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BIODIVERSITY OF ENDOMYCORRHIZAL FUNGI ASSOCIATED WITH SOME MEDICINALLY IMPORTANT PLANTS OF HIMACHAL PRADESH

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In the present investigation, biodiversity of VAM (Vesicular Arbuscular Mycorrhizal) fungi in some medicinally important plants of Himachal Pradesh was investigated. Thirty nine species of Vesicular arbuscular mycorrhizal fungi were found associated with these medicinal plants. Fungal association was assessed and different structures like mycelium, arbuscules and vesicles were observed in the cortical cells of root. It was found that *Acaulospora* was the dominant VAM fungus followed by *Glomus, Gigaspora* and *Sclerocystis* and root colonization range from 50 to 85 percent. Highest VAM spore number was observed in *Rubus ellipticus* and minimum in *Lepidagathis cristata*.

Key words : VAM fungi, medicinal plants, *Acaulospora*, root colonization

Medicinal plants form an integral part of life of people living in urban and rural areas of Himachal Pradesh. The need of medicinal plants increased rapidly with the consumption of drugs which led to the cultivation of these medicinal plants to support the increasing demand. It is estimated that 90% land plant species harbour VAM fungi (Remy *et. al.*, 1994). The beneficial effects of VAM fungi on plant health improvement is well established (Prasad 2000, 2002). So we can uplift agricultural and forestry practices by selecting the best plant fungus combination (Abbot and Robson, 1991). Keeping in view the importance of VAM fungi the present investigation was undertaken to assess the biodiversity of VAM fungi in some medicinal plants of Himachal Pradesh.

MATERIALS AND METHODS

In the present study, soil samples from the rhizosphere of ten medicinally important plants namely *Murraya koenigii* (P_1), *Mentha viridis* (P_2), *Berberis aristata* (P_3), *Rubus ellipticus* (P_4), *Vetiveria zizanioides* (P_5), *Premna barbata* (P_6), *Fragaria vesca* (P_7), *Arisaema halliborifolium* (P_8), *Thalictrum foliosum* (P_9) and *Lepidagathis cristata* (P_{10}) were collected and stored in polythene bags at 10^0C. VAM spores were isolated and counted from 50gm soil per sample by wet sieving and decanting technique of Gerdemann and Nicolson (1963) and then identified by using the keys of Walker (1983), Schenck and Perez (1990), Morton and Benny (1990), Mukerji (1996) and Morton and Redecker (2002). Root colonization was studied by rapid clearing and staining method by Phillips and Hayman (1970) and then percent root colonization was studied by using the following formula:

$$\text{Percent root colonization} = \frac{\text{No. of root segments infected}}{\text{Total no. of root segments studied}} \times 100$$

RESULTS AND DISCUSSION

All typical VAM features such as arbuscules, vesicles, intracellular hyphal coils, extra and intraradical hyphae were observed in the root samples. Glomalean fungal community in the rhizosphere soil of ten medicinal plants comprised of four genera i.e. *Acaulospora, Glomus, Gigaspora and Sclerocystis* with a total of thirty nine species (Table-2). Among these *Acaulospora* was the predominant genus represented by eighteen species, *Glomus* was represented by twelve species and *Gigaspora* by eight species and *Sclerocystis* by one species (Table-2). All the species were very well distributed and represented (Table-1). On global scale, VAM fungi are virtually ubiquitously present in tropical, temperate and arctic regions. With in the global regions, VAM fungi have broad ecological

