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Seasonal Variation In Microbial Population At Different Depths Of Normal And Sodic Soils Of Varanasi

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Abstract:

An experiment was conducted to count the microbial population at different depths and season. Soil samples were collected at 0-20, 20-40 and 40-60 cm depths from the two sites viz. BHU research farm for normal soils and Sushuwahi village of Varanasi district for sodic soils in all three season viz. winter, rainy and summer season for study of variation in microbial population such as bacteria, fungi, actinomycetes, Azotobacter and Pseudomonas. The physico-chemical and microbial properties of soil do not remain constant as seasonal variation. Soil depth and environmental conditions, directly affect the population of bacteria, fungi, actinomycetes, Azotobacter and Pseudomonas in soils. Increasing soil depth decreases the microbial population due to certain limit of physico-chemical behavior of soils.

Key words: *Soil depths, Seasonal variation, Microbial population, physico-chemical properties etc.*

1.Introduction

Out of all gift of nature, none is perhaps more important than soil for an agriculturist. It serves as medium for food and fuel production which nourish the life. It also acts as shelter and seat for various types of organisms such as bacteria, fungi, actinomycetes, azotobacter, pseudomonas, algae, protozoa and viruses. But soils differ among themselves regarding their physico-chemical properties which determine the nature of the soil environment in which microorganisms exists. The microbial population in soils varied widely with soil type, their physico-chemical properties, environmental fluctuations and synergistic and antagonistic behavior of one group with other. The population of microorganisms varies widely with soil type and cultural practices with optimum dose of fertilizers application (Singh, et al. 1999). There are various factors responsible for the seasonal variation in microbial growth in soils. Besides, these many lesser factors such as cultivation, season and soil are also responsible to variation in microbial population and growth in soils. Seasonal variation in the microbial population of wheat soils under dry and irrigated condition and observed a maximum growth in spring and minimum in summer. Fungi were generally more abundant in fine-texture soils (Lozanocalla, 1968). Since no much more systematic information is yet available on the present study was conducted to assess the status of different microbes in different soil depth in different season.

2.Materials And Methods

Soil samples were collected at different depths from the two sites viz. BHU research farm for normal soils and Sushuwahi village of Varanasi district for sodic soils. The experimental sites are spread over Indo-gangetic plain and lies between 25018’ to 16021’ N latitudes and 76020’ to 76038’ E longitudes. The Indo-gangetic belt of Varanasi region classified as semi arid zone where mean annual rainfall ranges from 750 to1000 mm which is normally confined during July to September in every year and the maximum temperature ranges from 28.20 C to 43.30 in summer season and minimum 9.30 C to 28.4 C in winter season. There is gradual increase in temperature in summer season and decrease in winter season also noted.

Soil samples were collected in the winter, rainy and summer season in the absence of crop and there was no rainfall occurred during the past 24-48 hrs. From each spot soil profile was dug and sample was collected from 0-20, 20-40 and 40-60 cm depth. Five representative soil samples were collected from each depths were mixed separately to get

a composite soil sample. About 1.0 kg of soil sample from different depth was taken separately in polyethylene bag. The same techniques of collection of samples were adopted in winter and summer also. Rice-wheat cropping system was adopted since last ten years in the normal soils of BHU research farm and sodic soils of Sushuwahi village was uncultivated barren land.

The physico-chemical characteristics of the soils were analyzed with standard procedures given by Black 1985; Jackson 1979 whereas microbial population such as Fungi by Martin's (1950) rose Bengal agar media, bacteria by Thornton's medium (1922), actinomycetes by Allen's (1959) Kenknight and Munaier's media, Azotobacter by Burk's(1940) agar medium and Pseudomonas by Pikovskaya's medium modified by Sundara Rao and Sinha (1963). Microbial population were counted by the serial dilution and plating method of taking 10 g of soil from each of composite sample and calculated as per moisture content of each sample. After an incubation period of 7-10 days at 25-300C, the microbial colonies were counted.

