The soil Properties and Cyanobacterial Diversity of "Usar" Soils.

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Abstract- Salinity is a problem of irrigated agriculture and recognized as a serious threat to crop production. "Usar" soils are extensively distributed in the northern part of India (2.5 million ha) and are characterized as alkaline and or/ saline depending on the salt contents. The vast areas of 'Usar' lands occurring in Uttar Pradesh, found with varying degrees of salinity and alkalinity. In Uttar Pradesh, "Usar" soils distributed in Azamgarh, Ghazipur, Mau, Jaunpur and Varanasi and many other districts covering about 1.29 million hectares. Saline/alkaline soils ("Usar") have high ph. and undesirable salts on their surface. Increasing soil salinity, high soluble salts, sodicity and high exchangeable sodium all are serious land degradation issues worldwide. Cyanobacteria (Blue-Green Algae) are a group of primitive phototrophic, Gram-negative and prokaryotic microbes occurring in a wide range of habitats including saline/alkaline soils. Environmental constraints including salinity and alkalinity significantly influence the diversity and abundance of microorganisms like cyanobacteria and their activity in the soils. The population dynamics of cyanobacteria studied in "Usar" soils of Eastern U.P. located at Azamgarh and Varanasi districts. Soil samples collected from the three different sites (two of Azamgarh district and one of Varanasi district) during the months of May 2016 to April 2017. Among the soil properties, pH is certainly the most important environmental influence determining the diversity and abundance of cyanobacteria. The value of pH and Ec (Electrical conductivity) found to be minimum in rainy season while maximum in summer. The maximum diversity found at lower pH in rainy season followed by winter and summer. On the basis, our results we could reach to the conclusion that the growth of cyanobacteria were slow in highly saline soils during summer season due to high pH. Only a few algae like *Nostoc sp.*, *Calothrix sp.* and *Anabaena sp.* could survive during highly saline condition. Cyanobacteria identified to grow on "Usar" soils were *Microcoleus chthonoplastes, M. vaginatus, Nostoc calcicola, N. punctiforme, N. spongiaeforme, Calothrix brevissima, Anabaena ambigua, A. fertilissima, Scytonema sp., Cylindrospermum licheniforme, Aphanothece parietina, Aulosira fertilissima, Gloeocapsa stegophila, Phormidium sp, Oscillatoria subbrevis, Chroococcus macrococcus, spirulina sp., Anabenaopsis, circularis* and *Lyngbya ceylanica.*

I. Introduction

Cyanobacterial are group of photoautotrophic, Gram (-) ve prokaryotic microorganisms that carry out oxygenic photosynthesis to generate the energy and reducing power required to assimilation atmospheric CO_2 and in some species, N_2. The interlinking position of cyanobacteria in the phototrophic world is compatible with the facts that they are prokaryotic and among the oldest organisms, dating from the early Precambrian period of 3.6×10^9 years ago (Stanier and Cohen-Bazier, 1977). They can be found in almost every conceivable habitats including saline/alkaline "Usar" soils. The Blue Green Algae or Cyanbacteria (A group of gram negative photoautotropic bacteria) are one of the most ancient component of earth present in the Archaean and protozoic eras (2.7 billion years ago) that were responsible our oxygenic atmosphere through their photosynthetic Activities (Ananya, Kamal. A and Ahmad I Z., 2014). The term biodiversity used here to describe the Number, variety and variability of living organisms in an ecosystem. India is one of the mega-diversity countries of the world, having almost possible kind of climatic variation, with a great diversity of microbes especially the cyanobacteria (Litavitis, 2002). Traditionally, cyanobacteria have been classified based on the morphological and ecological characters (Geitler,1932,Desikachary,1959,).The most fundamental meaning of biodiversity probably lies in the concept of species richness that indicating the number of species occurring at a site, in a region or ecosystem. Long time, morphological characteristics taken into account for a taxonomical Classification of cyanobacteria (Rippka et al., 1979, Schopf, 2000). Cyanobacteria are ancient organisms that inhabit the crust of the earth and have some specialized features to accommodate the changing or different environmental conditions such as light, pH, temperature and nutrient availability have received much attention because they participate in making the Cyanobacteria with-stand almost all the ecosystem (Kirrolia et al., 2012; Saadantia and Riahi, 2009). Cyanobacteria are photosynthetic prokaryotes and are one of the biological constituents of the soil (Whitton 2000). Cyanobacteria play an important role in the ecology of terrestrial ecosystems because they contribute to soil fertility due to the pro-duction of organic carbon (Kabirov & Gaisina 2009) and because they facilitate the processing of fixed atmospheric nitrogen (Pankratova 2006).

