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Vesicular–arbuscular Mycorrhizal Status of Plants Growing in Rock Crevices of Valley Samahni

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Abstract: The Mycorrhizal status of plants growing in the rock crevices of valley Samahni, Azad Kashmir are described for the first time. For this purpose five different stands were selected from different areas of the valley. Mostly angiospermic trees, shrubs and herbaceous species including grasses, i.e., *Themeda anathera*, *Heteropogon controtus* and *Eriophorum cosmosum* were found growing in these rock crevices. Forty-three plant species belonging to 26 different families in these 5 stands were reported for VAM infection during the period March – September 1999. A comparative study of the five stands for VAM status revealed great variations in infection percentages of the same plant species in different stands. In certain cases arbuscules while in others vesicles were absent. In some plants both vesicles and arbuscules were found to be lacking. Soils were generally loamy to sandy loamy type with pH varying from 7.4 to 7.8, organic matter 0.42 to 1.00%, phosphorous 4.36 to 12.5 ppm. Cultivated crops can be important factor in increasing productivity under adverse conditions.

Key Words: VAM infection, vesicular- arbuscular mycorrhizal status, Samahni valley

Introduction

Samahni is the beautiful valley situated in district Bhimber (AJ and K). It stretches over an area of 760395 kanals. The forests are found on all slopes but the condition of stocking and regeneration is very poor on exposed and hotter aspects. Mycorrhiza is a kind of mutualistic symbiotic association. This is a situation between two living partners, where both the members, i.e., fungi and roots of higher plants get benefit from each other without any harm (Harley and smith, 1983).

Vesicular–arbuscular mycorrhizae have a long history of existence in the roots of higher plants but they may develop some special associations with certain host plants (Mosse, 1981). These Vesicular-arbuscular mycorrhizal endophytes have now been reported in pteridophytes, i.e., marsilia, some mosses and bryophytes also have VAM infection (Nasim, 1990). There is no such reference on the vegetation of samahni valley inhabiting the micro fungi in their roots. The objectives of this study were to investigate the vesicular – arbuscular mycorrhizal status of plants growing in the crevices of rocks in some parts of Samahni valley.

Materials and Methods

The plant communities existing in rock crevices of valley Samahni were studied for the assessment of vesicular–arbuscular mycorrhizal infection during the period March- September, 1999. Luxmeter was used for measuring light intensity.

Collection of plants: The plants were dug out carefully with the help of spatula without injuring the finer rootlets. The plants were collected in small polythene bags and brought to Soil Microbiology Research Lab, Department of Biological Sciences, Quaid-I-Azam University, Islamabad.

Assessment of endomycorrhizal infection in roots: Roots of each plant were collected, washed very gently with distilled H_2O to remove the soil particles. The roots were then fixed in fixative (FAA) for 24 hrs. Fixed roots were washed and processed according to the method of Philips and Hayman (1970). Ten pieces of 1cm length of each plant were cut randomly and mounted in a drop of lactophenol stain. The segments were then examined under microscope for the assessment of endomy corrhizal infection.

For the percentage of vesicular-arbuscular mycorrhizal infection 10 root segments were drawn at random from above pool of processed roots.

Percentage of infection was calculated by the following formula (Giovannetti and Mosse, 1980):

$$\text{Root colonization} = \frac{\text{Number of infected segments}}{\text{Total number of segments}} \times 100$$

Plants were identified with the help of available literature (Nasir and Ali, 1970 - 1987). Soil was sampled upto a depth of 15cm and analyzed for physical and chemical features in Soil Analysis Laboratory, Agriculture Research Center, Muzaffarabad.

Results and Discussion

Data for comparative study of the five stands for Mycorrhizal status is given in Table 1. Following five stands were studied for VA mycorrhizal infection.

Stand I: This stand was taken from Panhyari. The exposure to sunlight was North – East and light intensity was high at noon, i.e. 828 lux (Table 2). This stand was established on sandy loam soil with pH of 7.6 (Table 3). Organic matter and phosphorous contents were moderate (Table 3). The common species in this stand was *Adiantum capillus veneris*. The highest VAM infection i.e. 100 and 80% was confined to *sonchus asper* and *solanum nigrum* respectively (Table 1). The highest % age of vesicular infection was confined to *Cannabis sativa,* while normal % age of arbuscular infection was confined to *Ficus palmata* (Table 1).

Stand II: This community was taken from Bandi – Sandallah on 20 April, 1999. The exposure to sunlight of this community was North – East and at moon the high light intensity was 609 lux (Table 2). This stand was present on loamy soil exhibiting slightly high organic matter content i.e., 0.92 % (Table 3). The abundant species in this stand was *Malvestrum coromandelian*. The frequency of occurrence of general infection to *M. coromandelian* was 10%. An extent of aseptate mycelium was 11.51 cm 100 cm^{-1}. The highest % age of arbuscular infection was observed in *Cynodon dactylon* i.e., 40% (Table 1).

