

Original Research Article

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Biodiversity of *Glomus* species in the Rhizosphere of Some Ornamental Plants of Family Asteraceae

Malvika Shekhar* and Monica Basu

Department of Botany, University of Allahabad, Allahabad 211002, Uttar Pradesh, India

*Corresponding author

ABSTRACT

Keywords

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In India, cut flowers are highly demanded due to their uses in religious and aesthetic purposes. Natural VA mycorrhizal associations in plants are highly beneficial. Thus, it is very essential to characterize the biodiversity of VAM fungi in plants of economical significance. VAM spores are differentiated in the rhizosphere and act as a reference structure for species identification of these fungi. Spores of species of *Glomus* exhibit the most diverse morphology in family Glomaceae. In the present study, the rhizospheric soils of some ornamental plants belonging to family Asteraceae were screened. Seven species of *Glomus* were isolated and identified during the investigation.

Introduction

Flowers have been the symbols of nature, beauty and love. In India, they are commonly used for religious purposes and they play an important role as décor items in weddings and festival occasions. Flowers are very important for their economic uses, such as, for cut blooms and for extraction of perfumes. Besides this, the seed and nursery business and export of the ornamental plants, seeds and bulbs are progressing every year. Some of the flowering ornamentals have medicinal value such as some species of calendula, tagetus, and chrysanthemums etc.

In India, Floricultural units have increased the export of Floricultural products and enabled the country to become small but important

player in the world market. In spite of this, India's share in the international market for these flowers is negligible due to inadequate research support. Therefore, Floriculture should be treated as agriculture instead of considering it as an industry and it requires much research work to improve the quality as well as quantity of floricultural products, by using VAM fungi as a potential biofertilizer. This needs extensive survey and study of the native VAM fungal composition for the selection of most appropriate and most efficient VAM fungal species as an inoculum, for a particular floricultural crop.

VA mycorrhizae are associated with almost all plants in nature (Hayman, 1982). They

become established in plant root cortical cells by forming hyphae, arbuscules and vesicles. There is bidirectional movement of nutrients between the fungus and the plant roots and thus their association is highly beneficial for the host plant. VAM fungal spores are produced in rhizosphere as well as roots. Spores can survive in the soil for a long time and they serve as fungal propagules. They also act as reference structure for species identification of VAM fungi. The morphological characteristics of spores are mainly used to taxonomically identify the respective fungal species.

Among all the genera of VAM fungi, *Glomus* is the largest and most commonly occurring genus. It may form an endosymbiotic relationship with 70-90% of extant vascular plants. Spores of species of *Glomus* exhibit the most diverse morphology in family Glomaceae. *Glomus* is the most important mycorrhizal fungus for increasing the biomass of crop plants, in agriculture and forest management.

The *Glomus*-plant symbiosis plays an important role in the economic sectors involving the growth of plants such as agriculture, horticulture, and forestry. As a fungi, *Glomus*, contributes to fungal biomass dominance of soils.

It is essential to characterize the biodiversity of VAM fungi in plants of economical significance. In recent years, the needs for indigenous VAM species isolation, screening and identification have been emphasized for their practical and applied aspects. With this objective, this investigation was conducted to isolate and identify the species of *Glomus* in the rhizospheric soils of some ornamentals plants of family Asteraceae. Asteraceae is one of the important families of ornamental flowering plants and some species are also of medicinal value.

Materials and Methods

Soil samples were collected from the rhizospheres of the selected ornamental plants of family Asteraceae (*Calendula officinalis*, *Chrysanthemum indicum* and *Tagetes erecta*) from different sites of Allahabad (Uttar Pradesh). Rhizospheric soils at a depth of 4-16 cm were collected in sterile polythene bags using soil auger. Spores of VAM fungi were extracted from the soil by wet sieving and decanting technique (Gerdemann and Nicolson, 1963). For taxonomic purpose, spores were mounted in PVLG medium.

Results and Discussion

Seven species of the genus *Glomus* were isolated and identified by using manuals of Trappe (1982), Morton and Benny (1990), Walker (1983), Schenck and Perez (1990) and Mukerji (1996).