Saline-alkaline soils/salt affected soils (commonly known as 'Usa'r soils in India occupy more than 7 million hectare (Mha) land in India (NRSA 2003). In U.P., the saline 'Usar' soil are distributed in Azamgarh, Varanasi, Kanpur, Lucknow, Hardoi, Unnao, Allahabad, and many other districts covering about 1.29 million hectares. The 'Usar' soils are grouped in to two broad categories- the saline (solenchak) and the alkaline (solonetz or sodic). Saline soils contain a concentration of neutral soluble salts sufficient to interfere seriously with the growth of most plants.

The electrical conductivity (EC) of a saturated extract of the soil solution is more than 4 decisiemens per meter (dS/m). The exchangeable sodium percentage (ESP) is less than about 15, and the pH usually is less than 8.5. Sodic soils are characterized by high exchanges Na^{+} ion (more than 15%) low quantities of Ca^{++} , EC less than 4 dS/m and high ph values that usually range between 8.5 to 10.5 (R.N.Singh,1961). Increasing soils salinity, high soluble salts, sodicity and high exchangeable sodium all are serious land degradation issue worldwide (Vanessa *et al*. 2009). In recent years, cyanobacteria have been studies to understand their level of halotolerence and physiological response to salinity (Reed et al., 1985). Due to their occurrence in saline/alkaline "Usar" habitats, these organisms are the excellent material for ecological and biotechnological studies. The objective of the present study was aim to the analysis of soil properties of Saline-alkaline "Usar" soils in relation to cyanobacterial diversity.

II. MATERIALS AND METHODS

Study area (site location)

The site selected for this present study includes of two districts. The one site districts Varanasi (Bhawanipur) is located at an elevation of 80.71 meters (264.8 ft) and coordinates 25.28°N 82.96°E. The temperature between 22 and 46°C (72-115°F) in the summers. In the wenter from December to February temperature, bellow 5°C (41°F) are uncommon. The average rainfall is 1110 mm (44 inch) The second districts is Azamgarh where two site selected Bunda and Alipur has an average elevation of 64 meter (209 ft) and its geographical are coordinates 26°3'36" North 8°11'10"East.The temperature and rainfall like as a Varanasi districts. Three sites selected from districts Varanasi and Azamgarh, Varanasi selected one site Bhawanipur and Azamgarh selected two sites Alipur and Bunda (Figure 1). Soil sample collected from 'Usar' field during May 2016 to April 2017. Occurrence of Cyanobacteria in saline/alkaline soil described by (Singh, 1950; Singh, 1961). Soil pH is an important factor in Cyanobacterial distribution in soil (Sardeshpande and Goyal, 1981).

