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Pakistan Journal of Biological Sciences, 2 (3): 778-780, 1999 **Research Articl**

Interactions among Arbuscular mycorrhizal (Am) Inoculum Potential of Soil, Landscape Position and Erosion

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Abstract
Edaphic conditions are largely responsible for arbuscular mycorrhizal (AM) spore density in soil. The soil characteristics Margalla hills were analyzed for AM root colonization and spore density. Root colonization and spore number were leas the soil collected from most erosive positions. Topsoil eroded from surface showed relatively low AM inoculum poten whereas that of captured soil collected from the foot-hills revealed high potential. The numbers of spores recovered by sieving technique were significantly greater in captured soil. Spots that trap eroded surface soils moving down slope act as an important reservoir of AM inoculum. It seems that the soil environment of Margalla hills will change as soon annuals colonize the hills and this will improve conditions for mycorrhizal fungi to increase.

Introduction
The occurrence of AM is widespread in natural vegetation and various soils (Brundrett, 1991), but because intensity of infection varies amongst individuals and species (Fitter and Merryweather, 1992) as well as due to edaphic characteristics (Allsopp and Stock, 1994; Rashid *et al.*, 1997), data on mycorrhizal distribution in soil and floras does not necessarily indicate mycorrhizal activity in different plant communities nor it gives a true picture of rhizospheric propagules density.

The soil contains AM spores as well as propagules. The term propagule refers a broader meaning and it includes fragments of mycelium, colonized root pieces and spores capable of producing mycorrhizal infection. Topsoil is considered a reservoir of fungal spores and other propagules of organisms important for decomposition, nutrient cycling, and mycorrhiza formation (Moorman and Reeves, 1979; Sieverding, 1991). That is why establishment and growth of mycorrhiza-dependent plants are significantly affected by availability of mycorrhizal fungi (Allen, 1991; Trappe and Luoma, 1992).

The present study was conducted on Margalla hills, Islamabad. The vegetation of Margalla hills is scrub type mixed with Pines. Forest fire in Margalla hills is an annual phenomenon. It occurs mostly between March 15, through July 15 followed by rainy season of August and September. Forest fire whether deliberate or accidental, results in loss of plant cover that in turns make the slopes devegetated and exposed (Rashid and Ahmad, 1996). The Margalla ecosystem is quite complex to understand due to the interaction of factors like fire devegetation, heavy rain fall particularly in Monsoon season and steep slopes resulting in dynamism in vegetation types and soil conditions. At present these hills experience severe erosion stress because changes in site and soil conditions after intense burning greatly influence erosion potential (Amaranthus and McNabb, 1984).

Considering these threats as disturbing factors the present study was undertaken to improve understanding of the interrelationships among mycorrhizal inoculum potential, soil erosion and landscape. For this purpose eroded soil and captured soil were used as AM inoculum source. It was hoped that highlighting the erosion effects on mycorrhizal fungi would enable us to know the consequences of eros phenomenon and its effect on the establishment of ne growing plant species that are mycorrhizal dependent. addition to that this study will also provide the means suggest effective conservatory measures to prevent eros losses.

Materials and Methods
Soil was collected from Margalla hills Islamabad. For purpose two regions were selected and five unifor spaced soil cores (4-cm diameter and 3-inches deep) w taken from each site. The region one was hill top where was mostly eroded and the samples taken from that reg were name as "exposed soil". Second set of soil samp was obtained from the foot-hills where the eroded coming from top had been accumulated. These were na as "captured soil". Prior to examine, all the soil samp were passed through a 2-mm sieve to remove coarse and rock fragments.

Ten 200 ml capacity disposable pots were taken and f with respective soil. Each pot was marked with corresponding soil code (exposed or captured). In each two pre-germinated seedlings of clover (*Trifolium*) w transplanted and watered at field capacity for eight we The clover plants were lifted after eight weeks, roots w washed gently with tap water to remove the attached particles. Fine root segments were then fixed in F (Formalin, Acetic acid and Alcohol, 5:5:90). Fixed r were cleared by autoclaving in 2.5 percent KOH solution 3-5 minutes (15 lb/inche^2). Roots were then washed u tap water and stained in Acid Glycerol Analine Blue autoclaving for 3-5 minutes (Koske and Gemma, 19 Stained root samples were cut into pieces (1cm each). root pieces of each root sample were carefully place the slide and gently covered with cover slip. These segments were then examined under microscope. For assessment of AM root colonization, slide length me was used (Giovannetti and Mosse, 1980).

The wet sieving and decanting technique (Gerdemann Nicolson, 1963) was applied to isolate AM spores from samples and their number was counted by the hel stereoscope.

The data of spore counts was subjected to chi-square followed by Tukey's Studentized Range test for comparison of means.

Results

The AM colonization was recorded in three categories i.e., hyphal, vesicular and arbuscular. The results of AM colonization revealed that clover grown in captured soil had higher infection percentage. On the other hand percentage of AM root colonization was very low in exposed soil. In all the samples of exposed soil, the hyphal infection ranges from 41 percent to 18 percent (Table 1). In case of vesicular infection these values ranged between 11 percent and 5 percent while arbuscular infection was observed only in three root samples whereas the other two root samples of clover plants were devoid of any arbuscular appearance (Table 1).

