Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 25s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Physiochemical And Microbiological Analysis of Some Local Saline Soils

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Cite this paper as: Mohsin Saidnoor Mulla, Jayashri Nanaware, Prakash Gheware, G.R. Pathade, (2025) Physiochemical And Microbiological Analysis of Some Local Saline Soils, *Journal of Neonatal Surgery*, 14 (25s), 640-649

ABSTRACT

Crop productivity is influenced by the soil quality. Adequate quantities of macronutrients as Ca, Mg, Na, K, and Mn, as well as the biokinetic range of soil pH, and bulk density, have a profound effect on productivity; organic nitrogen and phosphorous and carbon quantities must be as per need of crop. Soil fertility is controlled by the Microbial activity. When the macronutrients cross the threshold value, the soil becomes saline; it also imbalances pH, bulk density, and Microbial activities and ultimately reduces crop productivity. Taking into account these aspects known as saline soil from Sangli, Surli, and Miraj M.S India were tested for physiochemical and microbiological properties, it was found that pH was near neutrality macronutrients at the higher side while Microbial activities w.r.t total count of bacterial, fungi, and actinomycetes, nitrogen fixers and phosphate solubilizers and organic carbon content were at the lower sides than required. The nitrogen fixing, phosphate solubilizing, and actinomycetes isolates were obtained which can be used to ameliorate saline soils so as to increase productivity of such soil.

Keywords; *Saline Soil, physical properties of soil, chemical properties of soil, Microbial properties analysis of soil.*

1. INTRODUCTION

Soil is on the surface of the earth crust which has lots of components like minerals, air, water and organic materials. (Brady, & Weil, 2008). All these are formed by the help of nature like rocks by weathering, materials are deposited by the biological activity which provide necessary plants and helpful for ecosystem Plant growth, biotic communities and water retention is gifted us by soil. (Jenny. 1994)

Salinity:

Salinity means the concentration of salts in soils and water, with sodium chloride (NaCl) which is harmful foe agricultural farms it loose soil fertility but rather than potassium, chlorides, magnesium, and calcium which is not like salts. (Szabolcs, 1989). Some agricultural land due to accumulation land get less fertile this is because due improper irrigation practices done by man made in farms in arid and semi-arid regions were salts irrigation water accumulation in poorly drained soils, affect to abundant drain soil (Rengasamy, 2006)

Types of salinity:

Due to accumulation of water or salts, sodium chloride the primary salts with that magnesium, calcium and potassium light salts presence in soil affect the fertility of the soil (Szabolcs, 1989).

1. Primary salinity: this are naturally content saline soils found such as weathering, sea water flash and capillary rise from ground water.
2. Secondary salinity: It is common in agricultural lands where management of water is not proper. If the proper outlet of waste water not done in farm land affect farms. This affect the farm land more than due to primary salinity. Some land have high concentration of salts like sulphates and carbonates which electrical conductivity high.
3. Sodic Soil: This Sodic soils have more concentration of (Na) which ions replace with calcium and magnesium ions. This are soils are toxic to plants.

Induced Salinity: it is also called as irrigation salinity cause by over irrigation or poor managements of water irrigation. (Qadir, *et.al*. 2001)

Characteristics of the Saline Soil:

Physical properties

pH - The pH value of an aqueous solution is the negative logarithm of the hydrogen-ion activity. The value may be determined potential metrically, using various electrodes or calorimetrically, by indicators whose colours vary with the hydrogen-ion activity. The range of pH is scaled from 0 to 14 where 0 to 6 is acidic, 7 is neutral beyond 7 is alkaline. (*Skoog*, 1996)

Electrical conductivity - Salt concentration is the amount of dissolved salts in a given volume of water. A convenient method of estimating the amount of salt in a soil or water sample is to measure the electrical conductivity (EC) of a solution. (*Fettouch, et.al.2024*)

EC Values of soil salinity *(*The GSAS map)