3.Results And Discussion

3.1.Physico-Chemical Characteristics

The physico-chemical properties of the soils are given in Table 1.The pH of both normal and sodic soils varied with the depth and seasons. The pH of the normal soils was higher (7.8) at 40-60 cm depth in April and lower (7.2) at 0-20 cm depth in January. The pH of the normal soils was lowest in the winter season followed by rainy and summer season. It is noted that the pH of the soils increases with increasing soil depth in all seasons. It is due to more accumulation of exchangeable bases removed from the upper horizons. The pH of the sodic soils was higher (10.2) at 0-20 cm depth in summer season and lower (9.4) at 40-60 cm depth in both rainy and winter season and there was no difference in pH in rainy and winter season. The pH of the sodic soils decreases with the depth in all seasons. It is due to accumulation both exchangeable and soluble sodium salts on surface as soils is uncultivated barren lands. Likewise pH, the EC of both normal and sodic soils was also varied with the depth and seasons. The EC of the normal soils was almost similar in upper layer in all the seasons and it decreases with increasing soil depth, whereas in sodic soils, the EC was higher (1.45 dsm-1) in upper layer in the summer season and almost similar in both rainy and winter season. It was also decreases with increasing soil depth. The organic carbon content decreases in both the soils with

increasing soil depth in all the seasons. The normal soils contain maximum organic carbon than sodic soils. The organic carbon content in normal soil was higher in all the layers in winter season followed by summer and rainy season. In sodic soils, the organic carbon content has little variation in both the depth and season and noted higher organic carbon content in winter season followed by rainy and summer season.

It is evident from the observations that the total N content decreases with increasing soil depths in both the soils. Likewise above properties, the normal soils contain higher amount of total N content in the entire layer followed by summer and rainy season. In the sodic soils, the total N content was higher in winter season as normal soils while its quantity decreases in rainy season than summer season. Similarly, the C/N ratio increases with increasing soil depth in both the soils. The narrow C/N ratio was recorded in winter season than the summer and rainy season in both the soils.

3.2.Microbial Characteristics

3.2.1.Total Bacteria

The population of total bacteria was found non significant in normal soils and significant in sodic soils (table.2) which influenced by season and depth in both the soils. The maximum population of bacteria (30.34 $X10^5$/g) was found in 0-20 cm depth in winter season followed by summer (26.0$X10^5$) and lowest population (24.0 X 10^5/g) in the rainy season. In normal soils, the bacterial population was decreases with increasing soil depth. Maximum population was noticed in winter season followed by summer and rainy season in entire layers and the interaction of season and soil depth was non significant. High organic carbon content, sufficient moisture, low pH and narrow C/N ratio favors the bacterial population. It was also noticed that the bacterial population decreases with soil pH. However, soil pH is not only factor controlling bacterial population but there are many other variables which plays role in the multiplication and distribution of microbial population of soil (Stotzky and Rem, 1966; Chatterjee and Dalal, 1968; Gupta and Saharan, 1974). Sodic and normal soil of BHU showed higher bacterial population of surface soil (Singh *et al*. 1998) during month of January than April and August (Lozanocalle, 1998). Sodic soils have less bacterial population as compared to normal soils but its bacterial population was higher in winter season (26.0$X10^5$) followed by summer (22.667$X10^5$) and rainy (18.333$X10^5$) season. The interaction of season and soil depth was significant in sodic soils.

3.2.2.Total Fungi

Total fungal population in normal and sodic soils was significantly decreased with increasing soil depth. Likewise bacterial population, the maximum fungal growth was noticed in surface layer in all the seasons in both normal and sodic soils than lower layers. The maximum population of fungi (13.333 X 104/g) was found at 0-20 cm depth in winter season followed by summer (12.333X104) and lowest population (10.667 X 104/g) in the rainy season in normal soils and interaction of season and soil depth was significant. Fungal population in sodic soils was very low as compared to normal soils due to low organic matter and presence of high pH. The maximum population of fungi (3.0 X 104/g) was found in 0-20 cm depth in winter season followed by rainy (2.0X104) and lowest population (1.333 X 104/g) in the summer season in sodic soils and interaction of season and soil depth was non significant. . Normal soil gave more count in 0-20 cm depth in month of January which may be due to the greater amount of readily available organic matter in the upper layer of soil (Alexander, 1983). On the perusal of data it is clear that both the soils have higher fungal influence in winter season as compared to rainy and summer season.

