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Effect of different crop residues and amendments on chemical properties of salt affected soils of Purna valley

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Abstract
The present experiment was conducted to assess the effect of different crop residues and chemical amendments on chemical properties of salt affected soils of Purna valley. The soil samples were collected from Purna valley of Vidarbha region. The soil samples from six sites of Purna valley were collected and analyzed for various chemical properties. The initial soil chemical analysis revealed that, these soils were moderately to very strongly alkaline in reaction (pH 7.50 – 8.47), electrical conductivity varied from 0.12 to 0.22 dS m^{-1}. The exchangeable sodium percentage of salt affected soils of Purna valley varied from 5.12 to 9.86. Based on the higher ESP (9.86) value of salt affected soils of Dapura village, the laboratory incubation study was conducted. A 5 kg soil was filled in the earthen pot. The soil in each filled pots were amended with different crop residues and chemical amendments. The treatments consists of control (T1), gypsum @ 2.5 t ha^{-1}(T2), cotton stalk @ 5 t ha^{-1} (T3), soybean straw @ 5 t ha^{-1} (T4), FYM @ 5 t ha^{-1} (T5), wheat straw @ 5 t ha^{-1} (T6) and sulphur as per gypsum eqv. @ 2.5 t ha^{-1} (T6). The experiment was laid out in CRD with seven treatments replicated three times. The soil samples were analyzed for chemical properties at 0 and 60 days of incubation. The results of the present experiment revealed that, the pH was significantly reduced with the application of sulphur @ 2.5 t ha^{-1} (8.15) and gypsum @ 2.5 t ha^{-1} (8.26), lowest EC was recorded with the application of gypsum @ 2.5 t ha^{-1} (0.20 dS m^{-1}) and sulphur @ 2.5 t ha^{-1} (0.21 dS m^{-1}), the CEC of soils was found to be non-significant. The exchangeable cations viz; Ca^{++}, Mg^{++} and K^{+} was recorded to the extent of 36.30, 9.90 and 1.05 cmol (P^{+}) kg^{-1} with the application of gypsum @ 2.5 t ha^{-1} However, lowest exchangeable Na^{+} was recorded with the application of Gypsum @ 2.5 t ha^{-1} indicating application of gypsum @ 2.5 t ha $^{-1}$ was found beneficial to reclaim salt affected soils of Purna valley.

Keywords: Purna Valley, salt affected soil, ESP, FYM, soybean straw

Introduction

Salt-affected soils occur in all major physiographic regions of India. Salts released by weathering of silicate minerals are important original sources and are responsible for enrichment of soils and waters at specific favoured locations. Soil enriched with neutral salts is termed as saline while the one with salts capable of alkaline hydrolysis as alkali or sodic. Salt affected soils of Purna valley are developed on basaltic alluvium under arid and semi-arid conditions. The Purna valley of Vidarbha region is an east-west elongated basin with slight covering to the south occupying the part of Amravati, Akola and Buldhana districts of Vidarbha and extends from 20°45' to 21°15' N latitude and 75°25' to 77°45' E longitude with east-west length of 100-150 km having width of about 10 to 60 km covering an area of about 4.69 lakh hectares distributed in Amravati (1738 sq. km), Akola (1939 sq. km) and Buldhana (1015 sq. km). The salts have varying degree of deterioration i.e. salinity or sodicity and salinity-sodicity (Anonymous, 2010) [2].

The high pH, exchangeable sodium and presence of carbonates and bicarbonates in sodic soil and the high amounts of soluble salts in saline soils, not only adversely influence the physico-chemical and fertility properties of these soils and their ability to support plant growth, but also profoundly influence the soil biological condition-diversity of microbial species, their numbers and activities in soil. Yet researches worldwide have concentrated very largely, only on the physico-chemical aspects of the degradation of soils due to sodification of salinization both. The effect of physical and chemical degradation are readily apparent, while the effects of biological degradation induced due to the decline in soil organic matter and biomass carbon levels are more subtle.

It was only in the beginning of seventies of the 20th century, that increasing attention was paid to the microbiological attributes and biological activities of salt affected soils and how chemical and biological reclaimation measures bring about the amelioration of these soils and promote soil health.
In view of significant role of soil organic materials in improving salt affected soil, attempt have been made to reclaim salt affected soils of Purna valley having varying degrees of ESP. The laboratory experiment was conducted to reclaim salt affected soils with different crop residues, FYM and chemical amendments.