Glomus

Spores are borne terminally on a single undifferentiated hypha; spores attached with one or more subtending hyphae; spores produced singly or in loose or tight aggregates or in sporocarps in soil. The spores are formed at the end of hyphae which may be constricted at the point of attachment to the spore. The spore wall can have one to many layers, without ornamentation.

The taxonomy of spores of *Glomus* species that encountered during this survey is as under:

Glomus caledonium (Nicol. and Gerd.) Trappe and Gerdemann

Spores borne singly in soil, yellow to brown, globose to subglobose, 67-154µm x 73-154µm, with only one but occasionally two distinct funnel-shaped subtending hyphae.

Spore tapering towards hyphal attachment. Spore wall structure consists of two walls (Walls 1 and 2) in a single group. Wall 1 outermost, thin, subhyaline, unit wall. Wall 2 innermost, thicker than outer wall, yellowish-brown and laminated. Subtending hypha curved, single, funnel-shaped, 30µm wide at the point of spore attachment, hyphal pore closed by a septum, hyphal wall yellow, outer wall hyaline and inner wall yellow.

Description based on the spore isolated from the rhizospheric soil of *Calendula officinalis* L.

Glomus constrictum Trappe

Spores are formed singly in soil, globose to subglobose, 88-114µm x 92-139µm, pale brown and smooth. Spore wall structure consists of a single or occasionally appear two walled structure in a single group; composite wall thickness 7-10µm. Subtending hyphae are curved, yellowish-brown, the hypha is constricted to 8-9µm just beyond the point of attachment and beyond the constriction, the hypha inflated upto 15-18µm, hyphal wall yellow to yellow-brown in colour. Hyphal pore open.

Description based on spores isolated from rhizospheric soil of *Calendula officinalis* L. and *Tagetes erecta* Linn.

Glomus maculosum Miller and Walker

Spores formed singly in soil, globose to subglobose, yellowish-brown, 137µm in diameter with maculose or spotted ornamentation. Spore wall structure consists of three walls (walls 1-3) in two wall groups (wall group A and B). Wall group A consists of wall 1 and 2 together. Wall 1 hyaline, thin, unit wall and tightly adherent to wall 2. Wall 2 brittle, yellowish-brown, laminated.

Wall group B consists of single, innermost, membranous, a very thin wall 3, yellowish-brown; spores covered by dome-shaped outgrowths or spots of 6-10µm in diameter and up to 12µm deep; walls did not react with Melzer's reagent. Subtending hypha concolourous with spore wall 2, sharply recurved, parallel-sided, slightly constricted at the spore base, 5-6µm wide at a point of attachment to spore.

Description based on the spores isolated from rhizospheric soil of *Tagetes erecta* Linn.

Fig.1 A spore of *G. caledonium* with funnel-shaped subtending hypha and showing a scar. **Fig.2** Another spore of *G. caledonium* with subtending hypha



Fig.3 A spore of *G. constrictum* showing constricted subtending hypha. **Fig.4** Spore of *G. constrictum* showing recurved and constricted subtending hypha

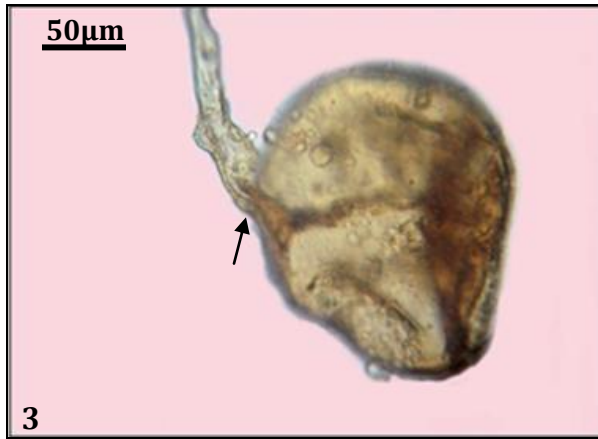


Fig.5 A spore of *G. maculosum* having spotted ornamentation. **Fig.6** A spore of *G. melanosporum* with ephemeral hyaline subtending hypha