3.2.3.Actinomycetes

Likewise the bacteria and fungi, the actinomycetes population growth significantly decreases with increasing soil depths in both soils and maximum population growth was noticed in normal soils than sodic soils. It is might be due to favorable soil pH, temperature, organic matter concentration (Table 3). The maximum population of actinomycetes (34.333 X 105/g) was found at 0-20 cm depths in summer season followed by winter (30.0X105) and rainy (26.667 X 105/g) season in normal soils and interaction of season and soil depth was non significant. Similarly, the maximum population of actinomycetes (35.667 X 105/g) was found at 0-20 cm depths in summer season followed by rainy (21.667X105) and rainy (18.667 X 105/g) season in sodic soils and interaction of season and soil depths was significant. Actinomycetes spores can tolerate a little higher temperature and dry condition (Niohi, 1975). It is believed that actinomycetes are not tolerated of low and high pH and the population size is inversely proportional to the pH, the population being mostly abundant in soil of pH 6.5- 8.0 (Waksman, 1952, Alexender, 1985). Fluctuation in actinomycetes population of normal and sodic soil is due to small variation of other factors (Alexender, 1985). Population decreased with increasing soil depths is due to reduced aeration and organic matter

content with significant variation. Season and soil depths play significant role in the growth and development of actinomycetes and a significant effect of season and soil depth on the distribution of actinomycetes was found in sodic soil. Actinomycetes grow well at optimum moisture, little higher temperature and neutral to slightly alkaline pH. It was a major factor for decrease of actinomycetes population in month of winter and rainy season as compare to summer season.

3.2.4.Azotobacter

Population of Azotobacter was found to vary in various seasons and soil depths but no definite trend could be observed. The maximum population (28.33 x 104) of Azotobacter was found in surface layer and minimum in lower layer. It was due to uneven aeration, temperature, organic matter content etc. at different depths. Aerobic conditions are more favorable for the proliferation of Azotobacter. The effect of seasons and soil depth on Azotobacter population was significant but effect of season and soil depth interaction was non- significant, while highest population 17.777 x 104 in sodic soil and 11.667 x 104 in normal soil in January month followed by April and August. On the basis of statistical data, increased population of Azotobacter was found in sodic soil than in normal soil due to changes in physico-chemical properties of soil in different seasons and depth, particularly, soil pH, might be aeration, moisture content, organic matter and status of available nutrients (Subba Rao, 1995) also. Better growth and development were found in surface soil (Singh, et al. 1999) in winter season. In the rainy season, increasing moisture leads to anaerobic condition which is not favorable for the growth of Azotobacter, which is highly aerobic in nature.

3.2.5.Pseudomonas

Higher population of Pseudomonas was significantly found at 0-20 cm depth in winter season (12.999 X103) than sodic soil (7.44 x 103) in summer and rainy season. It was due to variation in moisture, soil, pH, aeration, soil temperature and organic matter. Population of Pseudomonas was significantly decreased with increasing soil depth in both soils and in all seasons. The cause of variation in population of Pseudomonas with depth was due to aeration and organic matter, because Pseudomonas is aerobic microorganism. It cannot play a significant role in absence of oxygen in soil. Maximum population (21.333 x 103) of Pseudomonas was found in normal soil as composed to

sodic soil (18.667 x 103). Season and soil depth play significant role in microbial population growth while interaction of season and soil depth was non-significant.

4.Conclusion

The study leads to the conclusion that the physico-chemical and microbial properties of soil do not remain constant as seasonal variation, soil depth and environmental conditions, directly affect the population of bacteria, fungi, actinomycetes, Azotobacter and Pseudomonas in soils. Increasing soil depth decreases the microbial population due to certain limit of physico-chemical behavior of soil. Winter season was favoured for increasing population of bacteria, fungi and summer season for actinomycetes in both sodic and normal soil.