Sr No	Class Salinity	Sodicity Hazard	Salinity Intensity	EC
1.	None	none	none	<0.75
2.	None	slight	slight	0.75-2
3.	Yields of sensitive crops may be restricted	moderate	moderate	2-4
4.	Yields of many crops are limited	high	Strong	4-8
5.	Only tolerant crops yields satisfactory	extreme	Very strong	8-15
6.	Only a few very tolerant crops yields satisfactory	-	Extreme	>15

Chemical Properties Nitrogen

Nitrogen is one very necessary fertilizer for the plant growth and soil fertility. This gives green colour to the crops and boost the growth of ground vegetation. Plants absorb nitrogen in the form of nitrate (NH4) and ammonium (NH3). Nitrogen in soil is directly connecting to organic material which is content organic carbon which increase soil fertility this biological process that influence the availability of nitrogen in soil is called nitrogen cycle. (*Tale and Ingole, 2015*)

Potassium

Potassium is highly soluble in wet soils so it can be easily absorb by the roots in cation (K+) form absorb by plants. Opening and closing stomata is done by leaf gas exchange with the help of potassium ions this process helps to intake carbon dioxide and transfers (louse) water. Transporting some chemical s species in all membrane is done by electrochemical gradient organise by potassium. (Marschner, *2012)*

Calcium

The cell wall and membrane surfaces put in the intra molecular and inter molecular linkages by stable and reversible bonds of calcium. When the calcium is release it charge the proteins that is control by many important cell function supporting plants to act on the environment signals. This is due to calcium behaves like messenger inside plant cells. (*Bush, 1995*), **Magnesium**

It is necessary for activation of some enzymes carboxylase, phosphate, ATPases which is necessary for photosynthesis. Plant absorbed magnesium because of its solubility. Magnesium (Mg^{+}) ion attach molecules in the plant which helps in numerous processes. Most important is

use for production od ATP this molecules transfer and stores energy in cells of the plants, if there is no magnesium no ATP it is unable to synthesized ATP without magnesium. (Marschner, *2012*)

Phosphorus

Phosphorus is macro element that content various enzyme like nucleic acids, phospholipids, certain amino acids, and several coenzymes. It has an important work of transferring energy via pyrophosphate bond in adeno tri phosphate. Phosphorus is

absorbed by plants largely as the primary or secondary orthophosphate anions, phosphate (*Taiz, & Zeiger, 2010*).

Sulphur

Sulphur is absorbed by roots this process take place in form of sulphate inions (SO42-) sulphur dioxide (SO2) is absorbed by leaves of the plant after that this sulphate is reduced and in inserted into organic compound. It is a main component of the cysteine and methionine which is amino acids this both is are necessary to crack down into proteins. It contain coenzyme in that protein.

(Marschner, *2012)*

Iron

Iron is a transition metal characterized by its ability to readily change its oxidation state from (Fe3) to (Fe2), Iron is found in soils predominantly as the ferric ion, (Fe3), but absorption mechanisms exist in different species for either the trivalent or divalent forms of iron which use for chlorophyll biosynthesis necessary for photosynthesis. (Marschner, *2012)*

Zinc

Zine is taken up predominantly as a divalent cation, (Zn2) and it exists only in the (Zn) oxidation state when complexed with macromolecules. The metabolic working of situated for N-, O-, and S- ligands which is tetrahedral complexes.(*Vallee and Auld, 1990*),

Manganese

The predominant source of manganese in soils is (Mn2), but manganese can exist in the oxidation states, within biological systems, Because Mn can be oxidized readily to Mn2 manganese plays an important role in redox reactions (*Marschner, 2012*)

Copper

Copper is a transforming metal present in soil they are divalent (Cu21) or monovalent (Cu) cation. It complexes readily with many organic molecules, including proteins, and its strong electron affinity in the monovalent form makes it well situated for numerous redox reactions. (Sandmann and Boger, 1983)

Boron

Boron is necessary for plant trace form but compulsory it is essential for plant if not then it cause nutritional disorder which affect the metabolism of and growth of plants, *(*Shireen *et. al. 2018).*

Molybdenum and nickel

The requirements of plants for molybdenum and nickel are the least of all the mineral nutrients. These minerals are transition elements capable of existing in multiple oxidation states, and thereby function in redox reactions.