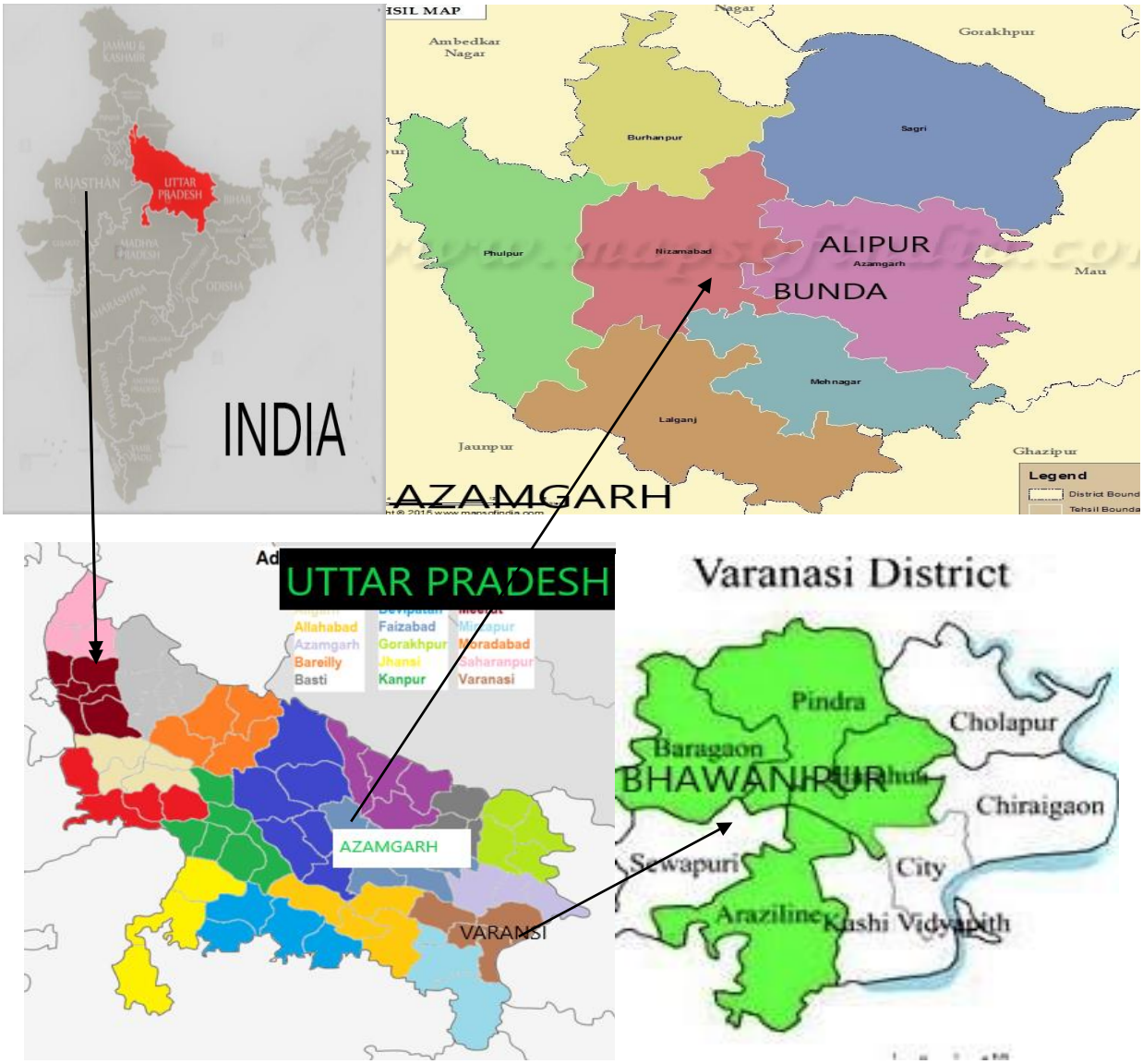


Fig-1 Location of the Eastern Uttar Pradesh Site-1 Bunda, Site-2 Alipur in Azamgarh district and Site-3 Bhawanipur is location of Varananasi district.

Sample collection and identification

"Usar" soils samples were collected from Site-1 Bunda (Azamgarh), Site-2 Alipur (Azamgarh) and Site-3 Bhawanipur (Varanasi) districts during May-2016 to April-2017. Soil samples collected from three different locations at the depth of 15cm. in zigzag pattern across the required areas. A composite soil sampling performed at each sites. Soil samples were collected 5-10 cm below the surface after digging a pit of 5"× 5" inch, packed into polythene bag, and delivered to the laboratory on the same day to avoid unpredictable changes and interference in characteristic. The collected samples dried at shaded place at room temperature, grinned and sieved for removal of debris and stones. The sieved soils used for analysis.

The soil samples were analyzed with respect to their electrical conductivity (EC) and pH ranges using soil/water suspension in (1: 2.5w/v) with microprocessor pH-EC-TDS meter model 1615. Soluble cations were determined by EDTA method and flam photometrically method respectively (Chopro & Kanwar 1991; Tondon 1993). The soluble anions determined by volumetric method (Chopra & Kanwar).

Moist culture of soil algae were prepared by spreading a layer of soil (about 1 cm. thick) and moistened with sterilized distilled water periodically in Petri dish covered with a sheet of glass both previously sterilized (John 1942). In about a fifteen night after incubation, the visible growth of algae appear in the culture ,one of the replicates was disturbed for microscopic examination while other were left undisturbed for further observation. For making unialgal culture, a few drops of the culture of the algal flora transferred to soil agar plate with the help

of fine pipettes. After 12-15days (about 2 weak), Petri dishes were observed for algal colonies. The colonies then transferred into various nutrient medium for their isolation and identification. Identification of the cyanobacterial samples carried out using the taxonomic publication of Desikachary (1959).

Diversity Analysis

Total number of cyanobacterial strains identify under the microscope, genera of the cyanobacterial isolated identified and strains sorted out on basis of their morphology. The genus counted for estimating diversity and richness of cyanobacteria in the study areas. Simpson's dominance (D), Shannon-Wiener index (H) (Shannon and Weaver,1949), Simpson's diversity (1-D) (Simpson,1949) and Mclntosh Evenness index (McE) were used to estimate the generic diversity among the cyanobacterial isolated (Table) using the following formulae:

Shannon-Weiner Index, H = -∑ pi ln pi

Simpson's Dominance, D = ∑ (pi)²

Simpson's Diversity Index, 1-D = 1- ∑ (pi)²

Where, pi= total number of strains of genus / total number of all strains

Mclntosh Evenness Index, McE = [N-√ (∑ni)] / N-(N/√S), (Mclntosh, 1967)

Where, ni = number of strains of genus i and S= Total number of genera and N= Total number of strains

Results

Physio-Chemical Properties of saline/alkaline/ "Usar" soil

Monthly variation among the physio-chemical properties of saline/alkaline soil was studies and represented in Table 1. pH, EC, soluble cations (Ca^{++}, Mg^{++}, Na^{+} and K^{+}) anions (Cl^{-}, CO_3^{--}, HCO_3^{-} and SO_4^{-}) and SAR variable is undertaken for study to describe the current status of alkaline/saline soil which collected from predefined study sites. Site-1 Bunda (Azamgarh), Site-2 Alipur (Azamgarh) and Site-3 Bhawanipur (Varanasi) study. These sites considered for study.

