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Application of Locally Available Admixtures for Saline Land Reclamation

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Abstract:- Soil collected from region of Sade. Parameters like bulk density, pH, electrical conductivity and sodium adsorption ratio are selected. A pot experiment was conducted on saline soil to compare and assess the reclamation ability of different admixtures based on soil quality parameters. After collecting soil samples from Sade region of Ahmednagar district, admixtures like Coal powder, Wheat straw and Cow-dung are selected to reclaimed the land. Single and combination of admixtures are used for this study. Treatments prepare were; T1 - control (soil only), T2 - Soil + Cow-dung, T3 - Soil + Coal powder, T4 - Soil + Wheat straw, T5 - Soil + Cow-dung + Coal Powder, T6 - Soil + Cow-dung + Wheat Straw, T7 - Soil + Coal Powder + Wheat Straw based on depth varies from 0 - 10 cm, 10 - 20 cm, 20 - 30 cm for both regions Sade. Admixtures are provided at 2 cm depth. Leaching treatment was provided at a rate of 2 lit/day per pot and the application was completed through 4 irrigation cycles/treatment with 8 days interval. After leaching of soils, results obtained for both regions the leaching show significant differences in bulk density, electrical conductivity (EC), pH and sodium Adsorption Ratio (SAR) among the treatments in comparison with the control. Therefore, incorporation of cow-dung increased the effectiveness of salt in reclaiming saline soils. Combination of admixtures gives better results for the removal of salts. The study has been given a mathematical approach by statistical analysis designed by Taguchi and the optimum combination was detected. The method included ANOVA table, S/N ratio with the smaller is better criteria for the maximum salt removal efficiency. Maximum Salinity was removed by combination of Coal powder with Cow-dung (T5) which gives more effective results.

Keywords: Electrical Conductivity, Leaching, Sodium Adsorption Ratio

I. INTRODUCTION

In the current study land affected by salt is reclaimed by leaching treatment using admixtures like coal powder, wheat straw, Cow-dung from the soil.

Soil Salinity is a major environmental issue in western Maharashtra mostly in irrigated areas. It is creating various problems such as loss in productivity, increased cost of cultivation and thus food security problems. It is necessary to find out practical solutions to overcome these problems. Leaching treatment is one of the recommended treatments for soil salinity reclamation. In the present study, leaching was carried out in the salt affected area. The soil analysis was carried out before and after the leaching treatment in the field. It is found that the treatment is effective for saline soil reclamation with certain conditions.

Saline soil is a soil containing salts in it. The term salinity refers to the presence in soil and water of various electrolytic mineral solutes in concentrations those are harmful to many plants. Dominant salts in soils are generally considered of NaCl, $MgCl_2$, $CaCl_2$, Na_2SO_4 and $MgSO_4$. These salts are originally present in soil parent materials and released within soils as result of bedrock weathering. Salts are usually moved into the soil subsurface horizons and may either remain in the soil solutions or precipitate within the root zone. Most common among these solutes are the dissociated cations Na^+, K^+, Ca^{2+} and Mg^{2+} and the anions Cl^-, SO_4^{3}, NO, HCO_3 and CO_3^{2}. The distinguishing characteristic of saline soil is an electrical conductivity of saturation soil extract of more than 4 dS/m at 25°C.

II. METHODOLOGY

A. Collection and Preparation of soil sample

Soil samples were collected randomly from 0-10 cm, 10-20 cm, 20-30 cm depth identified saline sites in Sade area along the coastal belt of the Ahmednagar district. Collected soil samples were brought to the laboratory. Salinity and Sodicity indicator parameters such as Electrical Conductivity (EC) and Sodium Adsorption Ratio (SAR) of the initial soil values were measured revealing that the soil of the experimental site is saline soil.

B. Materials

Materials are the main constituents which are required to perform experimentation. The materials used in this study are; water, low cost locally available admixtures i.e. coal powder, shell, wheat straw as well as cow-dung.

Fig 1: Coal Powder

Fig 2: Wheat Straw

Fig. 3: Cowdung

C. Preparation and application of admixtures

Cow-dung, Coal Powder, Wheat Straw were chosen as organic admixtures for this experiment. Five kilogram of soil sample is filled in each plastic pots. In each pots 2 cm depth admixtures has been added. The samples were then mixed.

