

Cyanobacteria as a Natural Biotechnological Tool for Bio-Reclamation of “Usar” Soils

¹Vivek Kumar Yadav, ²D.V. Singh

^{1,2}Department of Botany, Udai Pratap College (An Autonomous Institution) Varanasi-221002, (U.P.), India

Corresponding Author: viyadav30@gmail.com, Mobil No- 09696967253

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Abstract-Soil salinity is only of the best international challenging situations ‘Usar’ (Saline/Alkaline) soils. ‘Usar’ soil is widespread in eastern Uttar Pradesh India and is either saline or alkaline. Such soils are unproductive, impermeable, hard, barren, and compact. ‘Usar’ soils restrict plant increase through bad water infiltration, enhanced mechanical resistance to root growth, water logging, and bad water availability with inside the soil profile. The experimentally studied soil sample has high pH, EC, Organic compound, high exchangeable Na^+ , and low Ca^{2+} . The low amount of EC and Calcium in ‘Usar’ soil cannot support the conventional growth of plant species. Blue-green algae act pretty much as good plant food and will be used for reclamations of such soils. Heterocystous filamentous forms increase the N content of soil and area unit capable of solubilizing microorganism nutrients. The adhesive sheath of blue-green algae absorbs water and retains it. Comparatively, more growth of isolated cyanobacteria (*Nostoc linckia* Roth) in ‘Usar’ soils solution than in Allen-Arnon nutrient medium showed that the strain is alkalophilic and salt tolerant. The inhibition of sodium ion influx appears to be a major mechanism for the survival of cyanobacteria against salt stress and synthesis of salt-stress proteins have been found in cyanobacteria. Therefore, farmers will use blue-green algae to create their agricultural land and ‘Usar’ land nitrogen-rich and fertile economically and naturally.

Keyword- Cyanobacteria, “Usar” soil, Reclamation, Heterocystous and Salinity.

I. INTERODUCTION

‘Usar’ soils also have high pH, high sodium salt and very low total nitrogen content all these characteristics make the ‘Usar’ soil barren. “Usar” soils have excessive interchangeable Na^+ , excessive pH, and quantifiable measures of soluble carbonates and endure vast clay dispersion prompting negative hydraulic conduction and reduced soil air aeration [1]. High salts push reduce down the plant improvement and products yield [2]. Blue-green algae distribute over a large vary of salt concentrations and several other species will adapt to unsteady salinity conditions. Heterocystous thin forms increase the element content of soil and square measure capable of solubilizing microbic nutrients. The adhesive sheath of blue-green algae absorbs water within the dry and semi-dry areas that seriously influence agricultural production [3]. Their application in agricultural saline soil remedy has been in congestible in laboratory studies, however there's an absence of analysis relating to their use in natural ecosystems restoration. Cyanobacteria synthesize flavorings solutes as disaccharides (sucrose, trihalose and glucosyl glycerol), quaternary amines (glycine betaine) and free amino acids (glutamine) square measure nicely documented. The protection with inside the route of the alkalinescent atmosphere is equipped through manner of means of the synthesis of distinctive fatty acids, sucrose- and osmotic-strain prompted proteins. In blue green algae,

accumulation of inner diffusion with within the shape of inorganic ions and hindrance of intracellular Na^+ accumulation cyanobacteria at intervals aspect the route of salt strain and synthesis of salt-strain proteins are set.

A clinical technique for rehearsing crop improvement and beautifying crop productivity in saline/alkaline soils is that the reclamation (amelioration) of soil salinity. The reclamation of such soils needs the substitution of interchangeable Sodium through manner of Ca from there on leach of the changed Na. Historically, its miles were completed through manner of the employment of a way of boom of mineral ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$). Biologically reclamation through cyanobacteria is each specific technique. [4] Counseled that cyanobacteria are often in forced to the reclamation of alkalinescent soils considering the reality that they increase effectively on saline/alkaline soils the realm most flora overlook roughly to extend. [5][6] and [7] have inspired the employment of blue green algae within the reclamation of saline/alkaline soils. The explanation for the current discovery roughly has become to check out the employment of halotolerant blue green algae within the reclamation of saline-alkaline soils and to listen to their basis and impact on soil properties.

