J.A., P.T. Rygiewicz, L.S. Watrud and P.K. Donnelly. 2002. Influence of adverse soil conditions on the formation and function of arbuscular mycorrhizas. Adv. Environ. Res., 7: 123–138. https://doi.org/10.1016/S1093- 0191(01)00109-5

[12]Jackson, M.L., 1967. Soil chemical analysis. Prentice-Hall of India Pvt. Ltd., New Delhi. pp. 498. Jamal, A., N. Ayub, M. Usman and A.G. Khan. 2002. Arbuscular mycorrhizal fungi enhance zinc and nickel uptake from contaminated soil by soybean and lentil. Int. J. Phytorem., 4: 205-221. https://doi.org/10.1080/15226510208500083

[13]Jordan, N.R., J. Zhang and S. Huerd. 2000. Arbuscular mycorrhizal fungi: potential roles in weed management. Weed Res., 40: 397–410. https://doi.org/10.1046/j.1365- 3180.2000.00207.x

[14]Khakpour, O., and J. Khara. 2012. Spore density and root colonization by Arbuscular Mycorrhizal fungi in some species in the northwest of Iran. Int. Res. J. App. B. Sci., 3(5): 977- 982.

[15]Khan, A.G., 2005. Role of soil microbes in the rhizospheres of plants growing on trace lement contaminated soils in phytoremediation. J. Trace Elem. Med. Biol., 18: 355-364. https:// doi.org/10.1016/j.jtemb.2005.02.006

[16]Klironomos, J.N., 2003. Variation in plant response to native and exotic arbuscular Mycorrhizal fungi. Ecology. 84: 2292–2301. https://doi. org/10.1890/02-0413 Koide, R.T. and B. Mosse. 2004. A history of research on arbuscular mycorrhizal fungi. Mycorrhiza. 14:145

[17] 163. https://doi.org/10.1007/s00572- 004-0307-4 Koltai, H., 2010

[18]Lekberg, Y., R.T. Koide, J.R. Rohr, L. AldrichWolfe and J.B. Morton. 2007. Role of lement contaminated soils in phytoremediation. J. Trace Elem. Med. Biol., 18: 355-364.

[19]Mergulhao, A.C.E., H.A. Burity, B.T. Goto and L.C. Maia. 2010. Diversity of Arbuscular Mycorrhizal fungi in a gypsum mining impacted semiarid area. Acta bot. Bras., 24(4): 1052-1061. https://doi.org/10.1590/S0102- 33062010000400020

[20]Minal, T. and V. Anil. 2012. Mycorrhizae at polluted site of western Rajasthan. Int. J. Plant Anim. Environ. Sci., 2: 325–487.

[21]Nasrullah, M. Sharief, K. Robina and T. Burni. 2010. Occurrence and distribution of niche restrictions and dispersal in the composition in arbuscular Mycorrhizal fungal communities. J. Ecol., 95: 95–105. https://doi.org/10.1111/ j.1365-2745.2006.01193.x

[22]Nelson, D.W. and L.E. Sommers. 1982. Total carbon, organic carbon and organic matter. In: A.L. Page et al. (ed.) Methods of soil analysis: Part 2. pp. 539-579.

[23]Oehl, F., E. Sieverding, P. Ma¨der, D. Dubois and K. Ineichen. 2004. Impact of longterm conventional and organic farming on the diversity of Arbuscular mycorrhizal fungi. Oecologia. 138: 574–583. https://doi. org/10.1007/s00442-003- 1458-2

[24]Pande, M. and J.C. Tarafdar. 2004. Arbuscular mycorrhizal fungal diversity in Neem- plants growing in Marathwada Region of Maharashtra. Kavaka. 39: 33-36.

[25]Rodriguez-Rodriguez, R.M., P. Herrera and E. Furrazola. 2013. Arbuscular mycorrhizal colonization in Asteraceae from white sand savannas, in Pinar del Río, Cuba. Biota. Neotrop., 13(3): 136-140. https://doi.org/10.1590/ S1676- 06032013000300017