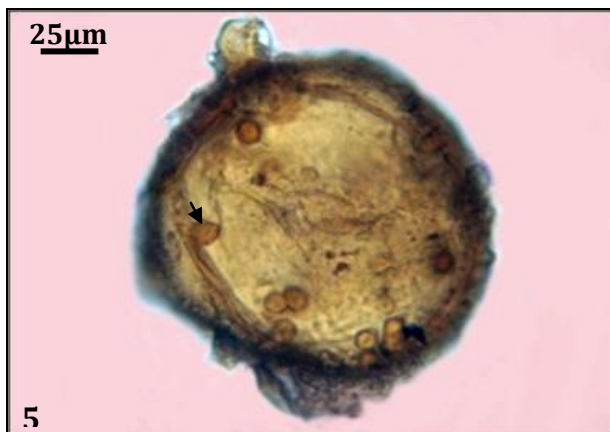


Fig.7 and 8 Clusters of spores of *Glomus microaggregatum* inside unidentified VAM fungal spores

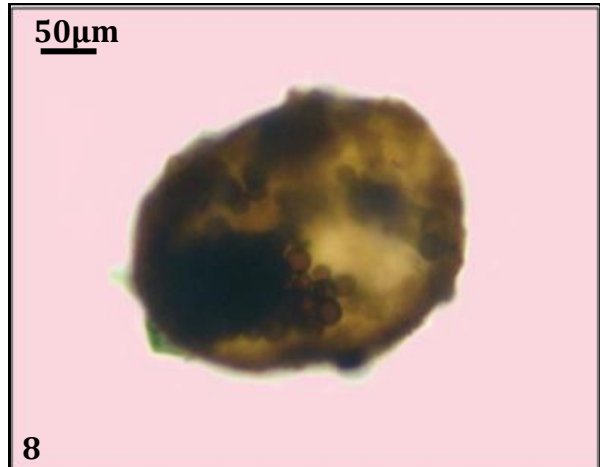
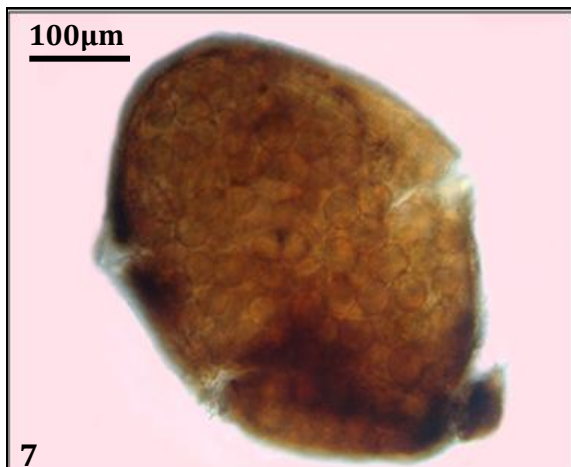


Fig.9 and 10 Spores of *G. microaggregatum*

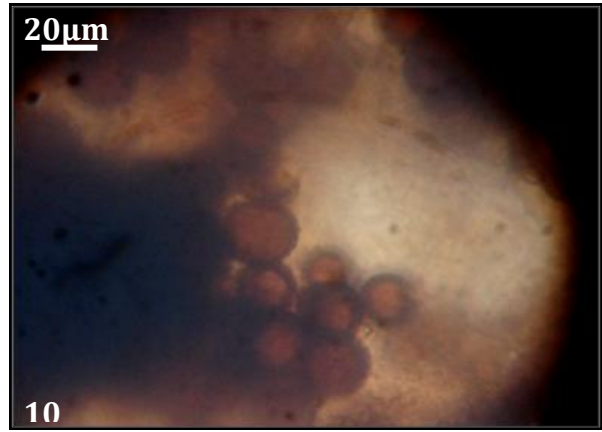
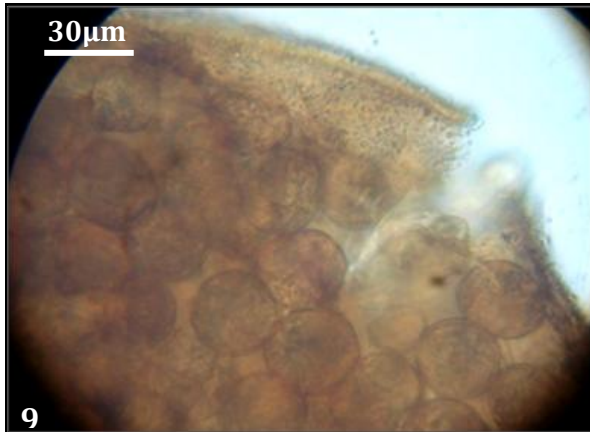


