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Influence of land configuration technique and soil amendments on nutrient uptake, soil amelioration and soybean yield in Vidarbha region of Maharashtra

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Abstract
The present investigation was carried out to study the Influence of land configuration technique and soil amendments on nutrient uptake, soil amelioration and soybean yield in Vidarbha region of Maharashtra. The treatments comprised of only BBF, BBF + FYM @5 t ha-1, BBF + gypsum @ 2.5 t ha -1 and BBF + FYM @ 5 t ha-1 + gypsum @ 1.25 t ha -1 combinedly. Treatments replicated in six farmers' fields one farmer as one replication with randomized block design. In this region poor drainage and sub soil Sodicity are the main problems. Salt affected soils limit crop yields around the world. Knowledge of how nutrient availability is affected in plants growing on salt affected soils is important in adopting appropriate management practices to satisfy plants' nutritional requirements and improve yields. In the salt affected environment plants required to absorb essential nutrients from a dilute source in the presence of highly concentrated nonessential nutrients. Nutrient uptake and use efficiency in salt affected soils is low due to salt stress and negative interactions with cations and anions present in high concentrations. Hence, a higher amount of nutrients is necessary in salt affected soils compared to normal soils. Biological nitrogen fixation is also adversely affected in legumes grown on salt affected soils. Salts also reduce activity of many enzymes which supply energy for nutrient uptake. The important soils and plant management practices which can improve nutrient uptake and use efficiency in salt affected soils. in our experiment we have used soil amendments to reduce effect of salts, application of farmyard manures to create favorable plant growth environments, leaching salts from soil profile and provided favourable drainage facilities through BBF. Use of FYM and gypsum recorded considerable increase in soluble Ca, Mg and K but decrease in Na. In respect of bicarbonates the significant reduction was observed in treatment T3, BBF + gypsum@ 2.5tha-1. Concentration of chlorides and sulphates also reduced in T4 (1.06 (me L-1) due to combined application of FYM @ 5 t ha-1 and gypsum @ 1.25 t ha-1. InT3 also observed remarkable reduction over T1. The nutrient uptake was significantly higher in treatment (T_4) in respect of nitrogen, phosphorus and potassium. 103.98 kg ha^{-1}, 24.62 kg ha^{-1} and 69.53 kg ha^{-1} respectively. Treatment in which farm yard manure @ 5 t ha^{-1},and gypsum @1.25 t ha^{-1} were united in soil. This might be due to effective amelioration by organic and in organic amendments under BBF and same way supplying the nutrients in slight quantities to the plants. When the vicinity of plant roots is in good condition obviously plants perceives more nutrients.

Keywords: Farm yard manure**,** Gypsum, amendments, amelioration,

Introduction
Out of 329 million hectares of total geographical area in our country, the arid and semi-arid zones occupy more than one-third of the area (127.4 m ha). The salt affected soils occurring in these zones occupy 12 m ha area spread over in 15 states of the country. These salt affected soils comprise of 4.12 m ha of alkali soil, 3.26 m ha of saline soil and 4.62 m ha of saline alkali soils. Among these salt affected soils, alkali soils are found to be highly problematic for crop production because of very poor physical and chemical environment particularly in irrigated areas. Sodicity problem in irrigated agriculture is becoming more and more serious because of faulty methods of irrigation, intensive cultivation of high water requirement crops, use of poor quality water, lack of adequate knowledge about soils and poor management practices. The amelioration of these alkali soils is not only expensive but also time consuming and laborious. (Gupta *et al.* 1995)

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 south occupying the part of Amaravati, 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 60km covering an area of about 4.69 lakh hectares distributed in Amaravati (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) [1]. These soils of are developed on basaltic alluvium under arid and semi-arid conditions have clay mineralogy, high swell-shrink potential, slow permeability with very low hydraulic conductivity and poor drainage conditions. Taxonomically these salt affected soils are classified as Sodic Haplusterts and Sodic Calciusterts (Padole *et al.*, 1998) [17].

Soybean (*Glycine max*. L.) is one of the important oil seed as well as leguminous crop. It is originated in Eastern Asia/China. It is second largest oil seed crop in India after groundnut. Soybean as a miracle “Golden bean” of the 21st century mainly due to its high content protein - 40%, oil - 20%, carbohydrates - 30%, fibre - 0.5%, lecithin - 0.5%, Vitamin C - 10%, Calcium - 27%, Iron 87%, Vitamin B1 and B6 - 20%, Magnesium -70% and saponins - 4%, and it is now making headway in Indian Agriculture. Soybean has special qualities such as ease in cultivation, less fertilizer and labour requirement. It fixes nitrogen and leaves about 25% for succeeding crop. Soybean is cultivating in the world over an area of 71.85 million hectares with a production of 154.32 million tonnes. In India grown on an area of about 6 million hectare with production for Kharif 2014 is 104.36 Lakh MT as compared to 94.768 Lakh MT during Kharif 2013 indicating an increase of 10.12% over previous year.