II. MATERIALS AND METHODOLOGY

Soil trials were accumulated from the experimental site (village-Bunda in Azamgarh) is decided 102 kilometers

faraway from Udai Pratap College Varanasi with inside April –July month i.e. driest season whereas exceptionally scanty patches of the cyanobacteria population had been there. The bottom soil exams had been taken from 0-15 cm profundity from six higher places of the neighborhood below investigation. Samples had been taken in triplicate the usage of soil sampler. Gathered soil checks are ready and applied for estimation. Before-after that in it slow immunization of cyanobacteria species, soil pH and EC were measured during a soil/water immersion extricates with pH meter and physical phenomenon connect, one once the alternative taking once the methods of [8]. Water dissoluble rubbish like-Ca²⁺ (Versenate technique), Na⁺ (Flame photometrically), natural carbon and Na retention proportion (SAR, scientifically) were likewise set as depicted by [8]. Two preliminary devices are ready, one with natural soil and exclusive with sterilized soil below research lab state of affairs (32±2⁰C and delicate intensity 25µE/m²/sec).

B.G.-11 [9] handled a medium having pH 7.5 has been used for maintaining up the style of life. Experimental soils (three hundred gram) had been saved in material pots (8 cm high and twenty cm in diameter) and mineral (powder) was once intermingled (200mg/100 gm of soil). Natural (unsterilized) and disinfected (1.05 kg/cm² weight for fifteen minutes) soil patterns were applied for the take a look at. Once flooding with Sterilized water for fifteen days, the cyanophyte species like blue-green algae *Nostoc linckia* (Roth), *Calothrix* sp., *Anabaena* sp., (inoculum thickness of twenty protein/ml) had been in pots. Four distinctive preparations of pots experimentation were finished with every of the sterilized soils. Pots of Set-I were taken as management, Set-2 were coated mineral, Set-3 contained mineral + blue-green algae linckia (Roth) and Set-4 was once coated with mineral integrate of eubacteria (viz; *Calothrix* sp., blue-green algae *Nostoc linckia* (Roth), *Anabaena* sp.) and notion had been created for 3 months (May-July2020). The blue green algae specimen had been damaged from a one cm floor via approach of utilizing sterilized executes and blue green algae introduction had been related to the assistance of [10] and [9]. Count of blue-green algae species had been

completed via approach of [11]. The test of vary became done that confirmed an oversized result of mineral on the cyanobacteria population.

III. RESULTS

Table 1 and 2 showed the soil properties and growth of cyanobacteria in natural and sterilized 'Usar' soils before and after inoculation treatments. Before inoculation, the characteristics of the soil under observation appearing in the table (1 and 2) shows the succession of cyanobacterial growth in both ordinary and pasteurized soils. In the beginning, both the soils were inoculated with three different halotolerant Cyanobacterial species- *Nostoc linckia* (Roth), *Anabaena* sp. and *Calothrix* sp. Amendment has been made in the form of gypsum, *N. linckia* (Roth) and culture of mixed N₂-fixing cyanobacterial species. After three months of observation, it is found that natural soil (in the form of control) shows different cyanobacterial species along with the inoculated halotolerant species *N. linckia* but in sterilized soils only inoculated halotolerant species *N. linckia* (Roth) were shown. It is noticed that the halotolerant species were observed in both natural and sterilized soil and *N. linckia* was dominant in both natural and sterilized soils. Experiments to study reclamation have been done in different sets. The development of indigenous algae has been observed in the control soil or of BGA inoculants either unamended or amended soils (both natural and sterilized). It has been noticed that the pots containing *N. linckia* + gypsum show the dominance of halotolerant BGA growth. It has been found that in natural soils, various heterocystous and nonheterocystous cyanobacterial species have been seen like-*Microcoleus* sp., *Phormidium* sp., *Lynghya* sp., *Oscillatoria* sp., *Calothrix* sp., *Anabaena* sp., *Nostoc calcicola*, *Nostoc punctiforme*, *Nostoc linckia*, *Cylindrospermum licheniforme*, *Aphanothece parietina*, and *Spirulina* species but inoculated genera like-*Nostoc linckia*, *Anabaena* sp. also; *Calothrix* sp. has also been seen in just sterilized soil. Population dynamics of cyanobacterial species have been studied in both natural soil and sterilized soil.