Table 1: Percentage root length colonization by AM fungi in clover, grown in exposed and captured soil, collected from Margalla Hills Islamabad

	Infection percentage		
Soil sample	Hyphal	Vesicular	Arbuscular
Exposed			
1	33	10	3
2	41	6	-
3	25	5	4
4	20	4	-
5	18	11	2
Captured			
1	61	16	7
2	73	14	10
3	55	19	9
4	65	21	7
5	72	11	2

Clover plants grown in captured soil manifested onsiderably higher AM colonization compared to exposed oil. All three types of infection i.e., hyphal, vesicular and rbuscular shows greater values (Table 1). The percentage f hyphal infection was observed 73 percent maximum to 55 percent minimum. Values for vesicular infection were etween 21 percent and 11 percent while arbuscular nfection was recorded in all root samples of clover. The aximum infection percentage for arbuscules was 10 while inimum 2 percent (Table 1).

he total number of spores isolated from exposed soil was gnificantly lower compared to captured soil. In case of posed soil, maximum 225 spores were recovered from 50 of soil sample while the minimum number was 55 spores. wever, in 50 g captured soil maximum 403 spores were overed whereas the lowest spore count was 195 (Table

scussion

r study suggests that there exist a positive correlation tween spore number and AM root colonization. Greater l infection was observed in plants which were grown in soils of upper few inches (captured) with maximum spore density. As surface soil is virtually more vulnerable to erosion particularly in the case of Margalla hills, that is why in exposed soil comparatively less AM root colonization was observed. In addition to that loss of top soil is considered hazardous because much of the nutrients are removed as well as AM spore abundance decreased. The highest density and infectivity of AM spores is reported in surface soil (Daniels and Skipper, 1982; Amaranthus and Trappe, 1993) probably this is the prime reason that we have observed a direct relation between spore number and root colonization. The earliest studies regarding the effects of varying landscape position on AM fungi highlighted similar results as well (Day *et al.*, 1987).

Table 2: Mean ± SD spore count 50 g (-1) soil by wet sieving and decanting technique

Sample	Exposed soil (spore number)	Captured soil (spore number)
1	$225^a \pm 39$	$277^a \pm 41$
2	$116^a \pm 20$	$326^b \pm 38$
3	$90^a \pm 17$	$195^b \pm 22$
4	$55^a \pm 18$	$219^b \pm 57$
5	$68^a \pm 21$	$403^b \pm 34$

Mean values in a line, followed by different letters are significantly different at $P < 0.01$ ($n = 3$).

Another hypothesis explaining the increased inoculum density in foot-hill soils is that overland flow (due to fire devegetation and rainfall), transported inoculum down the slope. If this were true, significantly greater values of spore counts might be expected in lower, depositional areas of the Margalla hills. Our results pertaining mean values of spore counts (Table 2) gave a clear indication of this. These findings are in consistent with those of Day *et al.* (1987) where significant effect of landscape position was observed on number of AM fungal spores.

On the study site, from where soil samples were collected, only remnants of some burnt stumps were visible and plant cover was very much reduced. Much of the organic matter was consumed by fire thus bare mineral soil was exposed with reduced surface infiltration and water holding capacity. This exposed soil showed low AM inoculum potential (Table 1) because mycorrhizal spores persisted without living host plants for about 6 months. Allen *et al.* (1984) reports even longer persistence after the eruption of Mount St. Helens which was about more than 24 months. Persistence in viability of inoculum in field for more than two years is uncertain, because well-dried inoculum can be stored successfully in closed containers at cool temperatures for many years, but if the soil is somewhat moist as in the case of Margalla hills, the spores deteriorate from the attack of microorganisms within two years (Sieverding, 1991).

Comparison of exposed and captured soils further revealed that both these soils not only varies in type but they also experience different kind of disturbances. In this context, both exposed and captured soil seems to belong to different micro-environments. Exposed being under severe erosion stress resulting in a continuous commotion. On the other hand the site of captured soil was relatively less disturbed and here AM population seems to be more stable. Although minor or gradual disturbances in agricultural and natural ecosystem may, or may not, lead to marked changes in mycorrhiza formation. Populations of AM fungi are considered to be capable of adjusting to gradual changes in the environment without abrupt changes in the extent of colonization. In contrast, more extreme or rapid environmental changes such as those associated with mining or erosion, may markedly decrease mycorrhiza formation (Abbott and Robson, 1991). However, our results have indicated that on exposed sites, population of AM fungi is in the phase of adjustment. As soon as soil surface conditions improve, AM fungi and their host plants will evolve and their interdependence will be a contributing factor in the stability of plant communities in Margalla hills. That is why perhaps the greatest potential for the utilization of AM fungi in sustainable plant production systems lies in the improvement of soil stability and erosion control (Bethlenfalvay, 1993). This study enable us to assume that the complexity of both AM and vegetation succession in Margalla hills will decrease with time after the restoration of plant cover and subsequent rise in spores density which in turn will lead to site conditions stabilize.

It is concluded that edaphic conditions, which are largely responsible for the AM spore density are probably responsible for low level of infection among exposed soil. It seems that the soil environment of Margalla hills will change with the establishment of annuals in coming growing season. This will definitely improve host (plant roots) availability for mycorrhizal fungi to proliferate. Moreover, topsoil eroded due to heavy precipitation can be an important inoculum source. Spots that trap eroded surface soils moving down slope may act as an important reservoir of AM inoculum. In this context, management practices that promote conservation of surface soil can assist in plant cover recovery by maintaining critical linkages with symbiotic soil organisms.

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