In Maharashtra the area under Soybean Cultivation during Kharif 2014 was 38.704 Lakh hectare as compared to 38.00 Lac hectares during Kharif 2013. The yield was 808 Kg ha-1.resulting into a production of 30.721 Lac MT during Kharif 2014. In Vidarbha the area under soybean during Kharif 2014 was 20.93 Lakh hectares as compared to 19.31 Lac hectares while in 2013 it was less Rochester *et al.*, (2001) [22].

Materials and Methods

The experiment was conducted on six farmer’s field with soybean crop in Ramagarh located at Dharyapur tehsil of Amravati district of Vidarbha region of Maharashtra during kharif, 2014 -15. The design of experiment was randomized block design (RBD), replicated six times, where each farmer was treated as one replication with four treatments comprised of only BBF, BBF + FYM @ 5 t ha-1, BBF + gypsum @ 2.5 t ha-1 and BBF + FYM @ 5 t ha-1 + gypsum @ 1.25 t ha-1 combined. The initial physical and chemical properties of the experimental soils were analyzed and presented in table 1. Soil samples were collected before sowing and after harvest of soybean and analyzed for the soil for soluble cations and anions. The saturated paste was prepared and the extract was obtained. The method described by Richards (1954) [21] was followed for the saturation extract preparation. These soil samples were analysed for pHs, electrical conductivity (ECe) and cations and anions as per the methods outlined by Richards (1954) [21]. Available Nitrogen was determined by alkaline permanganate method as described by Subbiah and Asija (1956). Available phosphorus determined by Olsen’s method as described by Watanabe and Olsen using 0.5 M sodium bicarbonate pH (8.5) as an extractant. Darco-G-60 soluble phosphorus was used to absorb the dispersed organic matter and make the filtrate colourless for further colorimetric analysis. (Watanabe and Olsen, 1965) [27]. Available potassium was determined by the flame photometer using neutral N ammonium acetate (pH 7.0) as an extractant as described by Hanway and Heidel (1952) [9]. Nitrogen was determined by Kjeldahl’s method using digestion mixture consisting of $CuSO_4$, K_2SO_4, Selenium powder and H_2SO_4 (Piper 1966). The phosphorus in the plant sample was determined by Vanadomolybdate yellow color method in nitric acid medium. The intensity of color was read at 420 nm wave length using spectrophotometer (Jackson, 1973). Potassium in the plant sample was estimated by atomizing the diluted plant extract in the flame photometer as described by Piper (1966) Similarly Seed and straw yields were recorded during the field experimentation. The data on different parameters were tabulated and analyzed statistically by the methods described by Panse and Sukhatme (1971) [18].

Table 1: Treatment details

Treatment No.	Details
T1	BBF
T2	BBF + FYM@ 5 tones /ha
T3	BBF + Gypsum @ 2.5 tones/ha
T4	BBF+FYM @ 5 tones/ha+ Gypsum @1.25 tones/ ha

Results and Discussion

The field experiment was conducted on farmers’ fields in Purna valley during 2014-15 in order to study the “Effect of BBF and soil amendments on soil properties and soybean yield in salt affected soils of purna valley in Vidarbha”. The results obtained from this investigation are presented and discussed here under.

Table 2: Initial physical and chemical properties of soil

S. No	Parameter	SITE I	SITE II	SITE III	SITE IV	SITE V	SITE VI
1	B D (Mgm^{-3})	1.68	1.65	1.64	1.60	1.61	1.67
2	HC ($cmhr^{-1}$)	0.49	0.53	0.48	0.51	0.47	0.49
3	MWD (mm)	0.58	0.57	0.63	0.65	0.63	0.59
4	pH (1:2)	8.50	8.67	8.64	8.51	8.57	8.68
5	Ec (dSm^{-1})	0.34	0.46	0.53	0.39	0.38	0.41
6	OC (gkg^{-1})	5.58	5.55	5.61	5.49	5.55	5.6O
7	$CaCo_3$ (%)	9.87	9.84	9.77	9.82	9.80	9.86
8	Exch.Ca (cmol(p^+)kg^{-1}	29.66	29.48	29.69	29.60	29.73	28.88
9	Exch.Mg (cmol(p^+)kg^{-1}	16.13	15.33	16.27	16.08	16.05	15.21
10	Exch.Na (cmol(p^+)kg^-	5.86	4.91	5.77	5.85	5.78	4.94
11	Exch.K (cmol(p^+)kg^{-1}	0.95	0.88	0.98	0.87	0.85	0.91