Table 1. Characteristics of the saline-alkaline soil before inoculation and after inoculation with treatments of natural and sterilized soils.

Parameter	Soil Status									
	Before Inoculation		After inoculation with Treatment							
	Natural Soil	Sterilized Soil	Natural Soil				Sterilized Soil			
			Pot 1	Pot 2	Pot 3	Pot 4	Pot 1	Pot 2	Pot 3	Pot 4
pH	9.86	9.74	9.58	9.49	9.12	9.37	9.71	9.62	8.79	8.94
EC (dSm ⁻¹)	5.23	5.17	5.23	4.84	3.43	3.4	5.11	4.68	3.38	3.46
O.C. (%)	0.47	0.46	0.47	0.58	0.67	0.63	0.45	0.49	0.66	0.57
Ca ⁺⁺ (MeL ⁻¹)	2.92	3.46	2.92	4.26	6.17	5.97	3.48	5.37	7.26	7.12
Na ⁺ (MeL ⁻¹)	52.57	52.43	52.57	50.86	48.34	45.74	52.38	48.25	43.47	44.64

*Pot 1-Control; Pot 2-Gypsum; Pot 3-Gypsum+ *N. linckia*; Pot 4- Gypsum+Mix BGA

The growth pattern of the BGA population was maximum in pot IV as compared to pot III, II and I. This growth pattern of BGA was also analyzed and confirmed Shannon index, richness and evenness. Shannon index, richness and evenness were found high in pot IV pursued by III, II and I pot in sterilized soil. Physico-chemical properties of pot soils (natural and sterilized) have also been studied. *N. linckia* + Gypsum amendment has a significant and beneficial effect on soil Properties. In natural soil, the changes in soil properties affected by the influence of genera appear. The conceivable decrement of pH, EC and Na⁺ appear in all treatments but the better decrement is seen with gypsum mixed with *N. linckia* cyanobacteria than gypsum alone. Shows a similar type of decrement found in the treated soil as observed in normal soil. The addition of gypsum + *Nostoc linckia* (BGA) together

causes dropping of pH, EC and Na⁺ other than controller pots. Gypsum + mixed BGA i.e. in pot IV was also responsible for an obvious decline in soil properties. Fig 7.1.2, 7.1.3 and 7.2.2, 7.2.3 have shown the progress in EC and organic "C" after treatments in natural and sterilized soil. Decrease in EC and improvement of soil properties with organic "C" brought about by gypsum and cyanobacterial culture in both soils. Table 2 showed that gypsums + *Nostoc linckia* inoculation cause a remarkable effect on the improvement of soil properties such as pH, EC etc. In conclusion, the role of blue-green algae in 'Usar' saline-alkaline soil reclamation can't be forgotten and a mixture of mineral and blue-green algae is a vast alternative for soil reclamation and it ought to be a matter of outstanding problem within the future.

