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Seasonal variation of arbuscular mycorrhizal status in rhizosphere of six plantation species grown in red lateritic soil of south West Bengal

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The physical and chemical soil characteristics in the rhizosphere of six plantation species, *Albizzia lebbeck Benth., Anacardium occidentale* Roxb., *Casuarinas equisetifolia* Forst, *Delonix regia* (Hook) Ref., *Acacia auriculiformis* A. Cunn. and *Eucalyptus tereticornis* showed seasonal variation in correlation with arbuscular mycorrhizal (AM) status. The Am colonization, spore population, species richness and diversity altered with seasons as well as with plant ppecies. The maximum mycorrhization was noted in *A. lebbeck* and *A. occidentale* followed by *C. equisetifolia*. Roof colonization was found maximum during rainy season and spore population in winter. pH was correlated with root colonization whereas organic matter with spore population.

Key words : Rhizosphere, plantation species, arbuscular mycorrlizal status, seasonal variation

INTRODUCTION

The acid leteritic soil of south West Bengal is deficient in basic elements i.e., calcium, magnesium, potassium, nitrogen and available phosphorus but rich in iron and aluminium oxides. Heavy leaching consequences in acidic condition and poor fertility (Koley, 2000). The unique role of arbuscular mycorrhiza (AM) fungi in nutrient and water uptake (Bolan, 1991), particularly in deficient soil (Bethlenfalvey *et al.*, 1998) is widely accepted. The symbiosis is known to be an essential component of any plant community (Smith and Read, 1997). The abundance of AM fungal propagule depend on many factors i.e., soil nutritional status, pH, organic content, moisture content, temperature, host plant etc. The rhizospheric environment influence the edaphic physical and biochemical conditions which may influence the AM fungal abundance and diversity. The six tree species commonly used for afforestation in this zone ; *Albizza lebbek* Benth., *Anacardium occidentale* Roxb., *Acacia auriculiformis* A. Cunn, *Casuarina equisetifolia* Forst, *Delonix regia* (Hook) Ref and *Eucalyptus tereticornis* was studied for their rhizospheric soil condition and AM fungal status in the three prominent seasons-summer, winter and rainy season.

MATERIALS AND METHODS

The study was conducted in the acid lateritic zone of West Bengal, India, located around 22°19′ N latitude and 87°19′ E longitude. The climate and soil conditions are given in Table 1.

Rhizospheric soil and root samples of the six trees were collected in three replicates from upto 30 cm depth scraping 1 cm top soil.

Root colonisation by AM fungi was studied. Colonisation percentage was measured by the formula :

$$\text{Colonisation\%} = \frac{\text{No. of root pieces colonised}}{\text{Total No. of root pieces observed}} \times 100$$

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About 50 root pieces (1cm) were examined for each sample. To assess the spore density, method of isolation and decantaton developed by Gerdeman and Nicolson (1963), was followed. Spore abundance 100^{-1} g soil sample was counted under stereo microscope (20x). Spores were mounted in Polyvinyl-Lactic acid-Glycerol (PVLG) mountant and melzar's reagent. The spores were identified with the help of the monographs by Schenk and Peréz (1990), and photo guides of INVAM (www.http://INVAM.com).

Soil pH was measured in 1:5 soil : water dilution in electric pH meter. Moisture content was measured by oven drying the know amount, of soil sample at 80°C overnight. Physical and chemical characteristics of soil were measured according to Jackson (1971).

RESULTS AND DISCUSSION

The soil remained acidic in all seasons but organic matter showed maximum rise in rainy season (Table 1). Moisture and pH content decreased in winter but increased in rainy season. The root

Table 1 : Soil characteristics of red lateritic soil

Properties	values
Coarse Sand	35.36%
Fine Sand	29.71%
Silt	19.29%
Clay	15.70%
Water holding capacity	32.67
Field capacity	14.60
Soil pH	5.6 ± 0.4
CEC	8.2 me/ 100g
Organic Carbon	0.37%
Total N	0.035%
Total P	0.0480%
Total K	0.013%
Available P	0.0021%
Available N	0.0035%
Available K	0.0028%

colonization showed increasing trend in rainy season and opposite to summer and also significant positive correlation with seasonal change in pH except in *A. auriculiformis*. Seasonal variation in moisture content was found positively correlated with mycorrhizal colonization in *C. equisetifolia* (r = 0.83), *A. occidentale* (r = 0.76) and *A. lebbek* (r = 0.81). Organic matter content showed no significant correlation with colonization level but for rainy season showed positive correlation in respect to all four species. Spore density showed no significant correlation with pH, moisture content and root colonization. Organic content showed significant positive correlation with spore population (r = 0.86). Spore density increased to its peak in winter and was least in rainy season. *A. occidentale* and *A. lebbek* showed high colonization percentage and spore density throughout the year. AM species belonging to *Gigaspora* and *Acaulospora* were

Table 2 : Seasonal variation of pH, moisture content and organic matter in rhizospheric soil of six tree species.