D. Experimental design and treatments

The study was arranged in a completely randomized block design using seven treatments. The pots containing 5 kg of soil with different combinations of the admixtures were prepared as follows: T1 - Control (Soil only), T2 - Soil + Cow-dung, T3 - Soil + Coal powder, T4 - Soil + Wheat Straw, T5 - Soil + Cow-dung + Coal Powder, T6 - Soil + Cow-dung + Wheat Straw, T7 - Soil + Coal Powder + Wheat Straw.

1. After collecting soil samples initial values (T1) of Sade and region have been find out.
2. After finding initial values, 32 days leaching was provided at a rate 2 lit/ pot and application was completed through 4 irrigation cycles/ treatment with 8 days interval.
3. Pots are used for this experiment, four pots for T2 – Soil + Cow-dung, four pots for T3 – Soil + Coal powder and four pots for T4 – Soil + Wheat Straw, four pots for T5 – Soil + Cow-dung + Coal Powder, four pots for T6 – Soil + Cow-dung + Wheat Straw, four pots for T7 – Soil + Coal Powder + Wheat Straw at depth 0-10 cm, 10-20 cm, 20-30 cm respectively.
4. In each pot admixtures are added at dose layer depth of 2 cm at 8 days interval respectively.
5. After combinations of soil and admixtures leachate treatment is provided at rate 2 lit/day for 8 days interval.
6. After 8, 16, 24, 32 interval soil quality parameters such as bulk density, pH, electrical conductivity (EC), sodium adsorption ratio (SAR) are determined.

E. Soil analysis

Samples were prepared by passing through a sieve of 2 mm after breaking the larger clogs using a wooden mallet. The soil bulk density was determined using core method. EC and pH of soil is determined by electrical conductivity meter (EC) and pH meter respectively. Sodium adsorption can be determined by saturated equation SAR= Na^{+} /$[Ca^{2+} + Mg^{2+}/2]^{½}$. Sodium of soil saturation extract was determined using flame photometer. Ca^{2+} + Mg^{2+} cations were determined by titrating the saturation extract against 0.01 N EDTA solution to blue end point using NH_4Cl + NH_4OH buffer and "Eriochome Black T" as an indicator.

F. Data analysis

Data collected was subjected to analysis of variance (ANOVA) using the linear model. Data were analysed using Minitab 17 software .

III. RESULT AND DISCUSSION

Physico- chemical parameters (like Bulk Density, pH, Electrical conductivity, Sodium adsorption ratio) of soil of affected areas before the treatment in study area (Sade region) are documented below.

Table 1. Physico-chemical parameters of soil of affected area before treatment from Sade region

Parameters	Soil Depth – cm		
	0-10	10-20	20-30
Bulk Density	1.60	1.47	1.38
pH	7.88	7.81	7.72
EC (dS/m)	25.89	24.12	22.35
SAR (mmol/l)½	15.88	15.22	14.55

Table 2. Mean value of soil parameters after 32 days of leaching

Treatment	Bulk Density	pH	EC	SAR
T1 - Soil control	1.37	7.67	20.49	10.33
T2 - Cow dung	1.19	7.41	16.43	10.00
T3 - Coal Powder	1.24	7.59	18.75	11.64
T4 - Wheat Straw	1.27	7.61	19.36	10.76
T5 – Cow-dung + Coal Powder	1.12	7.51	11.74	7.43
T6 – Cow-dung + Wheat Straw	1.15	7.53	13.24	8.12
T7- Coal Powder + Wheat Straw	1.23	7.54	15.50	9.45