The physio chemical analysis of Usar soil revealed that the Usar soil temperature ranged 5℃ to 45℃, ph ranged from 9.86 to 8.05, Electro-conductivity ranged from 4.98 to 3.34 dSm^{-1}. 'Usar' soil soluble cation like Ca^{++} ranged from 5.95 to 4.21 MeL^{-1}, Mg^{++} ranged from 5.96 to 4.26 MeL^{-1}, Na^{+} ranged from 55.25 to 54.32 MeL^{-1} and K^{+} ranged from 2.86 to 1.72 MeL^{-1}. "Usar" soil soluble anion like CO_3^{--} ranged from 7.32 to 6.12 MeL^{-1}, HCO_3^{-} ranged from 20.45 to 17.20 MeL^{-1}, SO_4^{--} ranged from 3.89 to 3.23 MeL^{-1} and Cl^{-} ranged from 52.22 to 49.38 MeL^{-1}, the SAR was ranged from 27.98 to 22.91. All these physio-chemical properties show in Table-1

Physico-Chemical character	Site name	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
pH	Site 1	8.23	8.21	8.08	8.87	8.92	9.86	8.78	8.73	8.25	8.16	8.65	8.45
	Site 2	8.13	8.22	8.11	8.83	8.88	9.83	8.76	8.74	8.23	8.62	8.52	8.34
	Site 3	8.12	8.18	8.05	8.82	8.82	8.78	8.71	8.63	8.26	8.19	8.57	8.28
EC(dSm^{-1})	Site 1	4.02	3.97	3.89	4.23	4.64	4.98	4.76	4.45	4.43	4.32	4.25	4.15
	Site 2	3.96	4.01	3.87	4.19	4.52	4.99	4.66	4.43	4.36	4.21	4.04	3.98
	Site 3	3.34	3.92	3.81	4.14	4.63	4.84	4.53	4.37	4.24	4.12	4.02	3.74
Ca^{++}(MeL^{-1})	Site 1	5.01	5.22	4.89	5.23	5.55	5.95	5.79	5.52	5.55	5.23	5.12	5.18
	Site 2	4.98	4.97	4.54	4.65	4.84	5.87	5.46	5.34	5.35	5.12	5.06	5.01
	Site 3	4.62	4.74	4.21	4.24	4.65	5.26	5.18	5.04	5.23	5.08	4.97	4.56
Mg^{++}(MeL^{-1})	Site 1	4.85	4.88	4.76	4.89	5.56	5.85	5.23	5.37	5.45	5.46	5.43	5.57
	Site 2	4.76	4.52	4.35	4.65	5.44	5.96	5.86	5.74	5.45	5.26	5.18	4.98
	Site 3	4.63	4.43	4.26	4.68	4.98	5.54	5.32	5.12	4.92	4.98	4.72	4.68
Na^{+}(MeL^{-1})	Site 1	54.43	54.34	54.14	54.29	54.65	55.25	55.12	54.94	54.86	54.75	54.64	54.56
	Site 2	54.27	54.26	54.18	54.36	54.62	55.16	55.11	54.87	54.54	54.46	54.34	54.32
	Site 3	54.32	54.49	54.32	54.26	54.56	55.14	55.04	54.76	54.45	54.42	54.38	54.34
K^{+}(MeL^{-1})	Site 1	1.92	1.84	1.81	1.98	2.45	2.86	2.54	2.42	2.34	2.24	2.12	1.97
	Site 2	1.88	1.85	1.77	1.85	2.36	2.82	2.52	2.38	2.31	2.21	2.08	1.98
	Site 3	1.84	1.76	1.72	1.98	2.32	2.78	2.49	2.33	2.29	2.18	2.02	1.92
Cl^{-}(MeL^{-1})	Site 1	51.48	51.43	49.76	49.98	51.68	52.22	52.16	51.94	51.86	51.78	51.67	51.65
	Site 2	51.46	51.38	49.42	49.92	51.57	52.18	52.14	51.92	51.82	51.76	51.64	51.62
	Site 3	51.42	51.34	49.38	49.89	51.48	52.12	52.08	51.88	51.83	51.72	51.58	51.52

