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Effect of seasonal variation and site factors on AM population associated with *Prosopis cineraria* (L.) Druce

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Abstract

The AM spore population was studied in three different sites *viz.*, *P. cineraria* at roadside area, *P. cineraria* as sole crop under field and *P. cineraria* under agroforestry area. The maximum AM population was observed under agroforestry area and minimum at roadside area. The impact of seasonal variation was noticed in spore population. During summer months (April, May and June), the spore population was minimum but at the onset of the first rain the spore population enhanced at faster rate during the month of July, August and September. The rainfall and relative humidity was recorded significant and positive influence on AM fungal population while temperature showed no correlation with the spore builds up under *P. cineraria*.

Keywords: Agroforestry, *P. cineraria*, sole crop, seasonal variation, site factors.

1. Introduction

The process of land degradation in arid areas of Rajasthan is more acute as this is ecological and economical disadvantaged region of India (Venkateswarlu, 1993). The scanty and erratic rainfall with high temperature, excessive evapotranspiration and strong winds on sandy landforms leads to massive soil erosion and soil movement. Drought is a recurring feature of the arid region of western Rajasthan. The AM fungi can bind soil particles into larger aggregates, necessary for a stable and porous physical structure of soil. This is particularly important in dry areas, where aggregation of particles permits more efficient use of available water. The AM fungi can therefore, play an important role in stabilizing sand dunes and establishment of shelterbelts (Tarafdar, 2005).

In arid-ecosystems, arbuscular mycorrhizal fungi (AMF) are major and significant component of rhizosphere microflora. Mycorrhizal association plays an important role in decomposition of soil organic matter, mineralization of plant nutrients and nutrient recycling (Tarafdar and Rao, 1997; Pare *et al.*, 2000). The population pattern of AMF varies greatly and their diversity is affected by various factors including soil, environmental condition, host plant and agricultural practices (Sanders, 1990; McGonigle and Miller, 1996). Plants infected with AM fungi get more easily established on disturbed sites through improved mineral nutrition (Shiffestin and Medve, 1979) and provide a primary mechanism for phosphorous uptake from the soil (Hayman, 1982). Distribution of arbuscular mycorrhizal fungi associated with *Prosopis cineraria* is expected to influence by edaphic factors as well as site factors. Keeping this objective in view the present investigation was undertaken to analyse the effect of seasonal variation and site factors on AM population.

2. Materials and Methods

To study the effect of seasonal variation and site factors on AM endophytes populations, the soil samples were collected in every month for a year from *P. cineraria* plantations of single age group (approx 12 years) at three different sites *viz.*, (a). *P. cineraria* at road side; (b). *P. cineraria* as sole crop under field and (c). *P. cineraria* under agroforestry area. Samples were collected from the base of five trees of each site, with three replications selected at random. Fifteen rhizosphere soil samples were taken from each site in sealed polythene bags. The soil sampling was done at a depth of 30 cm under the canopy of the standing *P. cineraria* trees. AM spores were isolated by wet sieving and decanting technique (Gerdemann and Nicolson, 1963). The spore density was expressed in terms of the number of spores per 100 g of soil. The correlation between AM propagules and edaphic factors under different sites were also worked out.

Monthly observations on AM population were recorded and correlated with (i). Rainfall (mean); (ii). Temperature (minimum and maximum) and (iii). Relative humidity (%) (minimum and maximum). Rainfall, Temperature and Relative humidity (%) data collected at Meteorological Department, CAZRI, Jodhpur. The experimental data on seasonal variation from different sites were recorded for twelve months from January to December .

3. Results

The total rainfall, mean minimum and maximum temperature as well as relative humidity during the month were presented as Table 1. The maximum rainfall (260.3 mm) was observed in the month of July while there was no rainfall during April and between October to December. The minimum average temperature was noticed in the month of January, while maximum was observed in the month of May. The mean relative humidity varies between 12 and 91%, which was least in the month of March and maximum in the month of August. It was observed that the spore population varied significantly ($P < 0.01$) in all the three sites (A) roadside area, (B) *P. cineraria* as sole crop and (C) *P. cineraria* under agroforestry areas. Population of spores were observed minimum in the rhizosphere of *P. cineraria* planted under road side and maximum in *P. cineraria* under agroforestry area. Seasonal variation plays an important role in spore population. Spore population was significantly ($p < 0.05$) low in summer season *i.e.*, April to June. It was drastically increased from July *i.e.* after the onset of first rain and then decreased gradually from October onwards upto February in all the sites, while in the month of March the spore population again increased marginally.