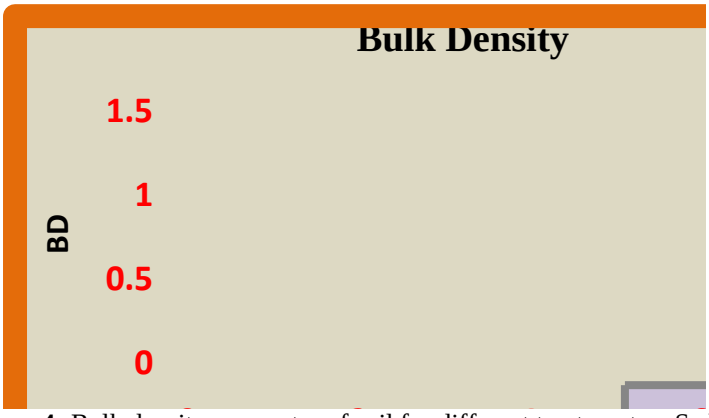

Figure 4: Bulk density parameter of soil for different treatments – Sade

Figure 4 shows that soil bulk density generally decreased after the application of admixtures and leaching in comparison with the T1 although treatments T2, T3, T4, T5, T6 had no significant differences among themselves (Table 2). The best treatment for bulk density reduction was T2 and T5. Bulk density reduces from 1.60 to 1.12. Combination of coal powder and cow-dung gives better effect as shown in table 2.

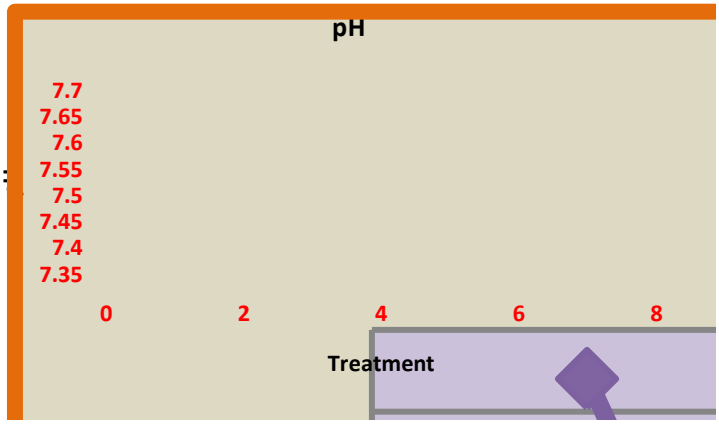

Figure 5: pH parameter of soil for different treatments - Sade

The pH reduced to 7.41 for Cow-dung, 7.51 for Cow-dung + Coal powder and 7.53 for Cow-dung + Wheat Straw combination after leaching with water (Table 2). Differences between treatments to control were significant. Lowest value recorded for combination followed by Cow-dung + coal Powder (T5). Organic admixtures only treatments showed a slight decrease in pH in the range of 7.51 to 7.41 in comparison to the control.

It is observed that the application of various organic materials decreased the pH values due to organic and inorganic acids formed when organic matter decomposition take place.

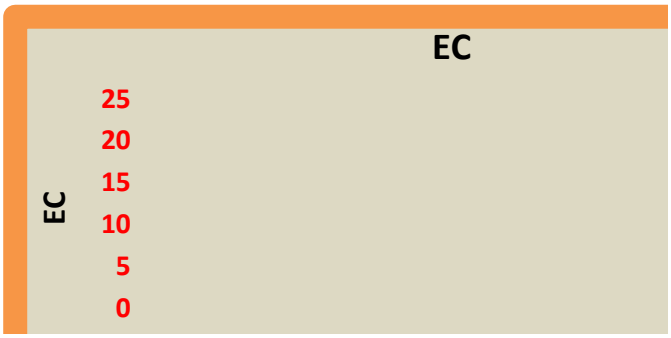

Figure 6: EC parameter of soil for different treatments - Sade

Among the treatments, Cow-dung + Coal powder combination was more effective in reducing the electrical conductivity (EC) of the soil as compared to coal powder + wheat straw combination. The possible reason may be the improvement in porosity and hydraulic conductivity, which resulted in enhancing the leaching of salts. Combined application of organic and inorganic ameliorants superior in reducing electrical conductivity (EC) of soil. The decrease in EC might be due to leaching followed by the addition of organic admixtures, which produced organic acids during decomposition, which was responcible for leaching of salts. Decreased EC was the result of organic matter triggered leaching of excessive ions by improving the physical properties of soil.

