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Distribution pattern and mycorrhizal status of weed flora grown in fly ash pond

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ABSTRACT

Sixty weed species grew naturally on fly ash pond of Bandel Thermal Power Station at Triveni, about 50 km North-East from Kolkata. Poaceae and Cyperaceae under monocotyledon and Compositae, Euphorbiaceae and Amaranthaceae under the dicotyledon were the predominant weed families based on the number of species recorded. The diversity of weed species was found higher in Poaceae followed by Cyperaceae and others. Out of sixty weed species recorded only seventeen belong to nine weed families- two under monocotyledon and seven under dicotyledon, were found to be inherently mycorrhizal. The frequencies of mycorrhizal and non-mycorrhizal weed species grown in ash pond zones nearer to the fly ash soil border were characteristically higher and gradually declined at the zones away from border i.e towards the centre of the pond. Mycorrhizal colonization in weed roots and mycorrhizal infectivity potential in terms of the most probable number (MPN) of rhizosphere fly ash were also exhibited the same trend. The predominant arbuscular mycorrhizal fungus amongst the species (AMF) isolated from plant rhizospheres of ash sample under study was *Glomus mosseae* followed by *G. fasciculatum*, *Gigaspora* sp and *Acaulospora* sp.

Key words: Fly ash, weed, mycorrhiza

Fly ash, a residue of burned coal and amorphous ferro-aluminium silicate, is produced in large quantities, 100 million tons/ years, by 82 thermal power plants in India (Sarma *et al*., 2003). Rough estimate indicates that around 10% of the total fly ash generated in the country has various alternative economic uses. But the disposal of the rest amount is still a great problem. The huge unutilized fly ash poses a threat in land use as substantial areas of fresh land are gradually covered up by the cumulative accumulation of residual fly ash and turning them also as industrial wastelands. Some emphases have recently been given on the reclamation and rehabilitation management of such industrial wastelands through re-vegetation from production, environmental and health hazards management point of view by adding suitable organic matter and symbiotic fungi. So, the symbiotic arbuscular mycorrhizal (AM) fungi could be played a significant role for restoration and sustenance of some vegetation on fly ash.

Weeds are the pioneer self-sustaining plant species that form the first stage natural vegetative cover on fly ash of thermal wasteland. They are known to harbour mycorrhizae (Kabir and Koide, 2000). It is well documented that mycorrhizae play an important role in re-vegetation management of wasteland by benefiting the plants through acquisition of scarce plant nutrients particularly phosphorus, copper and zinc, improvement of soil binding/aggregating capacity, plant's growth performance and hormonal level elevation and tolerance to toxic metals, diseases and soil drought. So, considering the significance of weed flora on the preservation of mycorrhizal potential of soil, an exploratory research work was conducted at the different zones of the fly ash pond under Bandel Thermal Power Station to see the distribution pattern of different mycorrhizal and non-mycorrhizal weeds grown there and also to identify the presence of predominant AM fungal species in the fly ash.

MATERIALS AND METHODS

Weed flora grown naturally on fly ash (pH-8.2, nitrogen 0.07%, available phosphorus 15 ppm, available potassium 72 ppm and EC 0.026 ds m^{-1}) pond of Bandel Thermal Power Station at Triveni, about 50 km North-East

from Kolkata, were collected from five well-demarcated zones of 0-2m, 2-8m, 8-25m, 25-50m and 50-80m from soil ash-pond borderline. Sampling of weeds was done from randomly selected one m^2 area at 10m interval within each zone. Weeds occurring in different zones during summer and winter were recorded and identified. Weed roots, rhizosphere- and non-rhizosphere- fly ash samples were collected for mycorrhizal and chemical analyses.

Weed root samples after thorough washing were preserved in formo-acetic-alcohol [Formalin- 5ml, Glacial acetic acid- 5ml and alcohol 70% 90ml]. Roots were processed and stained following methods proposed by Philips and Hayman (1970). Fifty stained root pieces of about one cm length were examined from each weed species for the assessment of mycorrhizal infection. Mycorrhizal infectivity status of different fly ash zones was assessed following five fold dilution end point technique (Powell, 1980) taking *Cajanas cajan* (L.) Milsp. as a test plant. To ascertain the dilution end point of inoculum, whole root of test plant under last 3-4 dilutions of the series only was examined for the presence or absence of AM infection. AM spores were isolated by wet sieving and decanting (Gerdemann and Nicolson, 1963). Isolated AM spores were identified from the spore morphology as per type description of the species proposed by Schenck and Perez (1990).

