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Seasonal variation in microbial profile of black cotton soil

A. RAMALAKSHMI[1] AND S. ANTHONI RAJ[2]
[1]*Dept. of Agrl. Microbiology, TNAU., Coimbatore-03*
[2]*Anbil Dharmalingam Agrl. College & Res. Inst. Trichy-09*

Abstract : The microbial profile of a typical black cotton soil of Kovilpatti was assessed at monthly intervals for a year from April 2001 to May 2002. The total bacteria, fungi, actinomycetes, diazotrophs, *Azotobacter* and phosphobacteria ranged from 144 - 760 x 10^6, 4 x 66 x 10^4, 14-28 x 10^4, 48 -148 n 10^4, 19 - 84 x 10^8 and 2-95 x 10^3 cfu g^1 respectively during April-Aug when the moisture content varied from 6.0 - 7.4 per cent and 125 - 586 x 10^6, 6 -18 x 10^4, 6-55 x 10^4, 27-84 x 10^4, 20-26 x 10^3 and 31.76 x 10^3 respectively during Sep-Dec when the soil moisture content increased and ranged from 10.8 - 17.3 per cent and 85-92 x 10^6, 15 - 46 x 10^4, 3-8 x 10^4, 43 - 71 x 10^4, 16 - 42 x 10^3 and 23 - 36 x 10^3 cfu g^{-1} respectively during Jan-Mar when the moisture content varied from 8.2 to 13.0. The results revealed the presence of microflora despite a low moisture content of less than 7 per cent in summer when there was hardly any crop or weeds indicate the survival potential of microbes in general and *Azotobacter* and phosphobacteria in particular despite the fact that black cotton soil almost get heated up and desiccated in summer.

Key words: Microflora, black cotton soil

Introduction

The black cotton soil of south Tamil Nadu which is calcareous in nature, is unique, dry and desiccated in summer and in non rainy periods but become sticky even for a low rainfall. Black cotton soil is subjected to dry and hot weather during summer is low and spread over only one cropping season during monsoon period. In order to assess the microbial profile and its fluctuation over seasons, soil samples of typical black cotton soil of Agricultural Research Station, Kovilpatti were collected at monthly intervals during fallow and cropping periods over a period of one year and analyzed.

Materials and Methods

The total bacteria, fungi, actinomycetes, diazotrophs, *Azotobacter* and Phosphobacteria were enumerated in soil samples collected at monthly intervals from April 2001 to May 2002. The enumeration was made after preparing decimal dilutions upto 10^6 and plating 1 ml of the appropriate dilutions in Nutrient agar (Rangaswami, 1966), Martin's Rose Bengal agar, Kenknight's agar, diazotroph medium (Watanabe *et al.* 1979) Medium No. 77 (Alien, 1953) and Sperber's hydroxy apatite agar medium (Sperber, 1957) respectively for total bacteria fungi, actinomycetes, diazotrophs, *Azotobacter* and phosphobacteria. The plates were incubated at room temperature (30+2°C) for 3 days for bacteria, diazotrophs, and phosphobacteria, 5 days for fungi and *Azotobacter* and 7 days for actinomycetes. The colonies were counted and expressed as population g^{-1} on oven dry basis.

Table 1. Microbial profile of black cotton soil of Kovilpatti in different months (April 2001- March 2002)

S.No.	Month	Moisture %	Population*					
			Total bacteria x 10^6	Fungi x 10^4	Actinomycetes x 10^4	Diazotrophs x 10^4	*Azotobacter* x 10^3	Phosphobacter x10^3
1.	April	6.4	505 (2.70)	5 (0.70)	14(1.15)	148(2.17)	30(1.48)	2 (0.30)
2.	May	7.0	760 (2.88)	27(1.43)	28(1.45)	115(2.06)	19(1.28)	95(1.98)
3.	June	6.0	220 (2.34)	4 (0.60)	19(1.28)	95(1.98)	84(1.92)	12(1.08)
4.	July	7.4	186 (2.27)	35(1.54)	16(1.20)	66(1.82)	48(1.68)	38(1.58)
5.	Aug	7.1	144 (2.16)	66(1.82)	20(1.30)	48(1.68)	72(1.86)	14(1.15)
6.	Sep	10.8	148 (2.17)	15(1.18)	55(1.74)	44(1.64)	26(1.41)	44(1.64)
7.	Oct	11.5	268 (2.43)	18(1.26)	7 (0.85)	84(1.92)	21 (1.32)	35(1.54)
8.	Mov	17.3	586 (2.77)	6 (0.78)	15(1.18)	35(1.54)	20(1.30)	76(1.88)
9.	Dec	14.3	123 (2.09)	18(1.26)	6 (0.78)	27(1.43)	26(1.41)	31 (1.49)
10.	Jan	9.3	92(1.96)	15(1.77)	3 (0.48)	71(1.85)	33 (1.52)	23 (1.36)
11.	Feb	13.0	85(1.93)	19(1.27)	8 (0.90)	65(1.81)	42(1.62)	30(1.48)
12.	Mar	8.2	92(1.96)	46(1.66)	6 (0.78)	43 (1.63)	16(1.20)	36(1.56)

*g^{-1} of soil on oven dry basis; Figures in parentheses are log values.