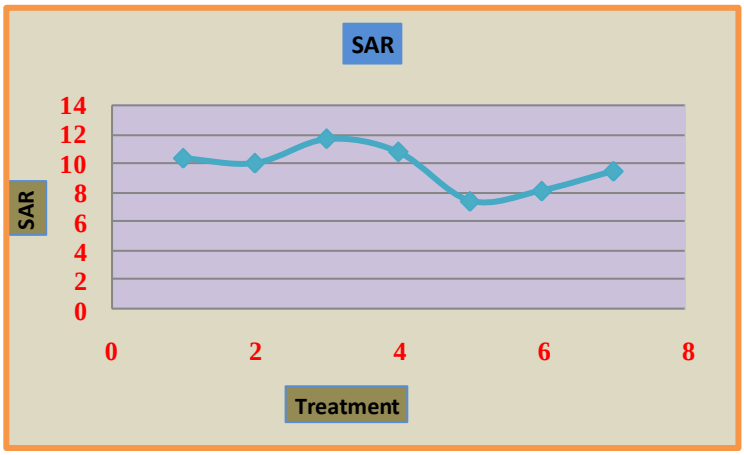

Figure 7: SAR parameter of soil for different treatments - Sade

A clear decrease in SAR was observed for amended soils after leaching. The decrease in SAR due to either increase in divalent cations (Ca^{2+} and Mg^{2+}), or decrease in monovalent cation (Na^{+}). The measured values of cations indicated that Na^{+} decreased while Ca^{2+} increased in the exchangeable complex after the application of organic and inorganic admixtures followed by leaching. The relatively high mobility and leachability of Na^{+} from soil due to the applied admixtures as compared with Ca^{2+} resulted in lower values of SAR. Hence, the SAR values of the treated soil were sharply decreased with leaching. Combinations of admixtures proved superior to organic admixtures only for treatments in reducing SAR. A decrease in SAR with simple leaching in control was likely due to mineral weathering and leaching out from the soil.

IV. STATISTICAL ANALYSIS

In the recent trend of research and development, Taguchi method has been found effective, accurate, and productive for the generation of better results and high quality output. Being applicable and useful as a statistical tool, the method has been used for the variety of experimentation. To serve the main purpose of the minimization of the experimental runs with maximum correct output, the mathematical and statistical approach of Taguchi has proved its significance in variety of experimentation.

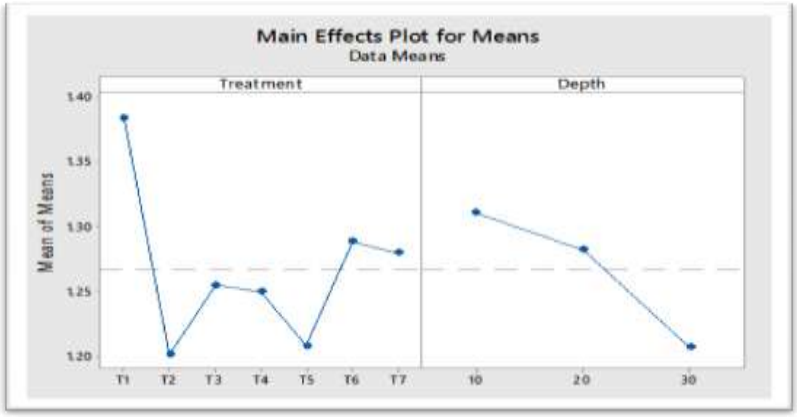

Figure 8: Main effects plot for means versus treatment and depth– Sade for bulk density

Response table for Signal to Noise Ratios can be ranked for their significance and their influence

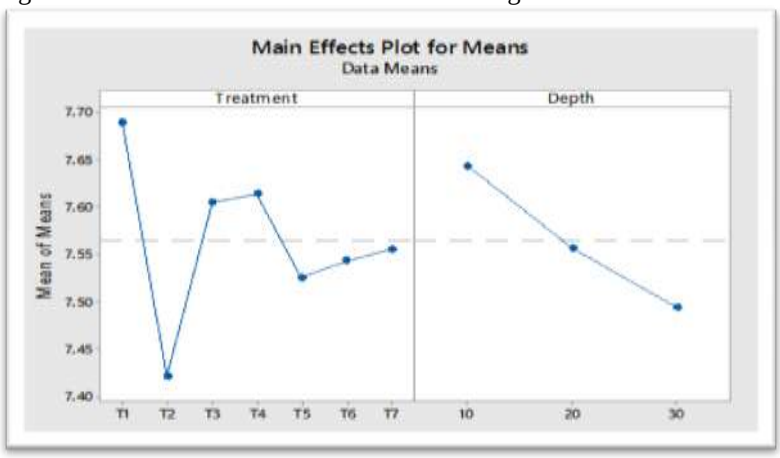

Figure 9: Mean of means versus treatment and depth – Sade for pH

Figure 9 shows main effects plots for Signal to noise ratio and main effects plot for means respectively. Signal to noise ratio rank has been decided on the basis of highest value of delta for treatment and depth. It indicates amount of salt get reduced by providing treatment T1 to T7 and depth 0-10 cm, 10-20 cm, 20-30 cm.