12	ESP	11.72	9.46	11.31	11.69	11.59	9.68
12	CEC (cmol(p^+)kg^{-1}	49.98	51.87	50.98	50.04	49.84	50.99
14	pHs (1:2)	8.46	8.54	8.58	8.66	8.43	8.54
15	ECe (dSm^{-1})	0.86	0.88	0.79	0.76	0.91	0.77
16	Sol Ca(me L^{-1})	3.26	3.34	3.16	3.20	3.19	3.28
17	SolMg(me L^{-1})	2.58	2.64	2.43	2.33	2.65	2.47
18	Sol Na(me L^{-1})	7.23	7.36	7.18	7.22	7.14	7.13
19	Sol K(me L^{-1})	0.64	0.58	0.60	0.61	0.55	0.52
20	HCo_3^-(me L^{-1})	7.32	7.41	7.30	7.29	7.26	7.22
21	Cl^- (me L^{-1})	1.44	1.53	1.26	1.18	1.41	1.43
22	So_4^- (me L^{-1})	4.61	4.54	4.69	4.53	4.58	4.47
23	Avail. N	176.65	168.94	178.09	175.55	173.42	177.88
24	Avail. P	18.98	18.86	18.91	18.95	18.90	18.99
25	Avail. K	324.65	323.38	325.21	329.41	324.77	325.36

Table 3: Effect of BBF and soil amendments on calcium, magnesium, sodium and potassium of saturation paste extract

Tr. No.	Treatments	Ca	Mg	Na	K
		(me L^{-1})			
T1	BBF	3.98	2.67	6.68	0.67
T2	BBF+ FYM@5 t ha^{-1}	4.72	3.97	6.25	0.74
T3	BBF+ Gypsum @2.5 t ha^{-1}	5.70	5.25	5.61	0.82
T4	BBF+ FYM @5 t ha^{-1} + Gypsum @1.25 t ha^{-1}	5.50	4.83	5.48	0.87
	SE(m) ±	0.09	0.21	0.12	0.03
	CD at 5 %	0.25	0.62	0.34	0.09
	Initial status	3.24	2.52	7.21	0.58

Table 4: Effect of BBF and soil amendments on bicarbonates, chlorides and sulphates of saturation paste extract

Tr. No.	Treatments	HCo_3^-	Cl^-	So_4^{-2}
		(me L^{-1})		
T1	BBF	7.28	1.95	4.92
T2	BBF+ FYM@5 t ha^{-1}	5.55	1.65	4.41
T3	BBF+ Gypsum @ 2.5 t ha^{-1}	3.42	1.21	3.58
T4	BBF+ FYM @ 5 t ha^{-1} + Gypsum @ 1.25 t ha^{-1}	3.63	1.06	3.18
	SE(m) ±	0.24	0.07	0.16
	CD at 5 %	0.71	0.20	0.45
	Initial status	7.32	1.44	4.57

Calcium played a significant role in cell division, maintenance of membrane integrity, regulation of ion transport and selectivity as well as cell wall enzyme activities (Fageria *et al*., 1997; Marschner, 1995) [13]. The uptake of Ca^{2+} by crop plants is influenced by its concentration in soil solution. Information is limited on magnesium-salinity and sulfur-salinity interactions.

Calcium is strongly competitive with Mg^{2+} and the binding sites on the root plasma membrane appear to have less affinity for the highly hydrated Mg2+ than for Ca^{2+} (Marschner, 1995) [13]. Based on the data obtained in respect of calcium and magnesium, during investigation, it was noticed that the highest value of soluble calcium found in treatment T_3 in which gypsum @ 2.5 t ha $^{-1}$ was incorporated. Similarly more or less closer values to the treatment T_3 were also noted in the treatment T_4, where gypsum @ 2.5 t ha^{-1} along with farm yard manure @ 5 t ha^{-1}. The calcium content was increased 30.17% in treatment T_3 over treatment T_1.This may be due to application of organic amendments which released remarkable amounts of calcium to soil solution and which was located on exchangeable sites or was removed from the soil during reclamation process. The results are in conformity with the results of Dubey and Mondal (1994) [6] While studying the effect of gypsum on rice and wheat in sodic soil observed an increase in the exchangeable Ca^{++}, Mg^{++} with gypsum incorporation. In the leachate collected from amended soil, the calcium content was enhanced with increasing levels of applied gypsum. (Shivakant and Rajkumar, 1992) [24]. The soluble sodium values varied from (5.48 me L-1) in T4 to (6.68 me L-1) in T1. The significant reduction of sodium was noticed in treatments T4 and T3. Reduction in soluble Na content in saturation paste extract under gypsum and FYM applied treatments, this might be due to removal of Na due as reclamation process. These results are in conformity with the findings of Singh *et al.*, (1980) [25]. It is obvious to reduce the ionic Na due to addition of Ca through amendments, which replaces Na from the clay complex of surface soil, Na decreased with increasing levels of applied amendments (Patel and Singh, 1991) [19]. The increase in soluble potassium all treatments except treatment T1 The highest value of soluble K was noticed in treatment T4 (0.87 me L-1) where FYM and gypsum were combined @ 5 t ha -1 and 1.25 t ha -1 respectively. The soluble potassium in T3 (0.82 me L-1) also increased considerably. The increase of K in organic amendments is due to addition of potassium through biomass. These findings are resembles with the results of Kharche *et al.*, (2010) [11] studied integrated use of gypsum and organic amendments and bio-inoculants for reclamation of sodic swell shrink soils of Mula command area and reported that combined use of gypsum and organic amendments increased soluble K concentration Similar results were also reported by Murtaza *et al.*, (1999) and Sharma *et al.*, (2001).