Table 1: Occurrence of VAM fungi in some medicinally important plants

Sr. No.	Botanical name of plant	Common name of plant	Family	Presence of M	A	V	% Root colonization	VAM spore No.
1	*Murraya koenigii*	Gandhila	Rutaceae	+	+	-	75 ± 0.52	82 ± 2.64
2	*Mentha viridis*	Mint	Labiateae	+	-	-	50 ± 0.81	148.6 ± 1.52
3	*Berberis aristata*	Kasmal	Berberidaceae	+	+	-	63 ± 1.29	160 ± 6
4	*Rubus ellipticus*	Akha	Rosaceae	+	+	+	81 ± 0.5	266 ± 3.60
5	*Vetiveria zizanioides*	Barya	Poaceae	+	+	+	85 ± 1.50	109 ± 2.64
6	*Premna barbata*	Bankar	Verbenaceae	+	+	+	80 ± 0.95	230 ± 1
7	*Fragaria vesca*	Strawberry	Rosaceae	+	+	+	83.3 ± 0.95	222 ± 2.64
8	*Arisaema halliborifolium*	Kidachalli	Araceae	+	+	+	68 ± 0.95	106 ± 4.04
9	*Thalictrum foliosum*	Meadow Rue	Ranunculaceae	+	+	+	59 ± 0.81	106 ± 3.60
10	*Lepidagathis cristata*	Bralu	Acanthaceae	+	-	-	52.5 ± 0.5	55 ± 0.5

M- Fungal mycelium; A- Arbuscules; V- Vesicles; (-) shows absent; (+) shows present. ± Standard Deviation

range. They are found in most of the ecosystems like woodlands, dense rain forests, grasslands, arid and semi arid deserts (Mehrotra *et al.*, 1997). There are many reports of mycorrhizal occurrence, status and diversity in medicinally important plants of India (Aggarwal *et al.*, 2005; Beena *et al.*, 2000; Muthukumar and Udaiyan, 2000).

The present findings are in agreement with the numerous reports on widespread occurrence of VAM fungi through out the world (Talukdar and Germida, 1993). In the present investigation, the total spore density did not correlate with mycorrhizal colonization possibly because of the presence of diverse population of VAM fungal species. The present results are in agreement with findings of Mehrotra (1998). According to Mehrotra (1998), these differences might be due to the presence of diverse type of VAM fungi in the rhizosphere soil of individual plant species or might be a manifestation of greater host susceptibility to VAM fungi. Both the species richness and spore density of VAM fungi depend upon the area, season and yearly variation in precipitation and temperature (Allen *et al.*, 1995). Formation of vesicles in the present investigation was inconsistent and fluctuating from plant to plant. VAM hyphae were observed in all the plant species. The formation of arbuscules is influenced by the stage of the plant development and is a short lived structure. In the present study, arbuscules are seen in all the plants except *Mentha viridis* and *Lepidagathis cristata*. According to Mosse *et. al.*, (1981) arbuscules are normally found during active vegetative growth due to availability of new cortical cells and high nutrient requirement by the host. At later stages, arbuscule formation decreases and vesicle formation increases. According to Toth *et al.*, (1990) the area of host protoplast during VAM infection is more in monocot than in dicots. In the present investigation, a monocot *i.e Vetiveria zizanioides* showed maximum root colonization (85%) in comparison to other nine dicots.

It can be concluded from the present study that the widespread presence of *Glomus* and *Acaulospora* in the soil makes it more favoured fungi for mass multiplication as well as seedling inoculation for better establishment of these medicinally important plants. All the plant species harbour mycorrhizal association however, these plants must possess adequate amount of mycorrhizal colonization at the planting stage in order to survive and perform better in adverse plantation sites.

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Table-2: Distribution of different VAM fungi in the rhizosphere soils of various medicinal plants