Neutral soils							Alkali soils				
Season	Soil Depth	Soil pH	EC (dSm^{-1})	Organic carbon (%)	Total N (%)	C/N Ratio	Soil pH	EC (dSm^{-1})	Organic carbon (%)	Total N (%)	C/N Ratio
Monsoon	0-20	7.4	0.25	0.65	0.075	8.6:1	10.1	1.4	0.24	0.018	13.3:1
	20-40	7.7	0.13	0.13	0.034	10.2:1	9.8	1.08	0.12	0.008	15.0:1
	40-60	7.8	0.12	0.13	0.011	11.8:1	9.4	0.81	0.08	0.005	16.0:1
Winter	0-20	7.2	0.24	0.70	0.083	8.4:1	10.1	1.4	0.26	0.021	12.3:1
	20-40	7.4	0.14	0.38	0.040	9.5:1	9.7	1.05	0.12	0.009	13.3:1
	40-60	7.7	0.12	0.19	0.014	13.5:1	9.3	0.80	0.06	0.004	15.0:1
Summer	0-20	7.4	0.26	0.66	0.077	8.5:1	10.2	1.45	0.20	0.015	13.3:1
	20-40	7.7	0.14	0.35	0.035	10.0:1	10.1	1.10	0.10	0.007	14.2:1
	40-60	7.8	0.12	0.18	0.014	12.8:1	9.6	0.85	0.05	0.003	16.6:1

Table1: Physico-chemical characteristics of normal and sodic land soils

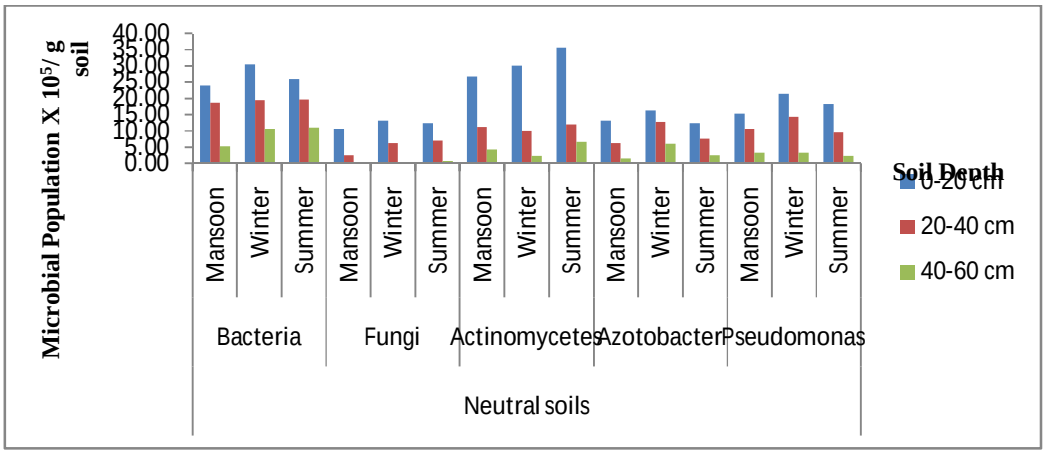

Figure 1: Seasonal variation in micro bial population at different depth in Neutral soils

Normal soil												
Total Bacteria population (X 10^5 /g soil)					Total Fungi population (X 105/g soil)				Total Actinomycetes population (X 105/g soil)			
Soil depth (cm)	August	January	April	Mean	August	January	April	Mean	August	January	April	Mean
0-20	24.00	30.334	26.000	26.778	10.667	13.334	12.334	12.111	26.667	30.000	35.667	30.334
20-40	18.667	19.334	19.667	19.223	2.667	6.334	7.000	5.334	11.334	10.000	12.000	11.112
40-60	5.334	10.667	11.000	9.000	0.334	0.334	0.667	0.445	4.334	2.334	6.667	4.445
Mean	16.000	20.11	18.889		4.556	6.667	6.667	-	14.112	14.037	17.667	-
CD(0.05) = Season –NS, Soil depth- 9.383 Season X Soil depth -NS					CD(0.05)= Season-2.458,Soil depth- 2.458, Season X Soil depth-3.530				CD(0.05) = Season-NS, Soil depth- 13.365, Season X Soil depth –NS			
Sodic land soil												
0-20	18.334	26.000	22.667	22.334	2.000	3.000	1.334	2.112	21.667	18.667	34.334	25.334
20-40	11.676	18.667	12.334	14.222	0.334	0.334	0.667	0.445	10.334	8.334	19.000	12.556
40-60	0.667	0.667	0.667	0.667	0.000	0.000	0.000	0.000	4.667	1.000	4.000	3.223
Mean	10.223	15.111	11.889	-	0.778	1.112	0.667	-	12.223	9.334	19.556	-
CD(0.05)= Season- 3.975, Soil depth -3.975 Season X Soil depth - 5.710					CD(0.05)= Season –NS, Soil depth- 2.678, Season X Soil depth - NS				CD(0.05)= Season-5.206,Soil depth 5.206,Season X Soil depth-18.579			

