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VASICULAR–ARBUSCULAR MYCORRHIZAL FUNGI IN QUINOA (*CHENOPODIUM QUINOA* WILLD.)

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ABSTRACT

Vesicular-arbusucular mycorrhizal fungi are known to be well distributed along with the hemisphere. During the present investigation Quinoa rhizosphere soil samples were collected from different parts of Telangana state and analyzed for the presence of VAM fungi. These fungi were found to be widely distributed throughout the area studies. More number of the spores were isolated from the rhizosphere soils of Quinoa which was collected from different areas of Telangana State. All the VAM fungi isolated are commonly found and are equally abundant being recorded from 90% of the most commly recorded. Among these were 2 species of *Acaulospora* 9 speceis are *Glomus* and one each or *Gigaspora* and *Scutellospora.*
Keywords: VAM fungi, Quinoa, Rhizosphere soil samples, Telangana state, *Acaulospora, Glomus, Gigaspora, Scutellospora.*

Introduction

Taxonomy provides an understanding that allows on to be predict from hypothetic events that are unobserved. Progress in taxonomy often causes confusion to the non-taxonomist who must have a name of the organism with which he is working. When names change he may regard it more as an outrage rather than progress towards a more reasonable system. VAM fungi vary considerably in their reaction to different plant and soil conditions; their proper application to further plant productivity will require that they may be taxonomically characterized.

Different species are identified separately on the basis of wall structure, subtending hyphae, shape, size, colour and their mode of germination of which wall structure and ornamentation is the most important criteria. Walker (1983) introduced concept of wall structure to standardize description of Endogonaceae. He described four types of wall size, unit wall, laminated wall, evanescent wall and membranous wall. Berch proposed modification of walker's terminology and used term wall layer instead of wall. This modification proposed on the basis of spore development. As more information on different species is collected, new terms will be introduced to describe distinct type of wall layers. This particular group of fungi is included in a single family Endogonaceae of Endogonales belonging to zygomycotina.

Materials and Methods

With a view to study the taxonomy of VAM rhizosphere soil was collected from different places in India, collections were made from variety of habitats. Three replicates of each soil sample were collected at the depth pf 6 inches and stored in polythene bags till further usage. VAM spores were isolated by wet-sieving and decanting technique (Gerdemann and Nicolson, 1963). Spore number per 10g of soil were determined and were identified with the help of synoptic key to genera and species of VAM provided by Berch.

Result and Discussion

Present investigation has shown wide distribution of VAM fungi in all the areas of investigation (about 90% of the sites examined). Among these were 2 species of *Acaulospora* 9 speceis are *Glomus* and one each or *Gigaspora* and *Scutellospora.* Different species isolated are listed below:

List of VAM mycorrhizal fungi of Quinoa (*Chenopodium quinoa* Willd.)

1. *Acaulospora delicate* (Walker, Pfeiffer and Bloss)
2. *Acaulospora nicolsonii* (Walder, Reed and Sanders)
3. *Gingospora margarita* (Backer and Hall)
4. *Glomus aggregatum* (Schenck and Smith)
5. *Glomus ambisporium* (Smith and Schenck)
6. *Glomus claroideum* (Nicolson and Gerdemann) Trappe and Gerdemann
7. *Glomus constrictum* (Trappe)
8. *Glomus fasciculatum* (Thaxter sensu Gerd) Gerd and Trappe
9. *Glomus macrocarpum* (Schenck and Smith)
10. *Glomus microaggregatum* (Koske, Gemm and Olexia)

11. *Glomus mosseae* (Nicol & Gerd.) Gerd. &Trappe

12. *Glomus viscosum* (Thaxter) Gerd. & Trappe

13. *Scutellospora tepuiensis* Furrazola & Cuenca

Explanation of Figures

1. *Acaulospora delicate* (Walker, Pfeiffer and Bloss)

Spores borne singly in the soil, pale yellowish-cream, globose, 93.84-112 µm diameter. Spore wall structure in two groups (Group A and Group B). Wall group A consisting of a thin, hyaline outer evanescent wall (Wall 1) is closely attached to wall 2 which is relatively a thick laminated wall. Soil particles and debris often adherent to the evanescent outer wall (Wall1); wall group B with two thin hyaline membranes (Fig. 6).

2. *Acaulospora nicolsoni* (Walder, Reed and Sanders)

Azygospore formed singly in soil, pale yellow to brown, globose, 216 µm diameter spore wall structure consists of three walls. Wall 1 with outer thin, hyaline evanescent wall, 0.5–1 µm tightly adherent to a thick, brittle, hyaline pale yellow to brown laminated wall. Inner wall is very thin, hyaline, and membranous at first it is smooth on outer surface but roughened as it breaks up and sloughs leaving granular fragments attached to wall 2. Spores contain many oil droplets (Fig. 7).