Sr. No.	VAM Fungi	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}
1	*Acaulospora lacunosa* Morton	-	-	+	+	+	+	+	+	+	+
2	*Acaulospora foveata* Trappe & Janos	-	-	-	-	-	-	+	-	+	-
3	*Acaulospora spinosa* Walker & Trappe	-	-	-	-	-	-	+	-	+	-
4	*Acaulospora laevis* Gerdemann & Trappe	-	-	-	-	-	+	+	-	+	-
5	*Acaulospora mellea* Spain & Schenck	-	-	-	+	-	+	+	-	-	-
6	*Acaulospora scrobiculata* Trappe	-	-	-	-	-	-	+	-	+	-
7	*Acaulospora bireticulata* Rothwell & Trappe	-	-	-	+	+	+	-	+	+	-
8	*Acaulospora nicolsonii* Walker, Reed & Sanders	-	-	-	-	+	-	-	-	-	-
9	*Acaulospora trappe* Ames & Linderman	+	-	-	-	+	-	-	-	-	-
10	*Acaulospora rehmi* Sieverding & Toro	-	+	-	+	-	+	-	-	-	-
11	*Acaulospora gerdemanii* Schenck & Nicolson	-	-	-	-	-	+	-	-	-	-
12	*Acaulospora* sp.1	+	-	-	-	-	-	-	-	-	-
13	*Acaulospora sp.2*	-	+	-	-	-	+	-	-	-	-
14	*Acaulospora sp.3*	-	-	+	-	-	-	-	-	+	-
15	*Acaulospora sp.4*	-	-	-	+	-	-	-	+	-	-
16	*Acaulospora sp.5*	-	-	-	-	+	-	-	-	+	-
17	*Acaulospora sp.6*	+	-	-	-	-	+	-	+	-	-
18	*Acaulospora sp.7*	-	-	-	-	-	-	-	+	-	-
19	*Glomus geosporum* Nicolson & Gerdemann	-	-	+	+	-	-	-	-	-	-
20	*Glomus multicaulis* Gerdemann & Bakshi	-	-	+	-	-	-	+	-	-	+
21	*Glomus deserticola* Trappe Bloss & Menge	-	-	+	-	-	-	-	-	+	-
22	*Glomus macrocarpum* Tulsane &Tulsane	-	-	-	+	-	+	+	-	-	-
23	*Glomus pulvinatum* Trappe & Gerdemann	-	-	-	-	-	-	+	-	-	-
24	*Glomus constrictum* Trappe	-	-	-	-	-	-	-	-	-	+
25	*Glomus pallidum* Hall	-	-	-	-	-	-	-	-	-	+
26	*Glomus convolutum* Gerdemann & Trappe	-	-	-	-	-	-	-	-	+	-
27	*Glomus aggregatum* Schenck & Smith	-	-	-	+	-	-	-	-	-	-
28	*Glomus fasciculatum* Walker & Korke	-	+	-	-	-	-	+	-	-	-
29	*Glomus sp.1*	-	-	-	-	+	-	-	-	-	-
30	*Glomus sp.2*	-	-	-	-	-	-	-	-	+	-
31	*Gigaspora gigantia* Gerdemann & Trappe	-	+	-	-	-	-	-	-	-	-
32	*Gigaspora sp.1*	+	-	-	-	-	-	-	-	-	-
33	*Gigaspora sp.2*	-	+	-	-	-	-	-	-	-	-
34	*Gigaspora sp.3*	-	-	+	-	-	-	-	-	-	-
35	*Gigaspora sp.4*	-	-	-	+	-	-	-	-	-	-
36	*Gigaspora sp.5*	-	-	-	+	-	-	-	-	-	-
37	*Gigaspora sp.6*	-	-	-	-	+	-	-	-	-	-
38	*Gigaspora sp.7*	-	-	-	-	-	-	-	-	+	-
39	*Sclerocystis* sp.	-	-	-	-	-	-	+	+	-	-

- shows absent; + shows present

P_{1-} *Murraya koenigii;* P_{2-} *Mentha viridis;* P_{3-} *Berberis aristata;* P_{4-} *Rubus ellipticus;* P_{5-} *Vetiveria zizanioides;* P_{6-} *Premna barbata;* P_{7-} *Fragaria vesca;* P_{8-} *Arisaema halliborifolium;* P_{9-} *Thalictrum foliosum;* P_{10-}*Lepidagathis cristata*

REFERENCES

Aggarwal A, Parkash V, Sharma D & Sharma S 2005 Mycorrhizal occurrence, status and diversity of some ethnobotanical plants of Himachal Pradesh. In: *The Fungi-Diversity and Conservation in India.* (eds Dargan J. S., Atri, G. S. & Dhingra, J. S.). Bisen Singh Mahendara Pal Singh. Dehradun, pp. 241-251.