Microbial Properties Bacteria

Bacteria are simple, single-celled led Microorganism, Bacteria inhabit a wide variety of habitats, including soil. Bacteria that improve a soil quality feed on soil organisms, decompose organic matter, help keep nutrients in the root zone, enhance soil structure. Some microorganism helps plant I growth and increase soil fertility like nitrogen fixing bacteria and potassium mobilizing bacteria (Rashid, *et. al. 2024)*

Fungi

Fungi are a diverse group of multi-cellular organisms. The best known fungi are

Mushrooms, molds, and yeast, but there are many others that go unnoticed particularly those living in soil, some mycorrhiza type fungi help plant to grow its roots. *(Lamża, 2023)* **Nitrogen fixing bacteria**

Nitrogen fixation is a process in which nitrogen (N2) in the atmosphere is converted into ammonia (NH3). Nitrogen fixation occurs naturally in the soil by nitrogen fixing bacteria affiliated with some plants (for example, Azotobacter, Acetobacter, Rhizobium etc). It also occurs naturally in soil. (Mahmud, *et. al. 2020)*

Phosphate solubilising bacteria

Phosphate solubilising bacteria (PSB) are beneficial bacteria capable of solubilising, inorganic phosphorus from insoluble compounds. P-solubilisation ability of rhizosphere microorganism is considered to be one of the most important traits associated with plant phosphate nutrition. Poshphate solubilizing bacteria biofertilizer helps plant fruits for ripening and growth. (Harvey, *et. al. 2009)*

The Present work was aimed at the study is to identify the nature and extent of salinity problems of the areas and recover a soil for reclamation purposes and classify the salinity area into

various salinity problems for the irrigation and water management. The objectives of were Physiochemical analysis of saline soil and Microbiological analysis of the saline soils. & to get Microbial isolates useful for reclamation of saline soils.

2. MATERIAL AND METHODS

- **Collection of saline soil samples**:

The saline soil samples was collected from three different places viz; Sangli. (District- Sangli), Surli., (District-Satara) and Miraj. (District-Sangli). Five soil samples were taken from each plot at random digging soil up to 20 cm depth. Each sample was about one kg in weight. The samples of a plot were mixed in a plastic bag then it was, taken as composite sample for tests in laboratory. These soil samples were sieved for removing pebbles and other foreign material. (Table 1)

Table 1 the details of sources of the saline soil samples collected are presented in

Soil Sample no	Sample (designation)	Place of collection	Site of collection in a place
1.	SA	Sangli (M.S.)	Madhav Nagar
2.	SU	Surli (M.S.)	LaxmL Nagar
3.	MI	Miraj (M.S.)	Krishna Ghat

- **Physical and Chemical characterization of saline soil samples (**Jaiswal, *2022)*

a) **Determination of pH**: pH was determined by using digital pH meter as per standard procedure.

b) **Determination of moisture content:** Determination of moisture content was done by oven drying method (Gravimetric)

Oven drying method:

a) Clean the cylindrical container with lid dries it & weight it

b) Take saline soil sample in the container & weight with lid

c) Keep the container in the oven with lid removed dry the saline soil sample with constant weight. Maintaining the temperature between 105°C to 110" C for a period.

Varying with the type of saline soil but usually 24 to 48 hours.

d) Record the final constant weight of the container with dried saline soil.

Calculation

The saline soil sample moisture content in weight **W = [(W2-W1)-(W3-W1)]**

SA moist (weight) = [(W2-W1)-(W3-W1)]

SU moist (weight) = [(W2-W1)-(W3-W1)]

MI moist (weight) = [(W2-W1)-(W3-W1)]

W1=weight of empty crucible bowl

W2=weight of moist saline soil sample with crucible bowl W3=weight of oven dried saline soil with crucible bowl

Finally the Moisture Content was determined in terms of gm/m^3

c) **Determination of Bulk Density**: Bulk density was done using the data obtained during moisture content Determination and using following formula.