3. *Gigaspora margarita* (Becker and Hall)

Azygospores formed singly in the soil, globose, 344.19 µm diameter spore walls smooth and hyaline composed of 4 – 8 rarely 10 fused laminations. Spore wall is 1–4.52 µm thick; content of spores white composed of many small oil droplets which tend to coalesce with age. Spore terminal has the subtending hyphae generally septate below the suspensor like cell. Suspensor like cell 36.3 x 58.06 µm in broad, hyaline to light brown, smooth, wall - 4 µm thick at the point of attachment to the spore (Fig . 8).

The present VAM spore measurement agrees with the original description in all the characters.

4. *Glomus aggregatum* (Schenck and Smith)

Chlamydospores formed in loose clusters or in sporocarps, periderm absent. Sporocarp size ranging from 625.5–800 µm, hyaline to light yellow. Chlamydospores globose to subglobose, 52.6 µm to 87.5 µm in diameter. Spores hyaline yellow; spores walls yellow to yellow brown, 2–3.5 µm thick consisting of an out wall slightly thicker and lighter in colour than the inner wall. Hypha is 10.5 µm to 14.0 µm wide at the point of spore attachment. Spore contents confluent with hyphal contents separated from hyphae by inner spore wall, pore not occluded by hyphal wall thickening (Fig. 9).

The description of present species closely resembles with the original description. This spore's aggregation, the size wall thickness and hyphal diameter at spore attachment similar to the original description.

5. *Glomus ambisporium* (Smith and Schenck)

Spores are dark brow to black, sub- globose, 315 to 690 x 424 -776 µm consisting of a single layer of spore wall. Spores are of two types chlamydospores and sporocarps which are present in soil and aggregated around the root. Spores with 3 walls membranous inner wall in 1 µm thickness, middle wall laminated 3-14 µm thickness, outer wall reticulate 2-4 µm thick (Fig.10).

6. *Glomus claroideum* (Nicolson and Gerdemann) Trappe and Gerdemann

Spores are single in soil. Spores are of two types of chlamydospores and sporocarps are up to 6 µm in diameter, sub globose spore dull yellow to brown. Spore walls are 4, 1 mucilaginous layer 0.6-1.8 µm in thick in young spore wall 1 and wall 2 slightly adherent. Wall 2 present in juvenile spore degraded organic debris accumulate on the surface wall 3 pale yellow in colour 0.0–0.2 µm sub layers are 2.8–6.2 µm in thick in matured spores. Wall 4 laminated layer with 0.5 µm thickness producing folds , if it is very thin hyphal spore seems like recurred septum (Fig . 11).

7. *Glomus constrictum* (Trappe)

Chlamydospores are formed singly or in loose clusters in soil, subglobose to globose, 145 to 230 µm in diameter, dark brown in colour, spore wall is 8–10 µm thick, and one layered base straight, attachment occluded by wall thickening. Spore contents of oil globules widely varying in size. Attached hypha recurred, just beyond the point of attachment of the hypha, constricted 11-13 µm in diameter, hyphal wall yellow to yellow brown (Fig.12).

The description of the present species is similar to the original.

8. *Glomus fasciculatum* (Thaxter sensu Gerd) Gerd and Trappe

Chlamydospores are loosely aggregated in the soil in the form of small compact clusters and in sporocarps. Chlamydospores are 86 µm – 112.8 µm, when globose, smooth (or) seeming roughened from adherent debris, spore wall 4.3 µm in thick, hyaline is yellow to yellow brown, the thicker walls often minutely perforated with thick in ward projections, hyphal wall attachment 8.6 µm in diameter, occluded at maturity.

It resembles with the original description in all its characters, however the size of the spores is slightly bigger (Fig .13).

9. *Glomus macrocarpum* (Schench and smith)

Spores are rarely single in soil, yellowish, globose to subglobose, 110-115 µm in diameter. Rarely ovoid to pear shaped spores. Wall is composed of two layers. Wall 1 hyaline is 1.2–1.5 µm in thick, granular. Wall 2 is laminate smooth yellowish 6.6 µm in thickness (Fig. 14).

10. *Glomus microaggregatum* (Koske,Gemm and Olexia)

Sporocarps are unknown. Singly in soil, in roots or clusters in inside dead spores of other Endogonaceae, globose, yellow to brownish yellow 30-50 x 15 to 40 µm in diameter. Spore walls are two. Wall one is smooth, wall two is membranous or unit wall (Fig. 15).