Table 2: Seasonal variation in population of bacteria, fungi and actinomycetes in different depth of Normal soil and sodic soil

Normal soil								
Azotobacter spp. population (X 10^5 /g soil)					*Pseudomonas spp. population* (X 105/g soil)			
Soil depth (cm)	August	January	April	Mean	August	January	April	Mean
0-20	13.334	16.334	12.334	13.999	15.334	21.334	18.334	18.334
20-40	6.334	12.667	7.667	8.889	10.667	14.334	9.667	11.556
40-60	1.667	6.000	2.667	3.445	3.334	3.334	2.334	2.999
Mean	7.112	11.667	7.222	-	9.771	12.999	10.111	-
CD(0.05) = Season-3.882, Soil depth -3.882 Season X Soil depth -NS					CD(0.05)=Season-4.218,Soil depth -4.218 Season X Soil depth-NS			
Sodic land soil								
0-20	14.667	28.333	18.000	20.334	14.000	18.667	15.000	15.889
20-40	8.667	16.667	12.334	12.556	3.000	6.000	4.000	4.334
40-60	3.667	8.334	7.334	6.445	0.667	4.000	3.334	2.667
Mean	9.000	17.778	10.000	-	5.889	9.556	7.445	-
CD(0.05)= Season -6.77, Soil depth- 6.44, Season X Soil depth-NS					CD(0.05)=Season-3.485, Soil depth-3.485 Season X Soil depth-NS			

Table 3: Seasonal variation in population of bacteria spp. in different depth of Normal soil and sodic soil

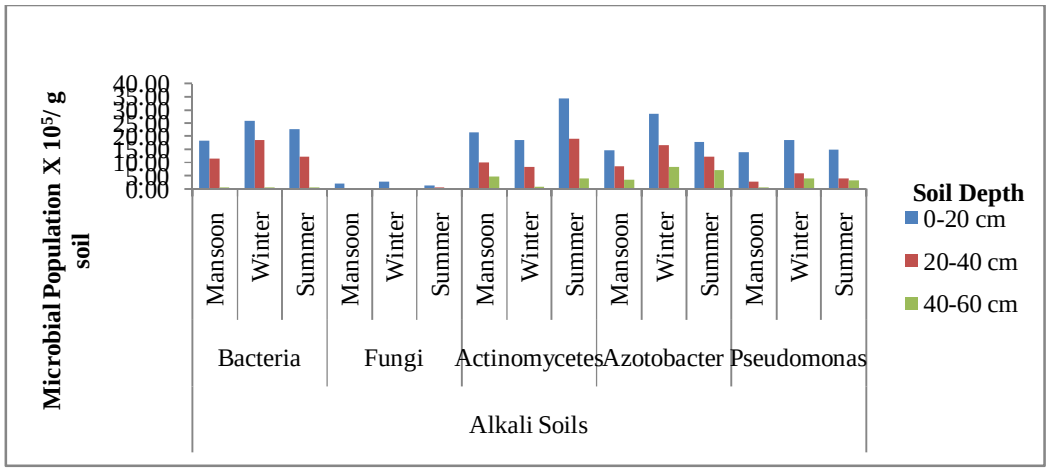

Figure 2: Seasonal variation in microbial population at different depth in Alkali soils

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