Oven dry weight of saline soil soil

bulk density(gm/cm) =

volume of saline soil

d) **Determination of Electrical Conductance** the saline soil sample was mixed in distilled water, and then by conductivity meter the electrical conductance was determined.

e) **Nitrogen estimation**: Nitrogen estimation was by Dumas Method

For nitrogen estimation by Dumas method following three steps were followed

a) Combustion: The saline soil sample was Weighed and purged of any atmospheric gasses it was heated in high temp furnace and rapidly combusted in the presence of pure oxygen at about 100°C this leads to release of substance such as carbon dioxide, water nitrogen dioxide and other several oxides.

Saline soil sample +O2 > CO2+H2O+Nx0x+02+ other oxides

b) Reduction and Separation: The combustion products was collected and allowed to equilibrate. The gas mixture was passed over hot copper to remove the oxygen and convert nitrogen oxides into molecular nitrogen. The sample was passed through traps that removed water and carbon dioxide.

CO2+H20+Nx0y+02+Cu> CO2+H20+N2 > N2

c) Detection: The measured signal from thermal conductivity detector for the saline soil sample was converted into total nitrogen content.

f) Phosphorus estimation:

Phosphorus estimation was done by Molybdenate Blue Method.

Phosphorus was determined by shaking 1gm of dry soil in 10 mL of 0.025M HCl & 0.03M Nitrate-Fluorine (NH4F) for 5min. Phosphorus was determined on the

filtrate by the molybdenate blue method used in ascorbic acid as a reluctant. Colour development was measured at 880nm on brinkman colorimeter.

g) Potassium estimation:

Potassium estimation was done by Atomic Emission Spectrometer Method,

Potassium was determined by shaking 10g of air dried soil for 2 hours in 1OmL of 1M NH2, organic acid for 5 minutes. The sample is then filtered, and the filtrate was analyzed by atomic emission in a Perklin Elmer Analyst 100 spectrometer.

h) **Calcium, Magnesium and Organic Carbon estimation**:

It was done by Inductively Couple Plasma Atomic Emission Spectroscopy Method. Base cations are determined by shaking 3 gm of air dried soil in 30 mL of 1 M NH4 Organic Acid for 30 min. Extracts are centrifuged, and the supernatant is decanted and analyzed by ICP-AES (Inductively Couple Plasma Atomic Emission Spectroscopy).

Calculation

$$\textbf{\% organic carbon} = \frac{M * V1 - V2 * 0.39 * mcf}{S2}$$

Where

M= Morality of ferrous sulphate solution from blank titration V1= mL ferrous sulphate solution required for blank

V2= mL ferrous sulphate solution required for sample s = weight of air dry sample in gm

0.39= 3 x 10-3 x 100% x 1.3 where 3 = equivalent weight of carbon. mcf = moisture correction factor.

Conversion of the % carbon to % organic matter is done by multiplying with imperical factor 2% organic matter =2 x %carbon.

Sr. No	Parameter	Method used	References
1.	**Soil colour**	Munsell Soil Colour Chart comparison	Munsell Soil Color Charts *(2000).*
2.	**Soil Texture**	Feel method	Bouyoucos, *G. J. (1962).*

3.	**Soil pH**	pH meter (electrode in soil-water suspension, 1:1 ratio)	Sparks, *D. L. (1996).*
4.	**Electric conductivity**	Conductivity meter (soil-water extract method, 1:2 ratio)	Rhoades, *J. D. (1996).*
5.	**Moisture**	Gravimetric method (oven drying at 105°C for 24 hours)	Gardner, *W. H. (1986).*
6.	**Bulk Density**	Core method (oven dry soil mass/volume of soil core)	Blake, *G. R.*, & Hartge, *K. H. (1986).*

Microbiological Analysis Saline Soil: (Cruickshank *et. al., 1975)*

Total Plate Count for Bacteria:

Enumeration of bacteria from saline soil sample was carried out by using standard plate count method.