Results and Discussion

Black cotton soil is unique in character and is subjected to dry and hot weather during summer leading to a decline in moisture reaching almost desiccation. During April-Aug when the weather is hot and soil is dry without any crop, the total bacteria, fungi and actinomycetes population ranged from 144 - 760 x 10^6, 4 - 66 x 10^4 and 14 - 28 x 10^4 cfu respectively as the soil showed a moisture content around 7% (Table 1). This clearly indicates the presence and survival of microflora despite the absence of any crop or weed during this period. Contrary to the expectation that dry, friable and desiccated soil might not contain large number of microorganisms and the soil contained a large degree of different groups of microbes even when the moisture was very low. In Sep-Nov, the moisture content of the soil increased and ranged from 10.8 - 17.3%. During this period the total bacteria, fungi and actinomycetes population ranged from 148-586 x 10^6, 6-18 x 10 and 7-55 x 10^4 cfu g^{-1} respectively exhibiting a slight increase in general. But subsequently the total bacteria, fungi and actinomycetes population were higher eventhough the moisture content of soil was low. The fungal population fluctuated and exhibited a relative increase when the moisture was high. However the results revealed a seasonal fluctuation in the

population of total bacteria, fungi and actinomycetes in black cotton soil under rainfed cotton and their population was higher even during summer.

The population of *Azotobacter*, phosphobacteria and diazotrophs ranged from 19-84 x 10^3, 2-95 x 10^3 and 48-148 x 10^4 cfu g^{-1} respectively during the month of April-Aug. In Sep-Nov, the population *of Azotobacter,* phosphobacteria and diazotrophs ranged from 20-26 x 10^3, 35-76 x 10^3 cfu g^{-1} and 35-84 x 10^4 cfu g^{-1} respectively. The population of these three groups ranged from 16-42 x 10^3, 23-36 x 10^3 and 27-71x 10^4 cfu g^{-1} respectively in the month of Dec-Mar. During this period the moisture content varied from 8.2 - 14.3 per cent.

The results revealed the presence of total bacteria, fungi, actinomycetes, diazotroph, *Azotobacter* and Phosphobacteria in black cotton soil throughout the year, but their population fluctuated greatly. The results indicated that in general the soil microflora was higher in black cotton soil even though the soil was subjected to dry and hot weather during desiccation. It is generally presumed that a wetland soil might contain a higher level of microflora than a dryland or a black cotton soil that appears dry over a stretch. It is very hard to see any vegetation in summer and even grasses seldom grow even though certain weeds like *Morinda tinctoria* grows at random. It is of interest to note a relatively higher population in dry periods and a decline in *Azotobacter* population after the receipt of monsoon rains. The *Azotobacter* and phosphobacteria population were high in black cotton soil during summer because they can persist in high temperature over a longer period. It is of interest to note a larger bacterial population even at very low soil moisture of 7 per cent. The *Azotobacter* and phosphobacteria were also found to be larger in number at this moisture. This might perhaps due to their capabilities of these bacteria to survive the adverse conditions in the form of cysts and spores. *Azotobacter* forms cyst while *Bacillus* forms endospores that usually tolerates a higher temperature than the vegetative cells. The *Azotobacter* is known to produce polysaccharides that can protect the cells from desiccation. Further these cells are known to produce a higher number of cysts when calcium is available and calcium ions were found to be structural units necessary for the coordination of coat composition into rigid cyst structure (Neeru Narula *et al.* 1998). Similarly there is a higher chance for *Bacillus* spp. abundant in soil to form endospores as calcium is rich in black cotton soil and it is a structural component of endospores as ca-dipicolinic acid complex. Although soil microbial profile has been investigated in the past by a few workers (Ramaswami, 1966, Ramaswami and Nair, 1966; Muralikannan and Anthoni Raj 1998), the specific comprehensive study on the distribution of *Azotobacter* and phosphobacteria in black cotton soil is very much limited. However the present study revealed that higher population of total bacteria, *Azotobacter* and phosphobacteria in black cotton soil might be due to their adaptation for dry condition and this gives an inherent fertility to the soil compared to that observed in a rice cultivated loamy soil of Vaigai command area at Madurai over the same period (Triveni 2002). The present observation is in agreement with the earlier report of high microbial count in black cotton soil by Ramaswami, (1996). The higher number of microorganism even during summer indicates that these may occur in abundance after cropping when rain is received.

References

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