Table 1 Effect of seasonal variation on AM population in *P. cineraria* trees in three different sites (Year 2003)

Months	Rain fall (mm)	Temperature îC		Relative humidity (%)		AM population 100 g^{-1} soil		
		Min.	Max.	Min.	Max.	A	B	C
January	0.7	11.2	25.4	26	60	72	116	121
February	23.1	13.8	27.2	22	57	65	85	110
March	2.7	18.1	33.6	12	38	70	90	130
April	0.0	24.3	39.6	13	34	61	78	85
May	0.4	27.0	41.0	16	42	53	63	75
June	65.6	28.7	39.4	36	69	42	55	70
July	260.3	26.0	34.3	66	86	166	310	331
August	65.3	26.0	33.7	68	91	200	340	362
September	1.6	24.5	35.2	48	81	170	187	220
October	0.0	18.3	37.0	14	43	152	160	176
November	0.0	15.4	31.6	18	44	104	143	160
December	0.0	11.7	26.6	23	63	80	125	155
LSD (p = 0.05)	-	-	-	-	-	10.83	8.29	7.87

A: *P. cineraria* at roadside area, B: *P. cineraria* as sole crop, C: *P. cineraria* under agroforestry area.

The correlation between AM population with rainfall, temperature and relative humidity (Table 2) showed that rainfall was directly and positively correlated with all the three sites of plantation (*i.e. P. cineraria* at roadside area, *P. cineraria* as sole crop and *P. cineraria* under agroforestry area), out of which

the site B (*P. cineraria* as sole crop) and site C (*P. cineraria* under agroforestry area) was highly significant (n = 36, P < 0.01) and site A (*P. cineraria* at roadside area) was marginally significant (n = 36, P < 0.05). There was no correlation of temperature (either maximum or minimum) with spore population during the year surveyed. The relative humidity (either maximum or minimum) was more significantly (n = 36, P < 0.01) and positively correlated with AM spore population for all the three sites.

Table 2 Correlation between AM population with rainfall, temperature and relative humidity under *P. cineraria* during the year 2003

Factors	Correlation (r)		
	A	B	C
Rainfall	0.3988*	0.6243**	0.6104**
Temperature			
Maximum	0.0027^{NS}	-0.0964^{NS}	-0.1181^{NS}
Minimum	0.2306^{NS}	0.2436^{NS}	0.2255^{NS}
Relative humidity			
Maximum	0.6374**	0.741**	0.7465**
Minimum	0.843**	0.843**	0.843**

A: *P. cineraria* at roadside area, B: *P. cineraria* as sole crop, C: *P. cineraria* under agroforestry area
* Significant at 5%, ** Significant at 1%, NS Non significant (n = 36)

4. Discussion

The more AM spore population under agroforestry area may be due to fertility status of soil and per cent soil moisture. In general organic C content was 12% higher under agroforestry area than road side soils. Moreover, the moisture status was 5-12% higher under field condition than road side plantation. The mycorrhizal population was more when P cineraria grown as sole crop under field may be due to the better soil environment and nutrients (Chandel, 1991; Mukerji *et al.*, 1996) under field condition.

Higher spore population in the month of July, August and September due to the higher plant growth and root development during that period (Chandel, 1991). Effect of season on population of AM spores is a natural phenomenon and has been studied by several workers under different plants (Hayman, 1970; Bakshi, 1974; Gemma and Koske, 1988; Mohan and Mahadevan, 1988; Shankar *et al.*, 1990; Mallesha and Bagyaraj, 1991; Thapar *et al.*, 1991; Diaz and Honrubia, 1994; Vijaykumar and Abraham 2001; Bhadauria *et al.*, 2003 and Uniyal, 2003) but there was no information under *Prosopis cinerara*, an important tree under arid region. The present observations resembles with the study of Hayman (1970), who has reported an increase in the number of spores during July and a decrease in population during winter. Diaz and Honrubia (1994) have observed higher spore density during the months of July to October. Bakshi (1974) has also reported an increase in the population of *Endogone* spores and *Glomus macrocarpum* after rains during June-October due to high soil moisture and their population falling to low levels between November and May.

In arid areas maximum sporulation occurs after first rain in the month of July since it favours sporulation. Mallesha and Bagyaraj (1991) observed higher spore count during the months of September to December. The spore population started declining from December and the lowest was in June. Bhadauria *et al.* (2003) studied the seasonal and edaphic variation in AM infection of fuel wood trees *Albizia lebbeck*, *Acacia nilotica* and *Prosopis juliflora* by *Glomus mosseae*. Highest AM infection levels were generally found in the rainy season in P deficient soils, low in moisture. They observed minimum colonization in the summer and maximum in the rainy season. Uniyal (2003) studied the AM association of *Populus deltoides* and reported that spores were most abundant in early winter *i.e.* November and least in summer.

It has been observed from present study that maximum rainfall and relative humidity was significantly and positively correlated with AM fungal population for all the three sites but there was no correlation with temperature (Table 2). Arid soil temperature exceeds air temperature and similarly exhibits wide variations diurnally as well as annually (Schenck and Schroder, 1974). Temperature may affect infection either through the direct effect on fungal metabolism or indirectly by influencing root metabolites necessary for fungal activity (Graham *et al.*, 1982). Due to high soil temperature and low moisture, AM endophytes and other microorganism failed to survive in top soil layers particularly in arid areas. This may be the reason to get insignificant correlation with temperature as we have sampled from 30 cm depth of the soil.

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