Stand III: This stand was taken from Jandallah. The exposure to sunlight was towards North. This stand was present on sandy loamy soil exhibiting high content of organic matter i.e., 1 % (Table 3). The abundant species in this stand was *Eriophorum cosmosum*. The frequency of occurrence of total general infection was 40%, 20 spores were present. An extent of aseptate mycelium was 57.65 cm 100 cm^{-1}.

Table 1: Comparative study of the five stands for mycorrhizal status

		% VAM infection in stands				
Plant Species	Family	1	2	3	4	5
Trees						
Dalbergia sissco Roxb.	Papilionaceae	-	-	70	30	-
Ficus palmata Forssk.	Moraceae	60	10	30	70	10
Ficus carica (L.)	Moraceae	10	-	-	-	-
Grawia villosa Willd.	Tiliaceae	-	-	-	80	60
Morus alba (L.)	Moraceae	-	30	40	-	20
Melia azadirachta (L.)	Meliaceae	-	-	-	80	30
Robinia pseudoacacia (L.)	Leguminosae	-	-	30	-	-
Shrubs						
Calotropis procera (Wild) (R.Br.)	Asclepiadaceae	-	-	-	-	80
Carissa opaca Stapf ex Haines	Caricaceae	50	-	10	20	-
Justicia adhatoda (L.)	Acanthaceae	-	-	60	-	-
Mallotus philippensis (Lam) Muell.	Euphorbiaceae	40	-	-	-	-
Maytenus reyleanus Wall ex. Lawson cufodont.	Martyniceae	-	-	40	-	-
Ziziphus jujuba Lam. non. Ll Mill;	Rhamnaceae	-	-	-	30	-
Herbs						
Ajuga bracteosa Wall. ex Bth.	Labiatae	-	-	10	20	30
Arteemisia scoparia Waldest and Kit.	Compositae	-	-	20	-	10
Cannabis stavia (L.)	Cannabinaceae	60	-	-	-	-
Chrysanthemum chrysanthmoides.	Compositae	-	-	-	70	-
Commelina benghalensis (Linn).	Commelinaceae	-	-	-	-	40
Conyza aegyptiaca Ait.	Compositae	-	-	40	-	-
Conyza bonariensis (L.) Cronquist.	Compositae	-	-	-	-	20
Conyza canadensis (L.) Croquist	Composita	-	-	80	-	-
Cynodon dactylon (L.)	Graminae	-	40	-	50	80
Eriophorum cosmosum (Wall. ex Rbx) Nees.	Cyperaceae	50	10	40	10	-
Heteropogon controtus (Dc.) Roem and shult.	Poaceae	-	20	10	30	10
Ipomoea pestigridis (Linn).	Convolvulaceae	-	-	-	-	60
Justicia peploides (Ness in Wall) T. Anders	Acanthaceae	-	-	-	-	60
Malvestrum coromandelianum (L.) Garcke.	Malvaceae	-	10	30	60	30
Mentha longifolia (L.) Huds.	Labiatae	10	-	-	-	-
Micromeria biflora (Ham) Bth.	Labiatae	40	10	90	20	20
Oxalis corniculata (L.)	Oxalidaceae	10	10	80	60	90
Panicum psilopodium Hook. F.	Poaceae	-	-	-	-	60
Phyllanthus niruri (L.)	Phrymaceae	-	-	-	-	10
Polygonum glabrum willd.	Polygonaceae	-	-	-	60	-
Solanum nigrum (L.)	Solanaceae	80	-	30	10	10
Sonchus asper (L.) Cyt.	Compositae	100	70	60	100	-
Taraxacum officinale Weber.	Compositae	50	80	-	30	10
Themeda anathera (Ness ex Steud.) Hack.	Poaceae	30	60	30	10	-
Xanthium strunarium (L.).	Compositae	-	-	-	-	60
Pteridophytes						
Adiantum capillus veneris L.	Pteridaceae	50	-	-	-	-
Adiantum incisum Forssk	Pteridaceae	-	10	-30	40	
Pteris cretica (L.) Hook.	Pteridaceae	70	-	-	-	-
Pteris vittata (L).	Pteridaceae	-	-	-	30	-
Bryophytes						
Marchantia spp.	Marchantiaceae	-	30	-	-	20

VAM: Vesicular - Arbuscular Mycorrhizal   1 2 3 4 5: Stands for Mycorrhizal status   "- " The Plant species not present in the stands

Table 2: Comparison of light intensity among different stands of investigated area