Table 2. Scattering arrangement of Cyanobacteria sps. in investigational pots

Forms	Natural soil				Sterilized Soil			
	Pot Number							
	I	II	III	IV	I	II	III	IV
* <i>Nostoc linckia</i>	0	×	D	D	—	×	□	D
* <i>Anabaena</i> sp.	0	×	×	×	—	0	×	×
* <i>Calothrix</i> sp.	0	×	□	□	—	×	×	×
<i>Oscillatoria</i> sp.	0	0	0	0	—	—	—	—
<i>Phormidium</i> sp.	0	—	0	0	—	—	—	0
<i>Lyngbya</i> sp.	0	0	0	0	—	—	—	—
<i>Microcoleus</i> sp.	0	0	0	0	—	—	—	—
<i>Spirulina</i> sp.	0	×	×	×	—	×	×	□
<i>Cylindrospermum</i> sp.	0	0	×	×	—	—	—	—
* = Inoculated species	× = Common species		0 = Taxon present		□ = Important		D = Dominant	
Pot I: Control	Pot II: Gypsum		Pot III: Gypsum+ <i>N.linckia</i>		Pot IV: Gypsum+ Mix. BGA			

IV. DISCUSSION

The reclamation of "Usar" soils (solonetz soils/alkaline soils), which may be substantially dispensed in India, is crucial to make one's soils fertile. It is plain from Table-2 that heterocystous blue-green algae (*Nostoc linckia*, *Anabaena* sp. and *Calothrix* sp.) were the extra-large individual of the saline-alkaline soils than the non-heterocystous forms. Since seasoned the assets to characteristic flavorings matter and N to the soil, they are going to be wanted for starting plant improvement in sterilized saline soils [12]. Water exhausting an operative for the reclamation of such soils joined with the resource of the usage of the boom of seasoned natural seldom and chemical substances like mineral or pyrites has likewise been prescribed amendments [4] and [5] betting on the credential of soil pH, that soil is also reclaimed via water action and finished mineral (uncooked CaSO₄) to update Na⁺ with Ca⁺⁺[4]. Due to the intense hydrogen ion concentration of saline/Alkaline soils, altogether options a lot of immediately or later of Na₂CO₃, the expansion of mineral offers a provider of Ca²⁺ that accelerates as CaCO₃

and HCO₃⁻ transfer around a lower in soil pH scale. In inclusion decrease in soil hydrogen ion concentration, the addition of gypsum still to proton era and eventually a touch cut price in hydrogen ion concentration happens [13]. By the rise of mineral in soil, there arise increments of Ca⁺⁺ and parallel decrement of Na⁺ (delineated during which can be as a result of the amendment of Na⁺ with the resource of the utilization of Ca⁺⁺ within the reclamation of soil, the transformation of clay into Ca⁺⁺ clay and exhausting of abundance Na⁺ happens. Taking once the addition of mineral and halotolerant cyanobacteria *N. linckia* (Roth) to sodic and saline soil, soil microorganism biomass (SMB) and respiration charge exaggerated despite unfriendly soil ecological things [14]. The rise of mineral reduces the pH scale 9.5-8.6 in natural soil and 9.5-8.8 in sterilized soil. Taking once the consolidation of mineral + *N. linckia* and mineral + BGA cyanobacteria along, the EC decreases. The untreated saline soils (control) had been amazingly alkaline and had excessive EC. Necessary trade in soil stocks has been considered after the development of the cyanobacterial population. The abatement in pH is moreover clean from our outcomes that is according with