Season	Tree species	pH	Moisture content (%)	Organic matter (%)
Winter	*A. auriculiformis*	5.6	1.8	1.35
	A. occidentale	5.8	2.2	2.25
	E. tereticornis	5.6	1.8	1.05
	A. lebbek	5.8	1.9	2.0
	C. equisetifolia	5.8	2.0	1.65
	D. regia	5.7	2.0	1.7
Summer	*A. auriculiformis*	5.5	0.6	2.68
	A. occidentale	5.6	1.8	4.1
	E. tereticornis	5.5	0.8	3.0
	A. lebbek	5.6	1.2	3.2
	C. equisetifolia	5.5	0.9	2.0
	D. regia	5.6	1.0	2.6
Rainy season	*A. auriculiformis*	5.0	4.4	3.9
	A. occidentale	6.3	7.1	6.8
	E. tereticornis	5.8	4.1	3.2
	A. lebbek	6.1	5.8	4.8
	C. equisetifolia	6.0	6.2	5.2
	D. regia	5.9	5.3	4.4

observed rich in diversity. *G. aggregatum* was much frequent and consistent. Spores of *G. nigra*, in general prevailed in soil rainy season to winter but was found in rhizosphere of *A. occidentale* throughout the year and was totally absent in *E. tereticornis*. *E. tereticornis* was found associated with several uncommon species lile, *Gigaspora gigantea*, *Scutellopsora savanicola* and *Acaulospora scobriculata*. Spores of *Gigaspora* and *Scutellopsora* were maximum in winter. The increase in pH increasing colonization has been reported earlier (Aziz and Habte, 1990). The tree species with high root colonization tend to show

Table 3 : Seasonal variation of VAM fungal colonisation, spore density and species composition in rhizospheric soil of six tree species

Season	Tree species	Colonisation (%)	Spore density 100 g^{-1} soil	Species richness	*AM-fungal species
Winter	*A. auriculiformis*	46 ± 3	2 ± 8[d]	6	S.c, G.m, A.d, A.s, G.a, S.s
	A. occidentale	72 ± 2	668 ± 11[a]	10	S.n, S.h, G.m, G.g, S.c, A.s, A.m, A.d, G.a, G.o
	A. lebbek	56 ± 4	660 ± 8[a]	9	S.n, S.h, G.m, S.c, A.s, A.m, A.d, G.a, G.o
	E. tereticornis	28 ± 2	501 ± 13[b]	5	S.c, G.h, G.g, G.a, A.b
	C. equisetifolia	66 ± 4	498 ± 7[b]	8	G.n, G.h, G.m, A.m, A.d, G.g, A.s, A.d
	D. regia	52 ± 5	215 ± 7[d]	5	S.h, G.a, A.d, A.m, A.a
Summer	*A. auriculiformis*	28 ± 2	102 ± 5[d]	4	A.b, A.s, A.d, S.a
	A. occidentale	61 ± 2	490 ± 7[b]	6	S.n, S.c, G.m, A.t, G.a, G.o
	A. lebbek	63 ± 7	592 ± 9[a]	5	G.a, A.d, A.m, A.s, A.t
	E. tereticornis	21 ± 2	57 ± 3[d]	2	A.b, A.m
	C. equisetifolia	51 ± 3	129 ± 9[b]	7	G.n, G.m, A.d, A.b, A.a, A.m, G.a
	D. regia	36 ± 4	109 ± 5[d]	4	A.s, A.m, G.a, A.b
Rainy season	*A. auriculiformis*	52 ± 3	43 ± 6[b]	3	A.b, G.n, G.a
	A. occidentale	78 ± 3	127 ± 7[a]	6	S.n, G.m, G.c, A.m, G.a, G.o
	A. lebbek	80 ± 6	103 ± 6[a]	5	S.n, G.m, G.c, G.a, A.m
	E. tereticornis	36 ± 3	36 ± 3[b]	2	A.b, A.m
	C. equisetifolia	78 ± 3	45 ± 6[b]	4	S.n, A.a, A.m, G.a
	D. regia	56 ± 6	36 ± 4[b]	4	A.d, A.m, S.n, G.a

* AM fungal species :
S.c — *Scutellospora calospora* (Nicol & Gerd) Walker & Sanders ; S.h — *S. heterogamre* (Nicol & Gerd) Walker & Sunders ; S.n — *S. nigra* (Redhead) Walker & Sanders ; S.s — *S. savanicola* (Herr & Ferr) Walker & Sanders ; G.g — *Gigaspora gigantea* (Nicol & Gerd) Ged & Trappe ; G.m — *G. margarita* Becker & Hall ; A.a — *Acaulospora appendicula* spain, Sieverding *et* Schenck ; A.b — *A. bireticulata* Rothwell & Trappe ; A.d — *A.delicata* Walker, Pfeiffer & Bloss; A.m — *A. myriocarpa* spain, Sieverding *et* Schenck ; A.s — *A. scobriculata* trappe ; G.f — *Glomus fasciculata* (Thaxter sensu Gerdemann) Gerdeman & Trappe ; G.a — *G. aggeratum* Schenek & Smith emend Koske ; G.o — *G. occultum* walker

high spore population throughout. This finding has been supported by Ebbern *et al.* (1987). *Acacia auriculiformis, Delonix regia* and *Eucalyptus tereticornis* were found less mycorrhizal than *Casuarina equisetifolia, A. occidentale* and *A. lebbek*. The variation in spore population may be affected by many factors i.e. species compatibility, host physiology (Siquera *et al.* 1996), nutrient availability (Lorgio *et al.* 1999) etc. Composition of AM fungal species has been found to be correlated with edaphic heterogeneity (Koske, 1987). The environmental factors and vegetation also define the habitat of AM fungi (Brundrett, 1991). The dominant genera, *Gigaspora* and *Acaulospora* were found to be associated with acidic soils (Abbott and Robson, 1991). The spore composition varied probably due to their variation in sporulation period. The high moisture and temperature evidently affected sporulation. Strees conditions was also reported to have adverse effects on sporulation (Lopez-Sanchez *et al.*, 1992).

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