				Light intensity 20,000 (Lux)			
Stand	Locality	Date	Exposure	Morning	Noon	Evening	Total No of plants
1	Panyari	23.03.1999 Sunday	North east	769	828	716	421
2	Bandi Jandllah	20.04.1999 Saturday	North east	374	609	410	120
3	Jandllah	20.07.1999 Sunday	North	440	536	219	238
4	Ghai	23.07.1999 Wednesday	East	612	776	580	337
5	Barjah	07.09.1999 Sunday	North	210	480 (Cloudy)	190	249

Table 3: Comparison of soil among different stands of investigated area

	Quantity				
Quality	Stand-I	Stand II	Stand III	Stand IV	Stand V
Saturation	28	36	30	27	30
Texture	Sandy loam	Loam	Sandy loam	Sandy loam	Sandy loam
pH	7.6	7.4	7.6	7.8	7.6
Organic matter (%)	0.67	0.92	1.0	0.42	0.92
Available phosphorus (lb acr^{-1})	19.00	120.00	20.00	120.000	80.00
Available Potash (lb acr^{-1})					

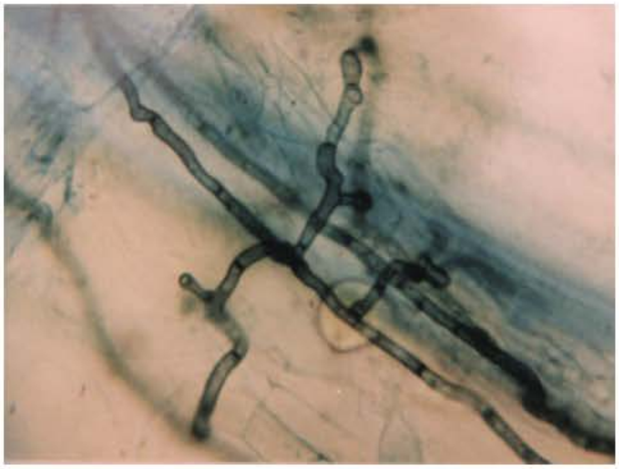

Fig. 1: A root segment showing branched septate mycelium with small terminal vesicles in the cortical cells of *Dalbergia sissoo*.(400x)

Fig. 2: Aseptate mycelium in the root cortex of *Micromeria biflora*. (400x)

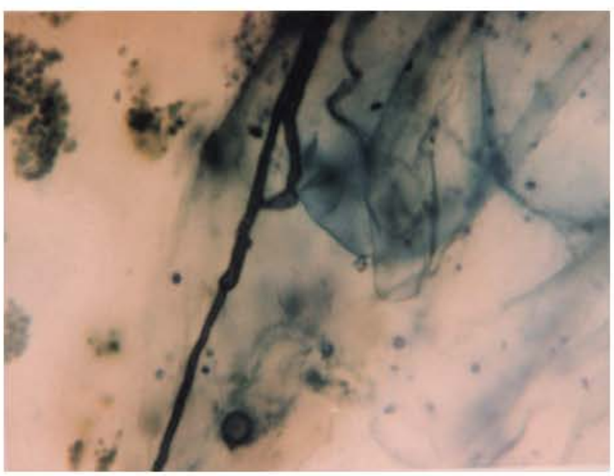

Fig. 3: Septate mycelium forming clamp-connection in the root cortical cells of *Carissa opaca.(400 x)*

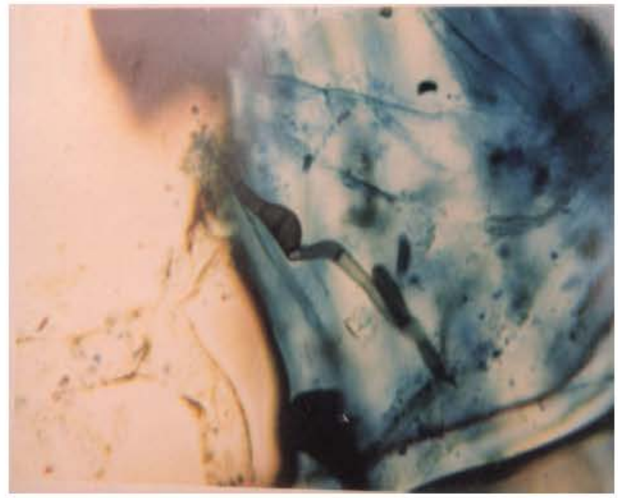

Fig. 4: Septate mycelium forming terminal conidia in the root cortex of *Themeda anathera*. (400 x)