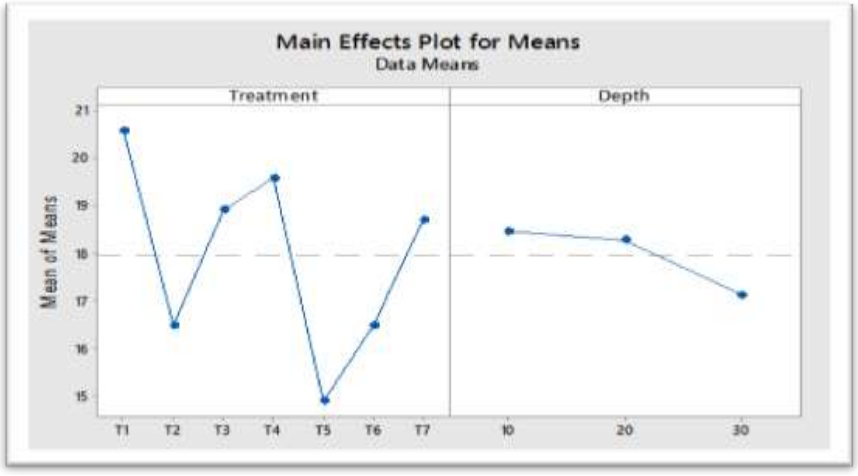

Figure 10: Mean of means versus treatment and depth – Sade for EC

Figure 10 shows that effect of signal to noise ratio and treatment T5 reduces large amount of salt.

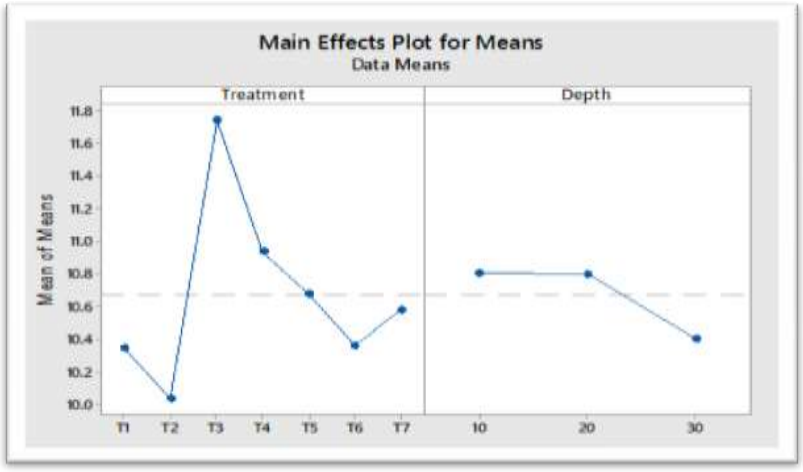

Figure 11: Mean of means versus treatment and depth – Sade for SAR
Signal to noise ratio gives better result which can be analysed by rank of response table.

V. CONCLUSIONS

1. The study revealed that addition of organic admixtures (Cow dung, Coal powder, Wheat straw) acted as ameliorant to saline soils. In this study, individual effect of Cow-dung and simple leaching was more effective in changing EC and SAR. Cow-dung is more suitable admixture to reduce salt content from land.
2. Coal powder is more suitable than wheat straw to remove salt from land.
3. These admixtures improve soil quality so that land can be reusable.
4. The combination of various admixtures gives better results than the single admixtures. Addition of Cow-dung with Coal powder (T5) in Soil gives more effective results to remove salt.
5. From Taguchi analysis we would conclude that electrical conductivity of Sade region is very small, it gives better results and also satisfies depth criteria (0-10 cm).

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