RESULTS AND DISCUSSION

Sixty weed species, forty three non-mycorrhizal and seventeen mycorrhizal, belong to twenty four families were collected from 0 – 80m zone of fly ash pond during summer and winter seasons (Table – 1and 2). Of them twenty three belong to three families under monocotyledon and other thirty seven belong to twenty one families under dicotyledon. The diversity and dominance of weed species, based on the types, was found highest in Poaceae followed by Cyperaceae under monocotyledon and in Compositae followed by Euphorbiaceae and Amaranthaceae under the dicotyledon. There were variations in distribution of weed species in five fly ash zones. However, only seven weed species, all belong to monocotyledon, growing as common to all the zones of fly ash pond. The enumeration of total number of weed species in different zones of the ash pond revealed their occurrence in higher proportion in zones nearer to the soil – fly ash pond border line and their frequency declined gradually with the progress of distance from borderline towards the centre of the pond.

Forty three non-mycorrhizal weed species belong to eighteen weed families – two under monocotyledon and sixteen under dicotyledon, were collected from different zones of fly ash pond (Table- 1). Maximum number of these weeds species under monocotyledon was recorded in Cyperaceae followed by Poaceae whereas the same under dicotyledon was recorded in Compositae followed by Amaranthaceae/ Euphorbiaceae and others. There were four weed species viz. *C. deformis, C. pilosus, K. brevifolia* and *F. miliacea* under Cyperaceae growing between 0 -80m as common weeds to all the zones of the fly ash pond. Weeds belong to the families viz. Cyperaceae, Euphorbiaceae and Amaranthaceae were not colonized in any of the zones as those commonly reported as inherently non-mycorrhizal. But interestingly the weeds of some of the commonly mycorrhizal families like Solanaceae and Leguminosae were found to behave as non-mycorrhizal here. The weed species under these mycorrhizal families should bear mycorrhizal colonization within 0 – 8m fly ash zones. Non-mycorrhizal behavior of the weeds of two mycorrhizal families may be assumed that the fly ash as growing medium may not support the establishment of the mycorrhizal

relationship. Further study on this aspect needs to be carried out for clarification. However, the study on distribution pattern of non-mycorrhizal weed species in different zones of fly ash pond revealed their occurrence in higher frequencies near the soil - fly ash border line and gradual declination in the zones away from it.

Seventeen mycorrhizal weed species belong to nine weed families- two under monocotyledon and seven under dicotyledon, were also collected from different fly ash zones (Table- 2). Maximum number of mycorrhizal weed species was present in Poaceae followed by Convolvulaceae/ Rubiaceae and others. Frequencies of mycorrhizal weed species grown in ash pond zones nearer to the fly ash soil border were characteristically higher and gradually declined at the zones away from the border. Even within the same zone there were variations in mycorrhizal colonization according to weed species grown. The weed species viz. *E. indica*, *L. filiformis*, *I. cylindrica* common to all fly ash zones were mycorrhizal nearer the soil fly ash border and were found non-mycorrhial in the zones away from the border. Mycorrhizal colonization in weed roots and mycorrhizal infectivity potential in terms of the most probable number (MPN) of rhizosphere fly ash were higher at the zones near the soil fly ash border and declined when weeds were grown away from the zone. Some mycorrhizal species occurred beyond the 8 - 25m zone behaved as non-mycorrhizal. The reason may be the presence of very low and negligible number of infective propagules in these zones. The extramatrical mycorrhizal hyphal network that perhaps extended from the roots of mycorrhizal weed species grown on the border line of the pond to those away from the border played a significant role to make some mycotrophic weeds mycorrhizal and to augment infectivity potential of the fly ash. The mycotrophic weeds that remained beyond the limit of extramatrical hyphal extension were found to behave as non-mycorrhizal. It may be assumed that any activity that suppresses directly or indirectly the weed population also reduces AM fungal propagules and infectivity potential (Schreiner *et al.,* 2001).