CO_3^{--}(MeL^{-1})	Site 1	6.65	6.45	6.24	6.64	6.98	7.32	7.15	7.12	7.08	6.98	6.88	6.78
	Site 2	3.36	6.32	6.28	6.57	6.85	6.98	6.95	6.65	6.62	6.58	6.43	6.38
	Site 3	6.38	6.35	6.21	6.12	6.83	6.92	6.83	6.62	6.58	6.54	6.43	6.34
HCO_3^-(MeL^{-1})	Site 1	19.32	18.86	18.25	18.95	19.65	20.45	20.32	20.23	20.14	20.08	19.93	19.48
	Site 2	19.29	18.83	18.11	18.92	19.62	20.42	20.27	20.19	20.12	20.06	19.86	19.43
	Site 3	19.24	18.38	17.29	18.72	19.45	20.38	20.24	20.16	20.11	20.03	19.83	19.41
SO_4^{--}(MeL^{-1})	Site 1	3.48	3.43	3.28	3.73	3.89	3.76	3.68	3.59	3.47	3.45	3.42	3.39
	Site 2	3.34	3.32	3.25	3.72	3.86	3.75	3.64	3.57	3.44	3.42	3.39	3.36
	Site 3	3.28	3.24	3.23	3.58	3.78	3.73	3.63	3.53	3.41	3.38	3.37	3.32
SAR	Site 1	17.33	17.03	17.42	17.05	16.39	16.08	16.6	16.64	16.54	16.74	16.82	16.64
	Site 2	17.38	17.61	18.17	17.82	17.03	16.03	16.32	16.48	16.59	16.9	16.98	16.18
	Site 3	17.86	17.99	18.66	18.16	17.67	16.78	17	17.17	17.09	17.15	17.46	17.87

Table-1. Physio-chemical parameters of the three different sites of Varanasi and Azamgarh.

seral number	Genus name	Total number of individual	Site 1	Site 2	Site 3
1	*Nostoc linkia*	188	48	105	45
2	*N.piscinle*	55		55	
3	*N.ellipsosporum*	292		224	68
4	*N.calcicola*	400	43	242	115
5	*N.spogiformae*	299	24	216	59
6	*N.punctiformae*	420	0	135	285
7	*Anabanapsis circularis*	80	0	80	0
8	*A.arnoldii*	180	0	120	60
9	*Anabaena iyangarii*	178	48		130
10	*A.ambigua*	180	0	35	145
11	*A.fertilisma*	369	0	115	245
12	*A.variobalis*	45			45
13	*A.ballygungllii*	337	0	62	275
14	*A.doliolum*	136		98	38
15	*A.circinalis*	133	0	75	58
16	*Microcoleus lacustris*	247	0	42	205
17	*M.cathanoplastas*	45		45	
18	*Oscillatoria oranata*	48	0		48
19	*O.pseudogermenata*	95		95	
20	*O.limosa*	68	0		68
21	*O.chlorina*	67	0		67
22	*O.subbrivis*	965	185	358	422
23	*Calothorix javanica*	68	68		0
24	*Lyngbya majuscule*	72	0		72
25	*L.arboricola*	277	0	175	102
26	*L.digueti*	83	83		0
27	*L.denalrobia*	123	123		0
28	*L.ceylanica*	278	93		185
29	*L.limnetica*	253	59	194	0
30	*L.dendrobia*	154		154	
31	*Phormedium anamala*	87	59	63	87
32	*P.lucidum*	108	108		
33	*P.perpuricus*	256	92		164
34	*Chrococcus micrococcus*	204	75	25	104
35	*C.giganteus*	240	0	72	168
36	*C.indicus*	92	0		92
37	*C.microsproa*	58	0		58
38	*Microcysties viridis*	56	0		56
39	*Gloeocopsa stegophila*	134	0	45	89
40	*G.montana*	85			85
41	*Spirulina laxissima*	245	73	167	46
42	*Schizothrix arenaia*	152	152		0
43	*Gomphaspharia dubium*	48	0		48
44	*Raphidiopsis curvata*	52	0		52
45	*Haplosiphon welwitschii*	148	43	16	86
46	*Stigonema mamillosum*	134	56		98
47	*Oscillotoria personato*	172		116	56
48	*phormedium ambigum*	133	0		133
49	*Cylendrospermum indicum*	105		16	89
50	*Cylendrospermum muscicola*	150	45		105

Table-2 Biodiversity of Cyanobacteria (Blue green algae) in three different sites of 'Usar' soil Varanasi and Azamgarh district (U.P.) INDIA.