Serial dilutions (10^{-1} to 10^{-9}) of soil sample were prepared using sterile dilution blanks. 0.1 mL of each dilution was spread inoculated on sterile nutrient agar plates. The plates were inoculated at 30^0C for 48 h. After incubation colonies were counted and standard plate count per mL was determined using the formulae.

SPC = Number of Colonies X Dilution factor X 10

Total Fungal Count:

Enumeration of fungi from saline soil sample.

Enumeration of fungi from saline soil sample by using Standard Plate Count Method.

Serial dilutions (10^{-1} to 10^{-9}) of soil sample were prepared using sterile dilution blanks. 0.1 mL of each dilution was spread inoculated on sterile Potato Dextrose agar. The plates were incubated at 30^0C for 5 days. After incubation colonies were counted and standard plate count per mL was determined using the formulae.

TFC = Number of Colonies X Dilution Factor X 10

Enumeration of Nitrogen fixing bacteria:

Enumeration of Nitrogen fixing bacteria from saline soil sample by using Standard Plate Count Method,

Serial dilutions (10^{-1} to 10^{-9}) of soil sample were prepared using sterile dilution blanks. 0.1 mL of each dilution was spread inoculated on sterile N2 free mannitol agar. The plates were incubated at 30^0C for 72 h. After incubation colonies were counted and standard plate count per mL was determined using the formulae,

Nitrogen Fixing Bacteria count = Number of Colonies X Dilution factor X 10

Enumeration of Phosphate solubilising bacteria:

Enumeration of Phosphate solubilising bacteria from saline soil sample by using

Standard Plate Count Method, Serial dilutions (10^{-1} to 10^{-9}) of soil sample were prepared using sterile dilution blanks. 0.1 mL of each bi was spread inoculated on sterile Pikovaskaya's agar. The plates were incubated at 30°C for 72 h. After incubation colonies were counted and standard plate count per mL was determined using the formulae,

Phosphate solubilising bacteria count = Number of Colonies X Dilution factor X 10

Enumeration of Actinomycetes:

Enumeration of Actinomycetes from saline soil sample by using Standard Plate Count Method, Serial dilutions (10^{-1} to 10^{-9}) of soil sample were prepared using sterile dilution blanks. 0.1 mL of each dilution was spread inoculated on sterile glycerol aspergine agar. The plates were incubated at 30°C for 8 days. After incubation colonies were counted and standard plate count per mL was determined using the formulae.

Actinomycetes Total count= Number of Colonies X Dilution factor X 10

3. RESULTS AND DISCUSSION

Result of physicochemical analysis of saline soil samples are depicted in Table No 1 & Table No 2

Table 1 Physical characteristics of saline soil samples

Saline soil sample	Soil colour	Soil texture	pH	Electrical conductivity (ds/m)	Soil moisture (gm/m3)	Bulk density (gm/m3)
SA	Medium black	Clay	7.8	4.39	2.9	0.86
SU	Shadow black	Loamy	6.8	4.48	3.4	0.82
ML	Medium black	Slity clay	7.4	4.5	1.8	0.84

It can be seen from Table 1 that among the saline soil samples collected SA and

MI was medium black and SU was shadow black in colour. Texture of SA was clay type, SU was loamy type and MI was slity clay type. pH of saline soil samples collected ranges between

6.8 to 7.8. Electrical conductance of saline soil samples ranges from 4.39 to 4.5. Soil moisture of saline soil samples ranges from 1.8 to 3.4. And Bulk density of collected saline soil samples were ranges from 0.82 to 0.86.