In the present investigation we found the presence of seventeen mycorrhizal having 21.0 – 76.4% root colonization and forty three non-mycorrhizal weed species in different zones of fly ash pond. Chan *et al.* (2006) also observed twenty mycorrhizal having 12 – 100% root colonization and four non-mycorrhizal plant species established naturally at the fly ash lagoons in Hong Kong,.

The predominant species of arbuscular mycorrhizal fungus (AMF) isolated from plant rhizospheres of ash sample under study were *Glomus mosseae, G. fasciculatum, Gigaspora* sp and *Acaulospora* sp. Mycorrhizal species diversity in the fly ash under study was low as compared to the AMF species retrieved from the fly ash pond site of Neyveli Lignite Corporation, Tamil Nadu, India where Selvam and Mahadevan (2002) recovered fifteen AMF species. Out of fifteen AMF species, three belong to *Gigaspora*, eight belong to *Glomus*, three belong to *Sclerocystis* and one belongs to *Acaulospora* species.

So, it may, therefore, be concluded from the above-mentioned experimental results that the frequencies of both non-mycorrhizal and mycorrhizal weeds grown in ash pond zones nearer to the fly ash soil border were characteristically higher and gradually declined at the zones away from border. Mycorrhizal colonization in weed roots and mycorrhizal infectivity potential in terms of the most probable number (MPN) of rhizosphere fly ash were also exhibited the same trend. Mycorrhizal species diversity was found very low in fly ash

Table 1 Distribution of non- mycorrhizal weed species in different zones of fly ash pond

Families (weed species) under monocotyledon	Fly ash zones				
	0-2m	2-8m	8-25m	25-50m	50-80m
Gramineae/ Poaceae – (6)					
Brachiaria ramose (L.) Stapf.	A	A	P	P	P
Dactyloctenium aegyptium (L.) Wild	P	A	A	A	A
Sporobolus airoides(Torr.) Torr.	P	P	A	A	A
Saccharum spontaneum L.	P	P	A	A	A
Leersia hexandra Swartz.	A	A	P	P	P
Paspalum conjugatum Berg.	P	P	A	A	A
Family Cyperaceae- (9)					
Cyperus rotundus L.	P	P	P	A	A
Cyperus difformis L.	P	P	P	P	P
Cyperus pilosus Vahl.	P	P	P	P	P
Cyperus iria L.	P	P	P	A	A
Kyllinga brevifolia Rottb.	P	P	P	P	P
Fimbristylis miliacea(L.) Vahl	P	P	P	P	P
*Fimbristylis dichotoma(*L.) Vahl.	P	P	A	A	A
Fimbristylis littonalis Gaud.	P	P	A	A	A
Fimbristylis junciformis Kunth.	P	P	P	A	A
Families (weed species) under dicotyledon					
Family Polygonaceae- (1)					
Polygonum orientale L.	P	P	A	A	A
Family Amaranthaceae – (3)					
Alternanthera sessilis(L.) R. Br.	P	P	P	A	A
Amaranthus spinosus L.	P	A	A	A	A
Achyranthus aspera L.	A	A	A	P	P
Family Capparidaceae –(1)					
Cleome viscosa L.	P	A	A	A	A
Family Leguminosae –(2)					
Cassia sophera L.	P	P	P	A	A
Mimosa pudica L.	P	A	A	A	A
Family Rutaceae –(1)					
Glycosmis pentaphylla (Retz.) Correa	P	P	A	A	A