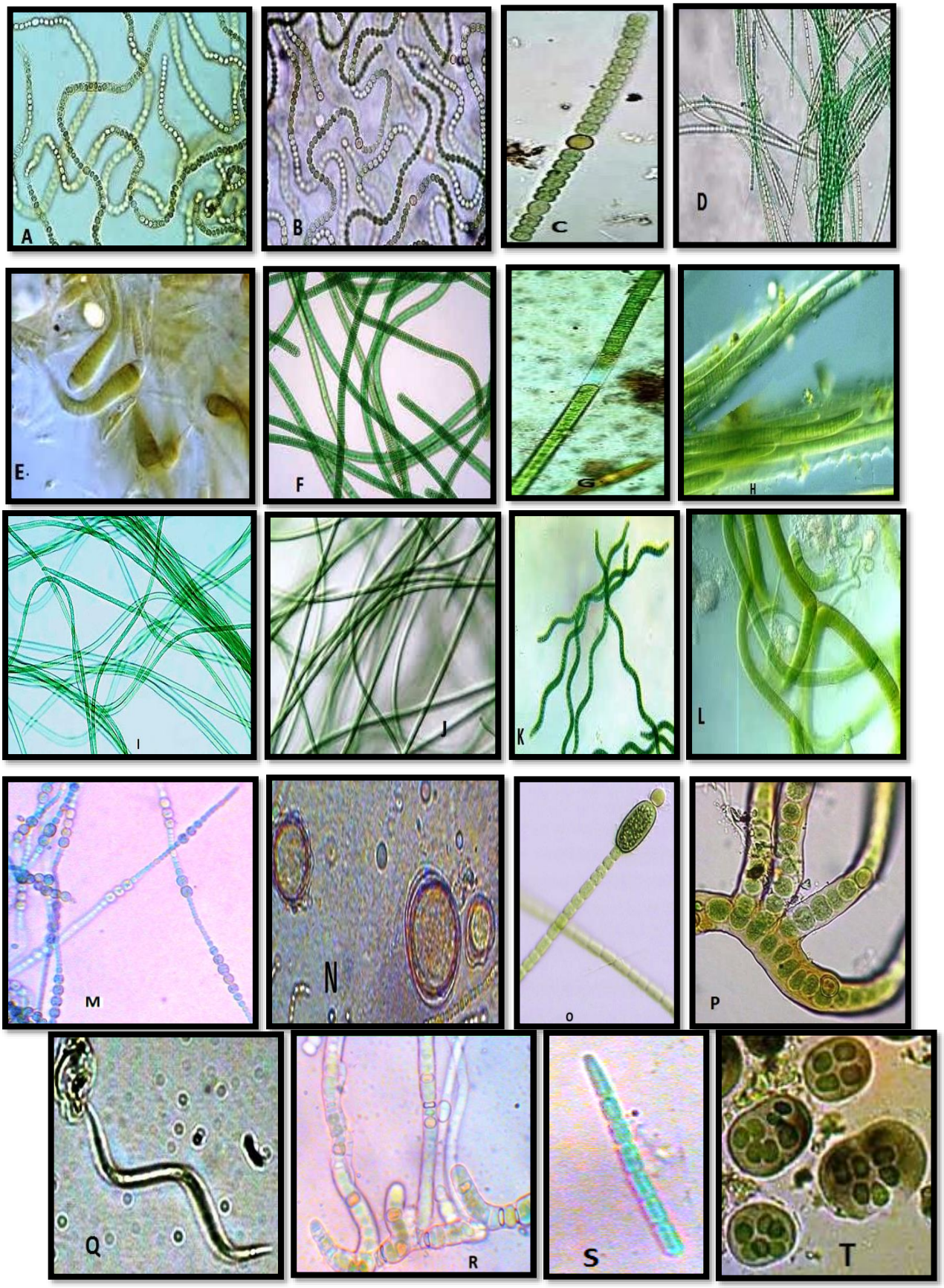


Fig-2 Cyanobacterial isolates from 'Usar' soil obtained in this study. **(A)** *Nostoc punctiformai*, **(B)** *N. calcicola*,**(C)** *Anabaena ambigua*, **(D)** *Anabaenopsis arnoldii*, **(E)** *Calothrix javinica*, **(F)** *Lyngbya arbicola*, **(G)** *L.cylinica*, **(H)** *Microcolius cathanoplatus*, **(I)** *Oscillatoria subrives*, **(J)** *Phomedium anamala*, **(K)** *Spirullina laxissima*, **(L)** *Stigonema mamillosum*, **(M)** *Anabaena fertilisma* and **(N)** *Chroococus macrococcus* **(O)** *Cylindrospermum indicum* **(P)** *Stigonema mamillosum* **(Q)** *Raphidiopsis curvata* **(R)** *Haplosiphon welwitschii* **(S)** *Schizothrix arenaria* **(T)** *Gloeocapsa stegophila*