Beena K R, Raviraj N S, Arun & Sridhar K R 2000 Diversity of arbuscular mycorrhizal fungi on the coastal sand dunes of west coast of India. *Current Science* **79**(10) 1459-1465.

Diaz E & Roldan A 2000 Effects of reafforestation techniques on the nutrient content, photosynthetic rate and stomatal conductance of *Pinus halepensis* seedlings under semi-arid conditions. *Land Degradation and Development* **11**(5) 475-486.

Gerdemann J W & Nicolson Y H 1963 Spores of mycorrhizae *Endogone* species extracted from soil by wet sieving and decanting. *Trans Brit Mycol Soc* **46** 235-244.

Harley J L & Smith S E 1983 Mycorrhizal Symbiosis. Academic Press, New York. 483 pages.
Morton J B & Benny G L 1990 Revised classification of arbuscular mycorrhizal fungi. (Zygomycetes): A new order, Glomales, two new suborders, Glomineae and Gigasporineae, with an emendation of Glomaceae. *Mycotaxon* **37** 471- 491.

Mosse B 1981 Vesicular-arbuscular mycorrhizal research for tropical agriculture. *Research Bulletin* **194** 5-81.

Mukerji K G 1996 Taxonomy of endomycorrhizal fungi. In: *Advances in Botany*.(eds Mukerji KG, Mathur B, Chamola B P & Chitralekha P). APH Pub. Co. New Delhi, pp. 211-221.

Mehrotra R S, Aggarwal A, Rani P & Kumar J 1997 Role of mycorrhizal fungi in reclamation of desert land soils. In: *Modern Approaches and Innovations in Soil Management*. (eds Bagyaraj D J, Verma A, Khanna K K & Kehri H K). Rastogi Publ Meerut.pp189-194.

Mehrotra V S 1998 Arbuscular mycorrhizal association of plants colonizing coal mine soils of India. *Journal of Agricultural Sciences* **130** 123-133.

Muthukumar B C & Udaiyan K 2000 Arbuscular mycorrhizas of plants growing in the Western Ghats region, Southern India. *Mycorrhiza* **9** 297-313.

Morton J B & Redecker D 2002 Two new families of Glomales, Archaeosporaceae and Paraglomaceae with two new genera, *Archaeospora* and *Paraglomus*, based on concordant molecular and morphological characters. *Mycologia* **93** 181-195.

Prasad K 2000 Growth responses of *Acacia nilotica*(L.) Del. inoculated with *Rhizobium* and *Glomus fasciculatum* VAM fungi. *Journal of Tropical Forestry* **16**(1) 22-27.

Prasad K 2002 Effect of arbuscular mycorrhizae on biomass yield, uptake and translocation of nitrogen, phosphorus and potassium in *Azadirachta indica* L. In: *Frontiers in Microbial Biotechnology and Plant Pathology*.(eds Manoharachary C, Purohit D K, Reddy SR, Singaracharya M A & Girisham S). Scientific Publishers Jodhpur pp 187-191.

Phillips J M & Hayman D S 1970 Improved procedures for clearing roots and staining parasitic and VAM fungi for rapid assessment of infection. *Trans Brit Mycol Soc* **55** 158-161.

Remy W, Taylor T M Hass H & Kerp H 1994 Four hundred-million-year-old vescular arbuscular mycorrhizae. *Proceedings of the National Academy of Sciences of the United States of America* **91** 11841-11843.

Schenck N C & Perez Y 1990 *Manual for the identification of VA mycorrhizal VAM fungi*.University of Florida Press,Florida,USA pp 241.

Toth R Doane C Bennett E & Alexander T 1990 Correlation between host fungal surface areas and percent colonization in VA mycorrhizae. *Mycologia* **82** 519-522.

Talukdar N C & Germida J J 1993 Occurrence and isolation of vesicular-arbuscular mycorrhizae in cropped field soil of Saskatchewan. *Canadian Journal of Microbiology* **39** 575-578.

Walker C 1983 Taxonomic concepts in the Endogonaceae spore wall characteristics in species description. *Mycotaxon* **18** 443-445.