Table 2. The results of macro elements of saline soil samples

Parameter	Unit	Saline soil samples			Limit
		SA	SU	MI	
Nitrogen	Kg/ha	0.95	1.92	1.76	0.90-1.90
Phosphorus	Kg/ha	0.41	0.36	0.32	0.30-0.40
Potassium	Kg/ha	2.84	1.8	2.17	2.5-3.0
Calcium	%	0.18	0.27	0.27	0.3 - 0.1
Magnesium	%	0.32	0.15	0.2	0.1 - 0.3
Organic carbon	%	4.1	3.30	2.7	>1.5

The study of macro elements of saline soil samples reviled that the nitrogen content of SA and SU was within limit while of MI was below limit. Phosphorous content of SU and MI was within limit while of SA was above limit, Potassium content of SA was within limit while of SU and MI was below limit. Calcium content of SA, SU, and MI was within its limit.

Magnesium content of SU and MI was within limit while SA was above limit. Organic carbon content of SA, SU, and MI was above limit.

Table 3. Microbiological analysis of saline soil samples

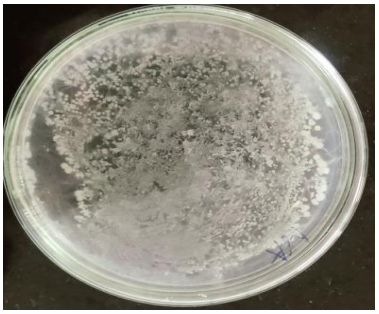
3. Microbiological analysis of saline soil samples.

Parameter	Unit	Saline Soil Sample			Average
		SA	SU	MI	
Total Plate count	Cfu/g	$10x10^6$	$9x10^6$	$7x10^6$	$8.6x10^6$
Total Fungal Count	Cfu/g	$13x10^3$	$4x10^3$	$5x10^3$	$7.3x10^3$

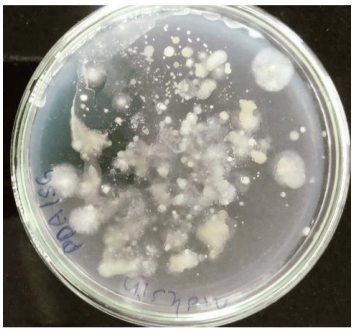
Nitrogen Fixing Bacteria	Cfu/g	$9x10^1$	$8x10^1$	$9x10^1$	$8.6x10^1$
Phosphate Solubilizing Bacteria	Cfu/g	$6x10^1$	$8x10^1$	$6x10^1$	$7.6x10^1$
Actinomcycetes	Cfu/g	108	110	170	$1.29x10^2$

It can be seen from Table 3. That Total plate count of collected saline soil samples of SA was $10x10^6$, SU was $9x10^6$, and MI was $7x10^6$, Total fungal count of collected saline soil samples of SA was $13x10^3$, SU was $4x10^3$, and MI was $5x10^3$. Nitrogen Fixing Bacteria of collected saline soil samples of SA was $9x10^1$, SU was $8x10^1$, and MI was $9x10^1$, Phosphate solubilizing bacteria count of saline soil sample of SA was $6x10^1$, SU was $8x10^1$ and MI was $6x10^1$. Actinomycetes count of saline soil samples of SA was 108, SU was 110 and MI was 170.

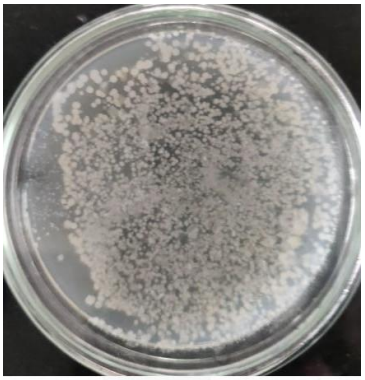
It can be seen from the Table 3. That Average total plate count of saline soil samples was found to be $8.6X10^6$ cfu/g which is much lower as compared to the plate count of Non- saline soil. The average total plate count of Nitrogen fixing bacteria, Phosphate solubilising bacteria and Actinomycetes was found to be, $8.6X10^1$, $7.6X10^1$ and $1.29X10^2$ cfu/g respectively, which was many times lower than the non-saline soil and is indicator of reduction of fertility of soil.