11. *Glomus mosseae* (Nicol and Gerd) Gred and Trappe.

Chlamydospores are yellow to brown, globose to subglobose, 1750 x 16.5–183.6 µm with one or occasionally two funnel–shaped bases 24.24–48.94 µm diameter, divided from subtending hyphae by a curved septum; wall 4 µm thick, with a thin, often barely perceptible hyaline outer membranous and thick, brownish–Yellow inner layer (Fig. 16).

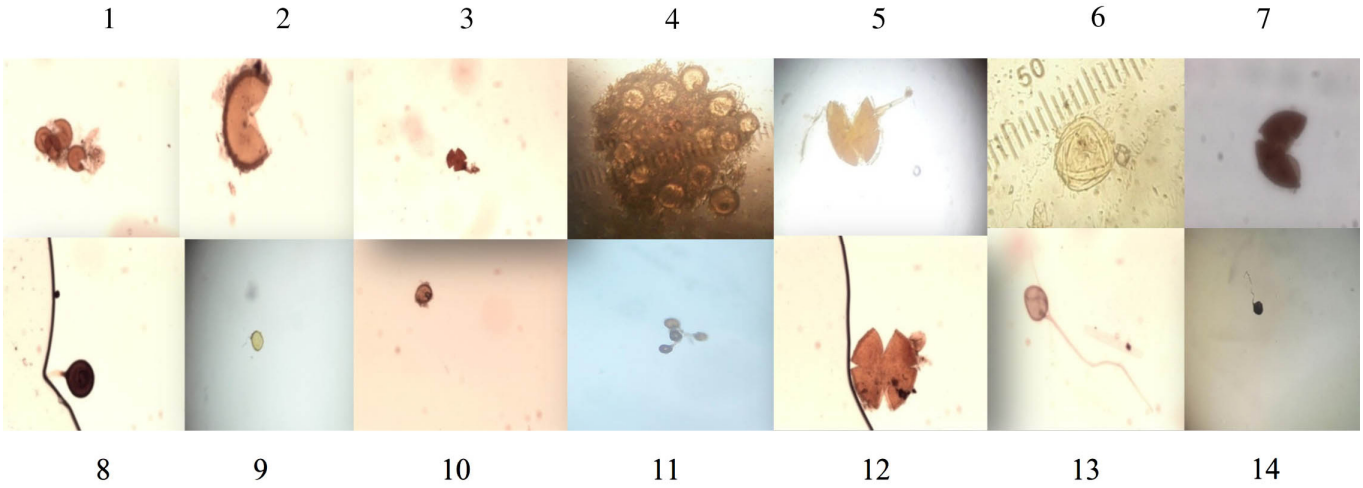
12. *Glomus viscosum* (Thaxter) Gerd. & Trappe.

Sporocarps are 13 x 10 mm in diameter forming crust on soil surface, white in colour. globose, occasionally ovoid, spore wall 4-8 µm thick. Laminate pale yellow. Thickening of spore wall extending into the hypha and nearly occluding the opening in the spore (Fig. 17).

13. *Scutellospora tepuiensis* (Furrazola & Cuenca.)

Spores are single in soil, globose to sub- globose, outer wall not clear if clear hyaline smooth 1 um in thick inner wall laminated with 2 sub walls dark yellow 5 – 7 µm separated into 2 sub layers. Wall 3 tightly attached to wall 2, wall 3, 1 µm in thickness, hyaline, membranous. Inner wall group consisting of layers 4, 5 and 6. Layer 4 is hyaline in 1.75 to 2 µm thickness; spores are smooth when crushed, wavy granular surface layer 4 attached to layer 5. Layer 5 hyaline 1 µm thicknesses, expanding to 9–30 µm in diameter (Fig. 18).

Photographs of VAM spores isolated from rhizospheric soil of Quinoa:



Aculospora delicate (Fig.1)
Aculospora nicolsoni (Fig.2)
Gingaspora margarita (Fig. 3)
Glomus aggregatum (Fig. 4)
Glomus ambisporam (Fig. 5)
Glomus claroideum (Fig. 6)
Glomus constrictum (Fig. 7)
Glomus mosseae (Fig.8)
Glomus fasciculatum (Fig.9)
Glomus macrocarpum (Fig. 10)
Glomus microaggregatum (Fig.11)
Gingospora margarita (Fig.12)
Glomus viscosum (Fig. 13)
Scutellospora tepuiensis (Fig. 14)

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