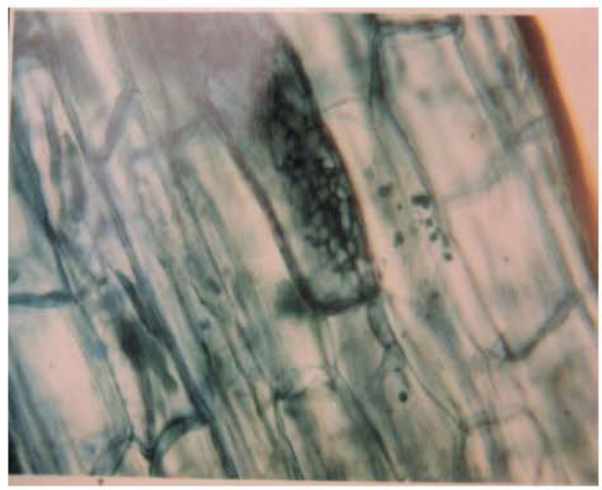

Fig. 5: A portion of root showing dichotomously branched arbuscules in the cortex of *Adiantum capillus veneris*. (400 x)

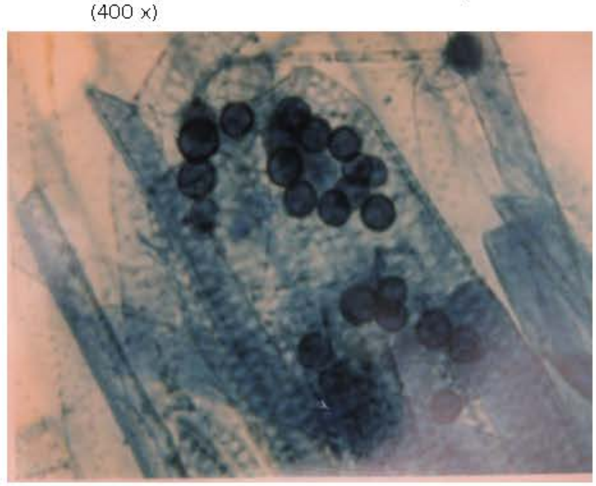

Fig. 6: Rounded thick walled VAM spores within the root cortex of *Morus alba*.(400 x)

Stand IV: This stand was taken from Ghai. The exposure to sunlight of this community was towards the east. The stand was present on sandy loam soil and exhibits relatively high amount 120.00-lb acr^{-1} of phosphorous (Table 3). The highest general infection, i.e., 100% was confined only to *sonchus asper*. The %age of vesicular infection was 70% and the infection of arbuscules was 10% (Table 1).

Stand V: This stand was taken from Barjah. It had North exposure. The soil is sandy loam and exhibits relatively high amount 0.92% of organic matter (Table 3). The highest general infection, i.e., 80% was confined to two species, *Calotropis procera* and *Cynodon dactylon* respectively (Table 1).

Great variations were found in the percentage occurrence of general VAM infections in different stands. In some plant species vesicles, while in others arbuscules were not seen. Spherical and elongated vesicles were seen in different species. In some cases (*Dalbergia sisso*) septate (Fig. 1), while in others (*Micromeria biflora*) aseptate hyphae were noted (Fig. 2). Hyphae forming clamp-connections were observed in *Carissa opaca* (Fig. 3) and conidia were also noted in *Themeda anathera* and photomicro graphed (Fig. 4). Small dichotomously branched arbuscules were present in Adiantum *capillus-veneris*. (Fig. 5). Rounded and thick-walled spores were seen (*Morus alba*) in the cortex and photomicrographed (Fig. 6).

Angle of exposure to sunlight seems to play an important role in determining the type of plants in rock crevices. All the five stands were exposed to the sun differently at different time intervals of a day. In high light intensity infections become abundant (Tabassum, 1986). It could be due to the fact that arbuscules could obtain more phosphates through fungal endophytes and these plants grow better than the plants with poor arbuscules (Hayman, 1970). Light intensity and nutrient availability influence the degree of mycorrhizal development. The possible explanation for this could be that high light intensity increases the amount of carbohydrates in the roots due to high photosynthetic activity of the plant. Thus the roots become more susceptible to mycorrhizal infections (Marx, 1972). The soil in the crevices was in the form of an absorbent web like material consisting of roots and decaying plant parts. So the present study also supports the view that infection spread, by root to root or mycelial contact (Rend *et al.*, 1976; Iqbal and Bareen, 1989). The absorbent web gives stability to the rocky walls against erosion by water.

It seems that in the investigated area phosphorus nitrogen and potash were deficient. That is why fungi were attached to the roots of plants, which collect the phosphorous nitrogen and potassium from soil and supply to the plants for their proper growth. Smith (1980) also reported that infection by VAM fungi may promote plant growth by enhancing the uptake of phosphate from the soil. The association of vesicular–arbuscular mycorrhizal fungi with roots of higher plants has greater land reclamation and agricultural practices on arid and acid lands, where drought and low soil fertility can be a major constraints to crop production. These results are in agreement with Sadia (1994), Gorsi *et al.* (1998) and Bilqees (2001), who concluded that plants in rock crevices play an important role in stability of rocks and mycorrhiza is indirectly playing a fundamental role in the establishment of plants in these crevices.

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