Fig.11 A spore of *G. nanolumen* showing very thick walls making the lumen narrow and somewhat triangular



Fig.12 and 13 Spores of *G. reticulatum*



***Glomus melanosporum* Gerdemann and Trappe**

Spores are formed singly in soil, globose to subglobose, light brown to dark brown, 114µm x 126µm and smooth walled. Spore wall structure consists of a single wall, laminated, grading in colour from dark brown at the outer surface and light yellowish-brown inner surface. Subtending hypha 1-2, thin walled, hyaline to pale yellow, difficult to observe, wide at the point of spore attachment, curved, pore open or closed by spore wall septum.

Description based on the spores found in the rhizospheric soil of *Calendula officinalis* L.

***Glomus microaggregatum* Koske, Gemma and Olexia**

Spores formed singly in the soil or in clusters inside the dead spores of other members of VAM fungi, hyaline to pale yellow to brownish-yellow, globose to subglobose, 11-30µm x 14-35µm in diameter. Spore wall structure consists of two walls (walls 1 and 2) in a single group. Wall 1 consists of smooth, brittle, unit, hyaline to pale brown. Wall 2 is membranous or unit wall, concolourous with wall 1. Subtending hypha cylindrical, straight, 1.5-2.0µm wide at the point of attachment, hyphal wall hyaline and up to 1.5µm thick, hyphal pore open but sometimes closed by a septum formed by wall 2.

Description based on the spores isolated from rhizospheric soils of *Chrysanthemum indicum* L. and *Tagetes erecta* Linn. They were found within dead spores of other VAM fungal members.

***Glomus nanolumen* Koske and Gemma**

Spores formed singly in soil, subglobose or pyriform ovoid, 100µm x 110µm, yellowish-

brown, smooth-walled. Spore wall structure consists of a double wall (wall 1 and 2). Wall 1 shining yellow to yellowish-brown, 2-3µm thick, unit wall, adherent to wall 2, smooth. Wall 2 brown, laminated, very thick 10-17µm, making the lumen of the spore narrow. Subtending hypha not observed.

Description based on the spore isolated from rhizospheric soil of *Calendula officinalis* L.

***Glomus reticulatum* Bhattacharjee and Mukerji**

Spores are borne freely and singly in soil, globose to subglobose or ellipsoidal, dark brown to brownish black, 90-105µm x 96-134µm having reticulate ornamentation. Spore wall structure consists of double wall (wall 1 and 2) in a single group. Wall 1 is yellowish brown, laminated and not fissured. Wall 2 is yellowish-brown to blackish-brown with regular geometric reticulate markings of 4-10µm apart. Subtending hyphae not observed.

Description based on the spores isolated from rhizospheric soil of *Calendula officinalis* L. and *Chrysanthemum indicum* L.

Earlier, some workers have reported various species of *Glomus* in the rhizosphere of different ornamental plants from different areas. Kumar *et al.*, (2009) studied species diversity of *Glomus* in some medicinal plants of Himachal Pradesh. Sharma *et al.*, (2008) also reported seven species of *Glomus* from the sunflower rhizosphere of Haryana. Kumar *et al.*, (2012) reported eleven species of *Glomus* in fifteen ornamental plants from Solan, Himachal Pradesh; Mishra *et al.*, (2016) reported thirty one species of *Glomus* from the rhizosphere of five ornamental plants from Allahabad. Shekhar and Basu (2017a) reported seven species of *Glomus* from the rhizosphere of *Chrysanthemum indicum* and *Tagetes erecta* and seven species

from the rhizosphere of *Helianthus annuus* (2017b) from Allahabad.

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