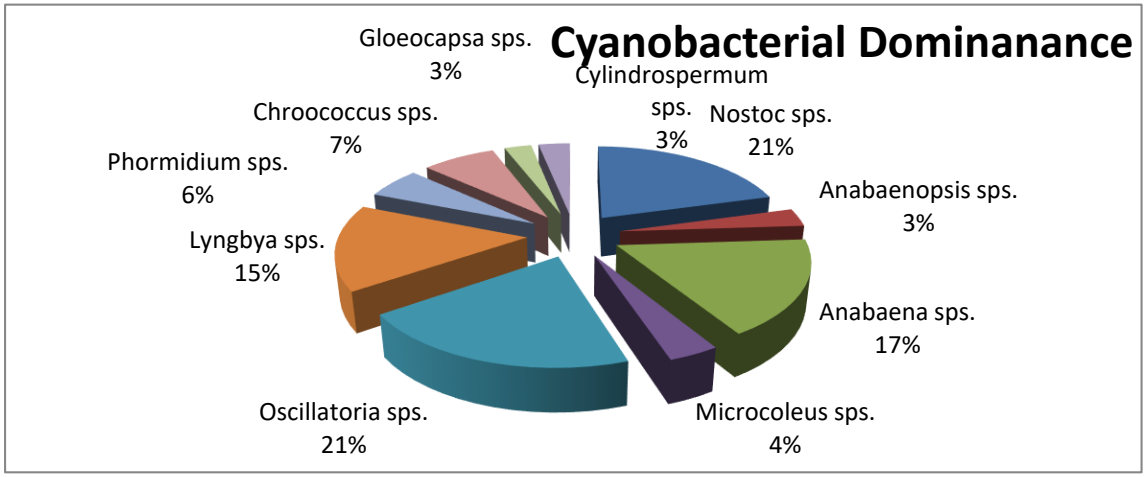
Cyanobacterial abundance

Percent abundance of cyanobacterial genera is persented in percent in the Fig. Bhawanipur recorded highest abundance of cyanobacterial genera followed by Alipur and lowest was seen in Bunda . The most forms.Morphologically they were either single celled,filamentus or branched filamentous forms.Microscopic observation showed presence of 10 differents cyanobacterial genera that are listed in Table 3. (*Nostoc*, *Oscillatoria*, *Anabaena*, *Lyngbya*, *Phormidium*, *Chroococcus*, *Microcoleus*, *Gloeocapsa*, *Anabaenopsis* and *Cylindrospermum*) abundant genera amoung all isolates were found to be *Nostoc* (20%), followed by *Oscillatoria* (20%), *Anabaena* (17%), *Lyngbya* (16%), *Phormidium* and *Chroococcus* (7%). The occurrence of rest of the genera were sporadic i.e, *Microcoleus* (4%), *Gloeocapsa*, *Anabaenopsis* and *Cylindrospermum* (3%) in these study sites.

Nostoc sps.	Anabaenopsis sps.	Anabaena sps.	Microcoleus sps.	Oscillatoria sps.	Lyngbya sps.	Phormidium sps.	Chroococcus sps.	Gloeocapsa sps.	Cylindrospermum sps.
1654	260	1378	292	1643	1240	451	594	219	255

Table-3. Genera wise abundance in the all sites

Fig-3. Percent abundance of cyanobacterial genera in all sites



Richness and Biodiversity analysis

Richness and Biodiversity in a measured by the number of species. More the number higher is the richness. Diversity indices take into accounts both relative abundance and richness to predict how well species distributed within a community. Four different statistical analyses used to encompass various diversity parameters in predicting the diversity indices of the individual sites as well as the overall diversity of all the study sites undertaken for analysis. This analysis revealed that of the three different sites Bhawanipur had the highest richness of cyanobacteria whereas Bunda showed lowest (Table-4). Nostoc Anabaena and Oscillatoria strain were widely distributed in all the sites emphasizing their adaptability and resilience under diverse environmental condition. Calculation based on Shannon-Wiener diversity index showed the Bhawanipur highest diversity (3.47) followed by Alipur (3.11) and lowest found in the Bunda (2.84). However, Evenness index was highest for Bunda (0.905) followed by Bhawanipur (0.826) and lowest in Alipur (0.806). Simpson's diversity index revealed the sequence of diversity: Bhawanipur (0.962) › Alipur (0.948) › Bunda (0.936). Simpson's dominance index was maximum in Bunda (0.0703) and minimum in Bhawanipur (0.0407). All these diversity indices for the various locations graphically represented in the Fig-4.

Diversity	Site 1	Lower	Upper	Site 2	Lower	Upper	Site 3	Lower	Upper
Dominance_D	0.06633	0.06384	0.07039	0.05344	0.05177	0.05586	0.03892	0.03763	0.0407
Simpson_1-D	0.9337	0.9296	0.9362	0.9466	0.9441	0.9482	0.9611	0.9593	0.9624
Shannon_H	2.826	2.794	2.845	3.1	3.073	3.117	3.457	3.433	3.473
Evenness_e^H/S	0.8885	0.8606	0.9052	0.7925	0.7718	0.8067	0.8138	0.7942	0.8264

Table-4 Generic diversity (Shannon's-Weinier index, evenness, Simpson's diversity and Simpson's dominance) of cyanobacterial population.

