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# A comparison of Arbuscular Mycorrhizal colonization and spore diversity in vegetation of Fly Ash deposited area of Kolaghat Thermal Power Station and adjacent normal soil vegetation

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Fly ash depositions are real problem to environment. Recycle and reclamation processes are on experiment. The plant root and rhizospheric soil samples were collected from fly ash deposited area of Kolaghat Thermal power station. The same plant root and soil samples were also collected from nearby area where no deposition was done. These samples were compared for AM colonization pattern, spore density and diversity. Fly ash samples showed low to high spore density depending on plant species as in normal soil. The same plant species showed less colonization in fly ash than normal soil. ArbuscularMycorrhizae species highly differed in two soil samples. Fly ash vegetation selected an AM flora that indicate to be beneficial in reclamation of flyash.

**Key words:** *Acaulospra,Gigaspora,Glomus, Sclerocystis*

## INTRODUCTION

Fly ash is an amorphous mixture of ferroaluminosilicate minerals generated from combustion of ground or powdered coal at temperatures ranging from 400-1500$^{o}$C with 2% excess air (Mattigod *et al.*, 1990).Approximately 90-99% of fly ash consists of Si, Al, Fe, Ca, Mg, Na and K. Major matrix elements in fly ash are Si and Al together with significant percentage of K, Fe, Ca and Mg. Fly ash contains all naturally occurring elements and is substantially rich in trace elements like lanthanum, terbium, mercury, cobalt, chromium (Van Hook, 1978; Adriano *et al.,* 1978). Field and greenhouse studies both indicate that on account of its heterogenous nature fly ash can benefit plant growth and can improve agronomic properties of soil (Aitken and Bell., 1985; Sharma *et al.*, 1990). Fly ash has been found to increase yield of alfalfa *(Medicago sativa)*, barley *(Hordeum vulgare),* and white clover *(Trifolium repens)* and improve physical and chemical characteristics of the soil (Martens, 1971; Page *et al.*, 1979; Weinstein *et al.*, 1989).Fly ash positively influences the micro ecology and chemistry of soil in addition to physical properties such as water holding capacity, bulk density and soil structure. Addition of alkaline fly ash to acidic wasteland increases pH, decreases bulk density, increases water-holding capacity and

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reduces compaction (Fail, 1987; Taylor and Schumann, 1988). Efficacy of fly ash for treating acidic coal mine spoilsas alternative to lime was evidenced by the results of a pot culture experiment using Sudan grass (*Sorghum sudanens*)and Oats (*Avena sativa*) as indicator crops.

Lateritic soils are formed under hot humid climate from several rocks like basalts, when basic elements like silica are washed down and iron precipitates as oxides. So the soil is deficient in basic elements *i.e.* calcium, magnesium, potassium, nitrogen and available phosphorus. Heavy leaching results in acidic condition and poor fertility of soil (Koley, 2000).

The unique role of arbuscularmycorrhizal (AM) symbiosis with plants in nutrient and water uptake; particularly in water and nutrient deficient soil (Aúge, 2000) is widely accepted. This symbiosis is now known to be an essential component in any plant community. In restoration of damaged ecosystem AM plays effective role. As Fly ash and AM both are reclamation agent, if these two work together, may be more effective. Study on AM association in natural flyash habitat is lacking. This study was done to assess the adaptability of AM in flyash and fly ash flora of AM.

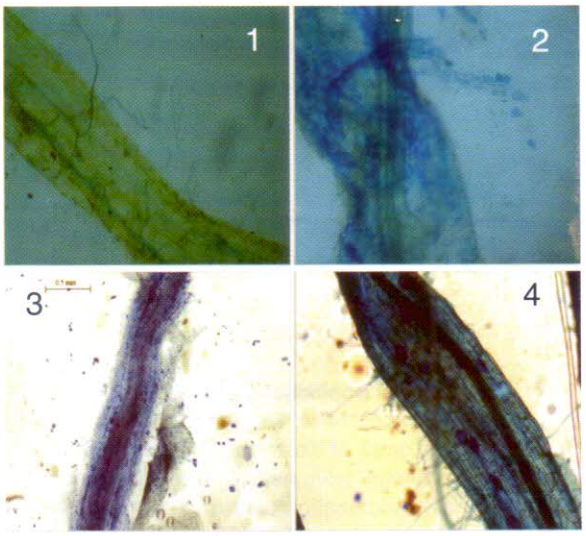
## MATERIALS AND METHODS

Root and composite rhizosphericsoil samples were collected in triplicate from vegetation in fly ash depositions of Kolaghat thermal power station, Midnapore, West Bengal. Samples from same plants were also collected from normal soil of same locality. Soil samples were tested for pH and AM spores of various sizes by decantation technique (Gerdemann and Nicholson,1963). Tertiary root samples were treated with 10% KOH solution and stained with tryphan blue (Phillips and Hayman 1970); mycelial, arbuscular, vesicular and total colonization were studied by the formula:

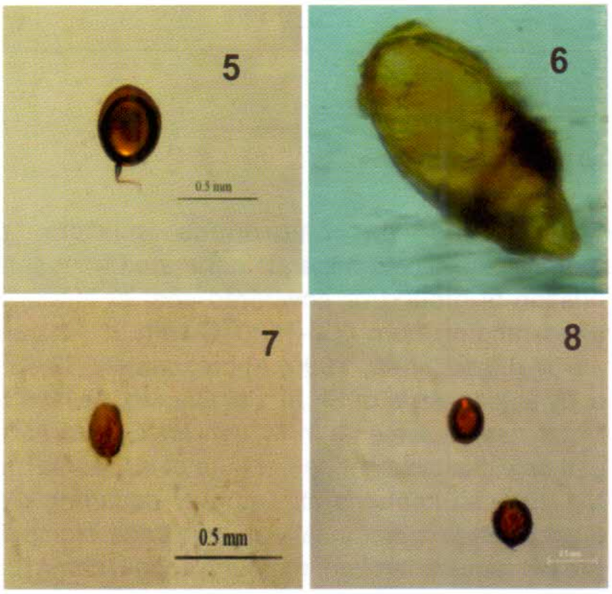
Colonisation % = Number of infected root segments (1cm.) × 100/ Number of total root segments observed.

## RESULTS AND DISCUSSION

Eleven plants were compared for AM hyphal colonization, arbuscular/vesicular colonization and total colonization. pH of fly ash ranged 6.4-6.7, in normal soil 6.3-6.5 (Table 1). In general, total/hyphal colonization of same plant was less in fly ash than normal soil but it varied with plants. Arbuscular and vesicular colonization in some cases increased in flyash. Vesicular colonization was increased in *E. hirta* and *L. nodiflora* but in others that was decreased or zero. Arbuscular colonization was low in flyash than normal soil except in *B.lacera, P. argentatum* and *C.arietinum*, high in flyash. Intense arbuscular colonization was found in these plants




**Figs. :** Root colonization:
1. Both fine and coaseendophytes colonized in fly ash.
2. Dense arbuscles in *Parthenium* root in fly ash.
3. Intensive colonization in *Cicer arietinum* roots in fly ash.
4. AM vesicles colonized but root hairs also present –unique feature in fly ash.




**Figs.** : *5. Gigaspora albida* in fly ash., 6. *Sclerocystis.,* 7. *Acaulospora.,* 8.*Acaulospora.*

**Table 1 :** The plant species grown in Fly ash (F) and normal soil (N), their rhizospheric soil pH and root AM colonization (%)

| Name of species | Site | Soil pH | Hyphal colonization% | Vesicle% | Arbuscle% | Total colonization% |
|---|---|---|---|---|---|---|
| *Euphorbia hirta* | N | 6.4 | 46 | 0 | 16 | 46 |
| *Euphorbia hirta* | F | 6.7 | 30 | 10 | 10 | 30 |
| *Hyptissu aveolens* | N | 6.4 | 56 | 8 | 15 | 56 |
| *Hyptissu aveolens* | F | 6.5 | 27 | 0 | 14 | 27 |
| *Alium sativum* | N | 6.5 | 77 | 0 | 6 | 77 |
| *Alium sativum* | F | 6.5 | 80 | 0 | 0 | 80 |
| *Lippia nodiflora* | N | 6.3 | 56 | 3 | 21 | 56 |
| *Lippia nodiflora* | F | 6.5 | 50 | 13 | 3 | 50 |
| *Blumea lacera* | N | 6.4 | 90 | 20 | 40 | 90 |
| *Blumea lacera* | F | 6.6 | 90 | 0 | 90 | 90 |
| *Croton bonplandianum* | N | 6.4 | 80 | 27 | 27 | 80 |
| *Croton bonplandianum* | F | 6.6 | 7 | 0 | 0 | 7 |
| *Oxalis corniculata* | N | 6.3 | 55 | 7 | 27 | 55 |
| *Oxalis corniculata* | F | 6.4 | 51 | 8 | 11 | 51 |
| *Pergularia daemia* | N | 6.4 | 96 | 9 | 66 | 96 |
| *Pergularia daemia* | F | 6.6 | 92 | 6 | 57 | 92 |
| *Cicer arietinum* | N | 6.4 | 91 | 68 | 90 | 91 |
| *Cicer arietinum* | F | 6.5 | 90 | 65 | 90 | 90 |
| *Parthenium argentatum* | N | 6.4 | 92 | 16 | 86 | 92 |
| *Parthenium argentatum* | F | 6.6 | 96 | 06 | 90 | 96 |
| *Ipomea biloba* | F | 6.4 | 7 | 6 | 4 | 7 |