Materials and Methods

The present investigation was carried at Dr. PDKV, Akola Akola (M.S.) to study the effect of different crop residues and chemical amendments on chemical properties of salt affected soils of Purna valley. The soil samples were collected from Purna valley of Vidarbha region. The soil samples from six sites viz; Paral, Dapur, Ner, Pastul, Hingana and Ugwa villages of Purna valley. In order to know the physico-chemical properties of the experimental soil, the soil samples (0-20 cm) were collected from selected sites of Purna valley on the basis of earlier characterization and existing field variability. All six sites were selected and soil samples were collected with the help of GPS.
The collected soil samples were subjected to chemical analysis viz; pH, EC, ESP, exchangeable cations (Ca^{++}, Mg^{++}, N^+ and K^+). On the basis of ESP of salt affected soils from different villages, the soil sample having high ESP (9.86) were used for laboratory incubation study. Briefly, Five kg air-dried soil sieved through 2 mm sieve were placed in pots. Crop residues, FYM, gypsum, sulphur added in to the pots as per the treatment (Table 1). Moisture content of soil were adjusted to field capacity and maintained throughout the incubation period. Incubation were carried out for 60 days. The treatments details are given in Table 1.

Table 1: Details of Treatments

Tr. No.	Details of treatment
T_1	Control
T_2	Gypsum @ 2.5 t ha^{-1}
T_3	Cotton stalk @ 5 t ha^{-1}
T_4	Soybean straw @ 5 t ha^{-1}
T_5	FYM @ 5 t ha^{-1}
T_6	Wheat straw @ 5 t ha^{-1}
T_7	Sulphur as per gypsum eqv. @ 2.5 t ha^{-1}

The experiment was laid out in CRD with seven treatments replicated three times.
Soil pH was determined in soil suspension (1:2) by a glass electrode pH meter after equilibrating soil with water for 30 min with occasional stirring (Jackson, 1973) [5]. Electrical conductivity was determined by conductivity bridge (Jackson, 1973) [5]. Cation exchange capacity was determined by saturating soil with 1 N NaOAC (sodium acetate pH 8.2), after removal of excess, sodium acetate by washing with alcohol, the absorbed sodium was extracted by washing with 1 N (NH_4OAC (ammonium acetate pH 7) and the leachate was made upto known volume. Na^+ present in the leachate was determined with flame emission spectrophotometer (Jackson, 1973) [5]. Exchangeable cations were determined by leaching the soils in 1 N KCI TEA, buffer solution (pH 8.2) and titrating the leachate with standard EDTA solution using mureoxide and EBT as an indicator (Jackson, 1967) [4]. Exchangeable sodium and potassium were determined by leaching the soil with 1 N ammonium acetate (pH 7) solution, Na^+ and K^+ from the leachate were estimated by using Flame photometer given by Page *et al.* (1983) [6]. The exchangeable sodium percentage was determined by the following expressions.

$$ESP = \frac{Ex.\ Na}{CEC} \times 100$$

Results and Discussion

Chemical Properties of Salt Affected Soils of Purna Valley

The soil samples of Purna valley were analyzed for various chemical properties. The pH of surface soil varied between 7.50 to 8.47, indicating that these soils are moderately to very strongly alkaline in reaction. The electrical conductivity of soil-water suspension (1:2) of Purna valley soil ranged from 0.12 to 0.22 dS m^{-1}. The exchangeable sodium percentage varied from 5.12 to 9.86.
The exchangeable Ca^{2+} content of these soil varied from 31.39 to 45.26 cmol (p^+) kg^{-1}. The exchangeable Mg^{2+} ranged from 10.21 to 11.81 cmol (p^+) kg^{-1}. The exchangeable Na^+ and K^+ content of these soils varied from 3.21 to 5.78 cmol (p^+) kg^{-1} and 0.86 to 1.05 cmol (p^+) kg^{-1} respectively. The cation exchange capacity (CEC) of these soil varied from 52.17 to 62.73 cmol (p^+) kg^{-1}.

Chemical properties of salt affected soils

pH and electrical conductivity

The pH and electrical conductivity at the beginning of incubation study was 8.51 and 0.24 dSm^{-1} respectively. The pH was significantly reduced with the application of sulphur @ 2.5 t ha^{-1} (8.15) and gypsum @ 2.5 t ha^{-1} (8.26).
The electrical conductivity was slightly decreased under almost all the treatments as compared to initial. However, lowest electrical conductivity was recorded with the application of gypsum @ 2.5 t ha^{-1} (0.20 dS m^{-1}) and sulphur @ 2.5 t ha^{-1} (0.21 dS m^{-1}). This decrease in the pH and electrical conductivity might be due to the rapid reaction of acid with soluble Na_2CO_3 and its neutralization (Dahiya and Abrol, 1974, Abrol *et al.*, 1975) [3, 1]. On the other hand, gypsum solubilize slowly and do not react with the soluble Na_2 CO_3 to some extent, which help increase their effectiveness in replacing exchangeable sodium (Verma *et al*., 1985).