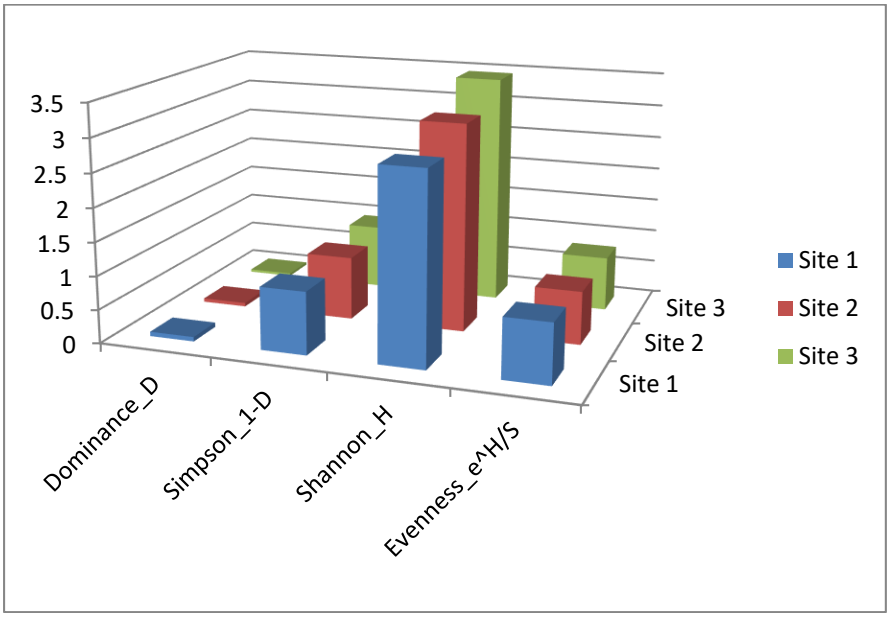


Fig-4. Graphical representation of diversity indices in Usar(sodic and alkaline) soil of cyanobacteria like as Shannon's-Weinier index, evenness, Simpson's diversity and Simpson's dominance

III. Discussion

A total of cyanobacterial isolate purified from the three selected sites. The pH of these sites ranged from 9.86-8.05. Eighteen different genera that included both heterocystous and non-heterocystous cyanobacterial isolates were found in these sites although the number of heterocystous isolates were for more in number than the non-heterocystous types. Small number of genera represented in the collection highlights the fact that growth and distribution of cyanobacteria in "Usar" soil ecosystem affected by the interplay among different physic-chemical parameters that constitute their immediate environment. The higher number of heterocystous forms further emphasize the fact that heterocystous forms are more adjustable than the non-heterocystous forms in "Usar" soil environment. Many researchers have already shown importance of physic-chemical parameters of the distribution and diversity of the cyanobacteria. (Prasanna and Nayak, 2007; Dey *et al*., 2010; Selvi and Sivakumar, 2011). Our observation the pH, EC and SAR are the affected the cyanobacterial diversity in "Usar" soil. The pH value was highest 9.86 Bunda and where the Simpson's Dominance was highest 0.0703 and pH value is low 8.05 Bhawanipur and where Simpson's Dominance was the lowest recorded 0.0407. The SAR value was also affected the cyanobacterial diversity Simpson's Dominance, Bhawanipur SAR value was highest 18.66 and Alipur was lowest 16.03. While Bunda Simpson's Dominance was lowest and Bhawanipur was highest. Simpson's Diversity, Shannon and Evenness are highest at Bhawanipur and lowest at the Bunda. The ECe was a highest at Bunda where the Simpson's Dominance is low but Simpson's Diversity, Shannon and Evenness was lowest. A look into the different genera isolated from all sites showed that the genus *Nostoc* and *Oscillatoria* was most abundant 20% in almost all sites. Abundance of this genus followed by *Anabaena* 17% *Lyngbya* 16% *Phormidium* and *Chroococcus* 7%. The rest of the genera found sporadically indicating their limitation in population arias that varied in terms of various ecological factor including pH, EC and SAR.

IV. Conclusion

The sampling of cyanobacterial diversity from three locations within Eastern Uttar Pradesh biodiversity. The present study provides an insight into the distribution, abundance, diversity and ecology of cyanobacteria of Azamgarh and Varanasi. The member of genus *Nostoc* and *Oscillatoria* to be most abundance in the region. This followed by *Anabaena, Lyngbya, Phormidium* and *Chroococcus*. In this study showed that "Usar" soil of Azamgarh and Varanasi districts/ U.P. (INDIA) has

cyanobacteria species diversity, were registered 50 species, the dominant species of cyanobacteria was *Oscillatoria* and *Nostoc* with percentage 20%, followed by *Anabaena* (17%), *Lyngbya* (16%), *Phormidium* and *Chroococcus* (7%). The occurrence of rest of the genera were sporadic i.e, *Microcoleus* (4%), *Gloeocapsa*, *Anabaenopsis* and *Cylindrospermum* (3%). The diversity of cyanobacteria species affected by physio-chemical factors (pH, EC and SAR) found positively correlated between them. Shannon, Simpson's and Evenness diversity indices of cyanobacteria recorded highest value of Bunda aria and lowest in the Bhawanipur site.

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