in fly ash (Figs. 2, 3).*B.lacera, P. argentatum, P. daemia* and *C.arietinum* showed very high colonization in both soil. Though the obnoxious weed, *C. bonplandianum*is with high colonization in normal soil, with poor colonization in fly ash.

In some cases, root hairs also present with AM colonization (Fig.4); though in normal condition, as AM hyphae take the function of root hairs, those not formed after infection. Maximum AM spores were found in rhizosphere of *B. lacera* followed by

**Table 2 :** AM spore density (100 g) in Fly ash soil according to size

| Name of species | 50 -100µm | 100-250µm | >250µm | Total Spores/100 g |
|---|---|---|---|---|
| *Blumea lacera* | 30 | 350 | 760 | 1140 |
| *Cicer arietinum* | 08 | 440 | 380 | 828 |
| *Croton bonplandianum* | 34 | 300 | 264 | 598 |
| *Euphorbia hirta* | 10 | 500 | 200 | 710 |
| *Hyptissu aveolens* | 16 | 560 | 160 | 736 |
| *Oxalis corniculata* | 08 | 360 | 300 | 668 |
| *Pergularia daemia* | 0 | 450 | 500 | 950 |
| *Lippia nodiflora* | 04 | 300 | 200 | 504 |
| *Parthenium argentatum* | 10 | 650 | 420 | 1080 |
| *Allium sativum* | 10 | 450 | 100 | 560 |

*P. argentatum, P. daemia* and *C. arietinum*; that is in accordance with colonization % (Table 2). Spores found maximum of 100 µm-250 µm; in some rhizospherefound more than 250 µm. Both fine and coarse endophytes were present (Fig. 1). In nearby soil, total and >250 µm spores population is less than flyash (Table 3). The spore composition in 100 µm-250 µm was also varied, as flyash those belong to mainly *Glomus* while in other soil these were *Acaulospora* spp. All AM was not identified up to species level, *Gigaspora, Acaulospra, Glomus* and *Sclerocystis* were present in fly ash (Figs. 5-8); small spores noted mainly belong to *Glomus microaggregatum.* Among *Gigaspora, G. albida* was most frequent (Figs. 5).

The result shows that fly ash not hindered AM colonization though in some cases it is less than normal soil; intense arbuscle formation depicts the active AM symbiosis. Members of Asteraceae seem to be best AM colonizer in this soil. The AM flora is some degree different as it contained maximum small *Glomus* spp and *Sclerocystis* spp which are less visible in lateritic soil.Plant's rhizospheric microclimate probably had an effect. The variation in sporulation is affected by many factors *i.e.* species compatibility and growth of host species (Eom *et al.,* 2000; Siquera *et al.,* 1998), variation of root production and phenologies (Brundrett, 2002),Composition of mycorrhizal fungal communities has been correlated to edaphic heterogeneity (Koske, 1987) and more specifically to factors such as soil C, N, P and pH (Johnson *et. al.,* 1991). The environmental factors and

**Table 3 :** AM spore density (100 g) in nearby soil according to size

| Name of species | 50-100μm | 100-250μm | >250μm | Total Spores/100 g |
|---|---|---|---|---|
| *Blumea lacera* | 16 | 310 | 70 | |
| *Cicer arietinum* | 0 | 430 | 56 | |
| *Croton bonplandianum* | 102 | 320 | 88 | |
| *Euphorbia hirta* | 12 | 230 | 26 | |
| *Hyptissu aveolens* | 0 | 240 | 16 | |
| *Oxalis corniculata* | 0 | 160 | 10 | |
| *Pergularia daemia* | 0 | 250 | 15 | |
| *Lippia nodiflora* | 04 | 210 | 20 | |
| *Parthenium argentatum* | 10 | 680 | 76 | |
| *Allium sativum* | 8 | 150 | 14 | 560 |

vegetation also define the habitat of AM fungi (Brundrett, 1991). As the plants are same, the spore as well as, species diversity is related to soil condition.

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