the result of Singh (1961) sure herbal metabolites created with the aid of using cyanobacterial sports had been likewise discharged with inside the soil that can be in fee of preserving up the richness of soil [15] and [16]. [17] furnished motives for the diazotrophic cyanobacteria boom in alkaline soils. Cyanobacteria can live on in excessive environments with enormously saline situations and may grow soil quality. Generally, cyanobacteria had been used as bio fertilizers. It is a test to eliminate salts from soils with the aid of using the use of cyanobacteria in phrases of amount however, the utilization of cyanobacteria in courting with salt-tolerant flora allows for the growth of the amount of eliminated salts. Under salt strain situations, cyanobacteria use N₂-fixation, excessive biomass manufacturing, and the manufacturing of polymeric materials (EPS) to assist them to live on. Several cyanobacterial genera had been utilized in distinctive pots and area studies, consisting of *Nostoc*, *Calothrix*, and *Anabaena*. Halotolerant cyanobacterial lines including *N. linckia* had been used to lower the soil pH and EC. Among the three cyanobacterial genera viz, sp. *N. linckia*, *Anabaena* sp. and *Calothrix* sp., *N. linckia* had been located to be the maximum predominant pressure in all of the investigational clay pots. (Table 2). *Nostoc* sp. is regarded be a standout among the maximum adaptable diazotrophic cyanobacterial genera noticed in an extensive variety of situations, present in each unfastened dwelling and symbiotic state-owned. The persons after this genus are experts for relatively a little performance of C and N vitamins that regulates them to characteristic environmental habitations [18]. The predominance of *N. linckia* is probably due to salt tolerating nature, which proposes that *N. linckia* may be an advanced opportunity for soil reclamation. Based on variety range lists, it is fertile soil, pot IV is located to be greater wealthy in BGA establishment after with the aid of using III, II and I and variety of species turned into moreover excessive in Pot IV took after with the aid of using III, II and I comparable remark has been observed for evenness. In sterilized soil as regarded in variety, richness and evenness had been excessive in pot IV come after with the aid of using III, II and I. Halotolerant cyanobacteria modifications synthesis of herbal osmoregulatory materials and situations in nitrogen absorption and photosynthetic O₂ development which stimuli its increased resilience close to salinity strain [19]. [6] moreover encouraged *N. linckia* as ameliorating employee for saline-alkaline soils. Expansion of *N. linckia* biomass may be achieved for discounts of soil salinity, pH content material and improved soil houses. The excessive share of *N. linckia* in saline/alkaline soils is probably because of its salts tolerance and N₂ solving capacity. Thus, *N. linckia* may be an advanced phycotechnological technique for reclamation of saline "Usar" soils.

V. CONCLUSION AND FUTURE SCOPE

In the reclamation of Saline/alkaline soils, physical and chemical ways, that embrace the addition of gypsum and are Sulphur or excessive irrigation used, do not take away

the soluble salts and interchangeable Na. Heterocystous blue-green algae, with the resource of the utilization of specific characteristics of their twin capability for photosynthesis and N₂ fixation, area unit cap potential of causative to production in some agricultural and ecological things [20]. Thoughtful the salt tolerance in blue-green algae nicely create impact a bearing control a way on finding out the damaging effect of salinity on crop flora [21]. Lastly, the feature of blue-green algae within the reclamation of saline/alkaline soils can't be unnoticed. A mixture of halotolerant cyanobacterium *N. linckia* and gypsum may be a stronger chance for saline/alkaline "Usar" soil reclamation on the thought of experimental statement and results, the halotolerant *N. linckia* may be used as a biofertilizer for reclamation/amelioration of saline 'Usar'/saline-alkaline soils in eastern U.P.

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AUTHORS PROFILE

Dr. Durg vijai Singh is professor in the Department of Botany, Udai Pratap College Varanasi (U.P). He had completed his Ph.D. And Qualify NET in 1984. M. Sc. and Ph.D. in Botany from Banaras Hindu University (BHU). He has 35 years of teaching experience and research in Udai Pratap College Varanasi (U.P) Affiliated by Mahatama Gandhi Kashi Vidyapeeth Varanasi. He supervised by 10 Ph.D. scholars. He has research skills in the area of Biotechnology and Environmental Biology. He has more than 30 research publications and two-book chapter in Advance in Biological Science and Biotechnology and one in Nova Science Publisher.



Vivek Kumar Yadav has completed his master Degree in Botany From department of Botany, Shibli National P.G. College, Azamgarh Affiliated Veer Bhadur Singh University Jaunpur. At present, he is pursuing PhD and has specialization in Biotechnology and Ecological Science from Udai Pratap College Varanasi (U.P) Affiliated by Mahatama Gandhi Kashi Vidyapeeth Varanasi. He has carried out her research work on Diversity of Cyanobacteria in “Usar” soils and how to help of Cyanobacteria “Usar” soils change into fertile soils. He has efficient knowledge in manuscript formatting, statistical analysis, software handling. He shows her potentiality in paper publishing and performing the project work competently.