Continued

Families (weed species) under monocotyledon	Fly ash zones				
	0-2m	2-8m	8-25m	25-50m	50-80m
Family Euphorbiaceae – (3)					
Euphorbia hirta L	P	A	A	A	A
Croton sparsiflorus Morong	P	P	A	A	A
Phyllanthus urinaria L.	A	P	A	A	A
Family Umbeliferae –(1)					
Centella asiatica (L.) Urban	P	P	A	A	A
Family Convolvulaceae – (1)					
Ipomoea hederacea Jacq	P	A	A	A	A
Family Solanaceae – (2)					
Solanum nigrum L.	P	P	A	A	A
Physalis minima L.	P	A	A	A	A
Family Acanthaceae – (1)					
Justicia simplex Don.	P	P	P	A	A
Family Cucurbitaceae – (2)					
Coccinia indica Wight & Arn.	A	A	P	A	A
Cucumis sp.	A	A	P	A	A
Family Compositae –(6)					
Dichrocephala latifolia DC	A	A	P	A	A
Eclipta alba (L.) Hassk	P	P	A	A	A
Mikania scandens Willd.	P	A	A	A	A
Xanthium strumarium L.	P	A	A	A	A
Erigeron canadensis L.	A	A	P	A	A
Erigeron glaucus Ker.	A	A	A	P	P
Family Rhamnaceae – (1)					
Zizyphus nummularia (Burmf.) Wright and Arn.	P	A	A	A	A
Family Sapindaceae –(1)					
Cardiospermum helicacabum L.	A	A	P	A	A
Family Portulacaceae –(1)					
Portulaca oleracea L.	A	A	P	A	A
Family Aizoaceae – (1)					
Trianthema monogyna L.	P	P	P	A	A
Total	32P,11A,	23P, 20A,	19P, 24A,	8P, 35A,	8P, 35A,

P= Weed species present, A= Weed species absent

Table 2 Distribution of mycorrhizal weed species in different zones of fly ash pond

Family (weed species) monocotyledon	Distribution of mycorrhizal (M) weed species under different fly ash zones (percent mycorrhizal colonization)				
	0-2 m with 880 AMF IP	2-8 m with 230 AMF IP	8-25 m with 40 AMF IP	25-50 m with 8 AMF IP	50-80 m with negligible AMF IP
Gramineae/ Poaceae – (7)					
Cynodon dactylon (L.) Pers.	P (76.4)	P (30.4)	P (6.7)	P (0.0)	A
Brachiaria mutica(Forsk.) Stapf.	P (59.3)	P (12.7)	P (0.0)	P (0.0)	A
Bothriochloa intermedia(R.Br.) A. Camus	P (30.2)	P (16.3)	A	A	A
Digitaria sanguinalis(L.) Scop.	P(30.4)	A	A	A	A
Eleusine indica(L.) Gaertn.	P (60.3)	P (27.2)	P (0.0)	P (0.0)	P (0.0)
Leptochloa filiformis (Lam.) Beauv.	P (28.3)	P (0.0)	P (0.0)	P (0.0)	P (0.0)
Imperata cylindrica (L.) Beauv.	P (47.6)	P (17.2)	P (0.0)	P (0.0)	P (0.0)
Family Aracaceae – (1)					
Colocasia esculenta (L.) Schott	P (77.6)	A	A	A	A
Family (weed species) dicotyledon					
Family Polygonaceae- (1)					
Polygonum perfoliatum L.	P (45.0)	P(40.3)	P (0.0)	P (0.0)	A
Family Malvaceae – (1)					
Abutilon indicum (L.) Sweet	P (33.7)	P (14.5)	A	A	A
Family Asclepiadaceae – (1)					
Calotropis gigantea (L.)Ait.f.	P (34.5)	P (20.6)	A	A	A
Family Convolvulaceae – (2)					
Convolvulus arvensis L.	P (52.4)	A	A	A	A
Evolvulus nummularius L.	P (30.6)	P (0.0)	A	A	A
Family Verbenaceae – (1)					
Lippia nodiflora Rich.	P (21.0)	P (0.0)	A	A	A
Family Rubiaceae –(2)					
Borreris hispida (L.) K. Schum	P (60.2)	P (30.4)	P (10.6)	A	A
Oldenlandia corymbosa L.	P (65.6)	P (14.3)	A	A	A
Family Lythraceae –(1)					
Ammania baccifera L.	P (43.6)	A	A	A	A
Total	17P	13P, 4A,	7P, 10A,	6P, 11A,	3P, 14A,

AMF IP = Arbuscular mycorrhizal fungal infectivity potential,
P= Weed species present, A= Weed species absent

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