Exchangeable cations

The exchangeable cations i.e. Ca^{++}, Mg^{++}, Na^+ and K^+ at the start of incubation study were 32.43, 9.28, 5.14 and 0.95 cmol (P^+) kg^{-1} soil respectively. The application of gypsum @ 2.5 t ha^{-1} recorded significantly highest exchangeable Ca^{++} (36.30 cmol (p+) kg^{-1}) followed by sulphur @ 2.5 t ha^{-1} (34.10 cmol (p+) kg^{-1}). Among the organics, application of FYM @ 5 t ha^{-1} recorded significantly highest exchangeable Ca^{++} (34.80 cmol (p^+) kg^{-1}) followed by wheat straw @ 5 t ha^{-1} (33.12 cmol (p^+) kg^{-1}) and soybean straw @ 5 t ha^{-1} (32.86 cmol (p^+) kg^{-1}). In case of exchangeable Mg^{++}, application of gypsum @ 2.5 t ha^{-1} and sulphur @ 2.5 t ha^{-1} recorded highest value viz., 9.90 and 9.85 cmol (p^+) kg^{-1} soil, respectively. However, these treatments were found at par with each other.
The exchangeable Na^+ was significantly decreased with the application of gypsum @ 2.5 t ha^{-1} (4.30 cmol (p^+) kg^{-1}) and sulphur @ 2.5 t ha^{-1} (4.45 cmol (p^+) kg^{-1}). Among organics, application of FYM @ 5 t ha^{-1} found beneficial in decreasing

exchangeable Na^+ (4.70 cmol (p^+) kg^{-1}) followed by soybean straw @ 5 t ha^{-1} (4.91 cmol (p+) kg^{-1}) and wheat straw @ 5 t ha^{-1} (4.94 cmol (p^+) kg^{-1}). The exchangeable K^+ was slightly increased with the application of crop residues and chemical amendment. This increase in the exchangeable K^+ was higher in the treatment gypsum @ 2.5 t ha^{-1} (1.05 cmol (p+) kg^{-1}). Similar work was also reported by Shila *et al*. (1986) [7]. They observed the increase in exchangeable Ca^{++} and Mg^{++} with the incorporation of FYM regardless of the state of sodification is explainable with decrease in exchangeable Na^+ in sodic soil.

Cation exchange capacity and Exchangeable Sodium Percentage

The cation exchange capacity of soil at the start of incubation study was 58.59 cmol (p^+) kg^{-1}. The CEC of soil was found to be non-significant. The exchangeable sodium percentage of salt affected soils of Purna valley at the start of incubation study was 8.77. The application of gypsum @ 2.5 t ha^{-1} recorded significantly lowest ESP (7.33) followed by sulphur @ 2.5 t ha^{-1} (7.59). Among the organics, application of FYM @ 5 t ha^{-1} recorded significantly lowest ESP (8.07) followed by soybean straw @ 5 t ha^{-1} (8.37). The decrease in ESP with the application of gypsum (T_2) and sulphur (T_7) may be associated with the reduction in the exchangeable Na^+.

Table 2: Effect of different crop residues and chemical amendments on chemical properties of soil (after 60 days incubation)

Treatment		pH (1:2)	EC (1:2) dS m^{-1}	Exchangeable cations cmol (P^+) kg^{-1}			
				Ca^{2+}	Mg^{2+}	Na^{2+}	K^+
T_1	Control	8.50	0.24	32.46	9.26	5.15	0.96
T_2	Gypsum @ 2.5 t ha^{-1}	8.26	0.20	36.30	9.90	4.30	1.05
T_3	Cotton stalk @ 5 t ha^{-1}	8.46	0.23	32.42	9.50	5.04	0.96
T_4	Soybean straw @ 5 t ha^{-1}	8.41	0.22	32.86	9.54	4.94	0.97
T_5	FYM @ 5 t ha^{-1}	8.39	0.22	34.80	9.70	4.70	0.98
T_6	Wheat straw @ 5 t ha^{-1}	8.44	0.23	33.12	9.50	4.94	0.96
T_7	Sulphur @ 2.5 t ha^{-1}	8.20	0.21	34.10	9.85	4.45	0.97
SE(m)±		0.04	0.01	0.17	0.01	0.02	0.004
CD at 0.05%		0.017	0.03	0.53	0.03	0.06	0.012
Initial value		8.51	0.24	32.35	9.28	5.14	0.95

Table 3: Effect of different crop residues and chemical amendments on chemical properties of soil (after 60 days incubation)

Treatment		C EC cmol (p^+) kg^{-1}	ESP
T_1	Control	58.51	8.8
T_2	Gypsum @ 2.5 t ha^{-1}	58.63	7.33
T_3	Cotton stalk @ 5 t ha^{-1}	58.48	8.61
T_4	Soybean straw @ 5 t ha^{-1}	58.52	8.37
T_5	FYM @ 5 t ha^{-1}	58.64	8.01
T_6	Wheat straw @ 5 t ha^{-1}	58.62	8.42
T_7	Sulphur @ 2.5 t ha^{-1}	58.60	7.59
SE(m) ±		0.006	0.004
CD at 0.05%		N.S.	0.012
Initial value		58.59	8.77

Conclusions

Based on results of present study, it is concluded that the soil chemical and biological properties were adversely affected in salt affected soils. These properties can be improved with the application of organics (FYM and crop residues) and chemical amendments (gypsum and sulphur). The added organics will have significant bearing on microbial function and cycling of nutrient element, hence, chemical composition of organics needs to be considered while planning the crop residues addition to the soil.

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