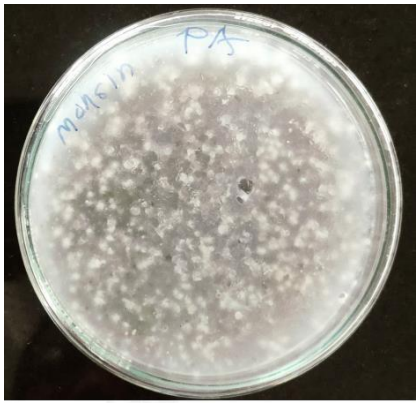
Photoplate 1: A plate of Nutrient Agar with Total Plate Count of bacteria at 30^0C for 48 h in incubation



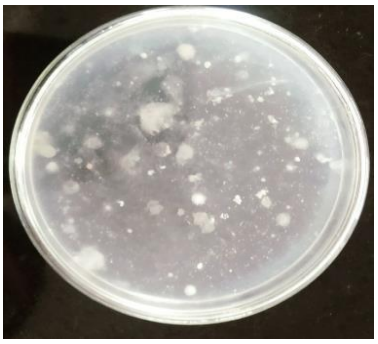
Photoplate 2: Total fungal count of saline soil sample on PDA at 30^0C for 5 days incubation



Photoplate 3: Nitrogen fixing bacterial count of saline soil sample on N^2 free mannitol Agar at 30^0C for 72 h in incubation.



Photoplate 4: Phosphate solubilizing bacterial plate count of saline soil sample on pikovskaya's Agar at 30^{0}C for 72 h incubation.



Photoplate 5: Actinomycetes plate count of saline soil sample on Glycerol Aspergine Agar at 30^{0}C for 8 days incubation.

SUMMARY AND CONCLUSIONS

Summary

Saline soil sample of different places from M.S. (District Sangli M.S.), Surli (District Satara M.S.) and Miraj (District Sangli M.S.) were collected and analysed all samples were subjected to examination of physical, chemical and Microbiological characteristics. In physicochemical pH, bulk density, soil moisture, colour, soil texture and electrical conductivity were studied and macro elements were identified.

The Microbiological exam of saline soil samples revealed the following.

a) Total bacterial count of saline soil samples was found to be $10x10^6$ cfu/g in Sangli, $10x10^6$ cfu/g in Surli and $7x10^6$ cfu/g in Miraj. The Average total bacterial count was found to be cfu $8.6x10^6$ cfu/g

b) Total fungal count of saline soil samples was found to be $13x10^3$ cfu/g in Sangli, $4x10^3$ cfu/g in Surli, and $5x10^3$ cfu/g in Miraj. The Average total fungal count was found to be $7.3x10^3$ cfu/g.

c) Nitrogen fixing bacterial count of saline soil samples was found to be $9x10^1$ cfu/g in Sangli, $8x10^1$cfu/g in Surli and $7x10^1$cfu/g in Miraj. The Average Nitrogen fixing bacterial count was to be $8.6x10^1$ cfu/g.

d) Phosphorus solubilising bacterial count of saline soil samples was found to be $6x10^1$ cfu/g in Sangli, $8x10^1$ cfu/g in Surli. and $6x10^1$ cfu/g in Miraj.. The Average Phosphorous Solubilising bacterial count was found to be $7.6x10^1$cfu/g.

e) Actinomycetes total count of saline soil samples was found to be 108 cfu/g in Sangli., 110 cfu/g in Surli, and 170 cfu/g in Miraj. The Average total Actinomycetes count was found to be $1.29x10^2$ cfu/g.

4. CONCLUSION

The bacteria fungi, N2 Fixers, PO4 solubilizers and actinomycetes isolates if produced in large quantities and apply to saline soils along with organic manure can be studied to check the reclamation of saline soils through crop productivity.

Conflict of interest:

There is no conflict of interest amongst the authors.

Acknowledgement:

We are very much thankful to the management of the KVVDU for providing all the required facilities for the research work

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