In respect of bicarbonates the highest significant reduction was observed in T3 (3.42 me L-1) where was gypsum applied @ 2.5 t ha-1 while in treatment T4 (3.63 me L-1) also remarkable reduction was noted in which farm yard manure and gypsum @ 5 t ha-1 and @ 1.25 t ha-1 was applied. The application of gypsum was found effective in removing soluble anions in soluble phase. The results are in conformity with findings of Patel and Singh (1991) [19]. The results of their findings showed that gypsum and press mud application were most effective in removing CO2-3 and HCO-3 respectively. Similar findings with respect to gypsum application were also reported by Sharma *et al.*, (2001). The excess chlorides increase the osmatic pressure of soil water and lower the water availability to plants. Some plants are sensitive to chloride and develop leaf burn symptoms when chloride concentration reaches about 0.5 %.In the present study noticed that chlorides significantly reduced in treatment T4 (1.06 me L-1) where we have applied farm yard manure @ 5 t ha-1 and gypsum @ 1.25 t ha-1. The next considerable reduction was see in the treatment T3 (1.21 me L-1) where gypsum @ 2.5 t ha-1 was applied. With considering these reduction organic and in organic amendments are working very effectively in reducing soluble chlorides concentration. The Sulphates of saturation paste extract was influenced by various treatments. The significantly highest reduction was noticed in T4 (3.18 me L-1.) The reduction in gypsum and farm yard manure amended furrow might be due to fast reclamation of gypsum as against organic amendments. Similar findings were also reported by Kharche *et al.*, (2010) [11]

Table 5: Effect of BBF and soil amendments on Nutrient uptake

Tr. No.	Treatments	N	P	K
		(kgha^{-1})		
T1	BBF	83.67	18.57	51.91
T2	BBF+ FYM @ 5 t ha^{-1}	94.04	22.66	66.75
T3	BBF+ Gypsum @ 2.5 t ha^{-1}	98.92	23.93	64.28
T4	BBF+ FYM @ 5 t ha^{-1} + Gypsum @ 1.25 t ha^{-1}	103.98	24.62	69.53
	SE(m) ±	1.19	0.33	0.65
	CD at 5 %	3.45	0.95	1.88

As regards of nutrient uptake by soybean under broad bed furrow and soil amendments. The nutrient uptake was significantly higher in treatment (T_4) in respect of nitrogen, phosphorus and potassium. 103.98 kg ha^{-1}, 24.62 kg ha^{-1} and 69.53 kg ha^{-1} respectively. Treatment in which farm yard manure @ 5 t ha^{-1},and gypsum @1.25 t ha^{-1} were united in soil. This might be due to effective amelioration by organic and in organic amendments under BBF and same way supplying the nutrients in slight quantities to the plants. When the vicinity of plant roots is in good condition obviously plants perceives more nutrients. Similarly nutrient uptake in treatment (T_3) also recorded remarkable amount of nutrient uptake where gypsum @ 2.5 t ha^{-1} was added. Meanwhile the less significant uptake noticed in treatment (T_1) in this treatment there was no any amendment applied. These results are resembles with the findings of Naidu *et al.*, (2009) He reported that application of FYM and Gypsum at 5t/ha, significantly improved N,P and K uptake over no FYM and gypsum application which was probably due to proper amelioration and balanced and sustained supply of nutrients to plants. Sharma (1997) stated that application of FYM @ 4 t ha^{-1} along with recommended dose of fertilizers (NPK) significantly improved the seed yield of soybean by 14 per cent over and NPK by 51.8 per cent over control.

Verma *et al* (2006) reported that N, P and K uptake increase with the combination of inorganic fertilizers with biological and organic fertilizers.

Table 6: Effect of BBF and soil amendments on soybean yield.

Tr. No.	Treatments	Grain	Straw
		q ha^{-1}	
T1	BBF	10.33	14.55
T2	BBF+ FYM @ 5 t ha^{-1}	12.05	18.47
T3	BBF+ Gypsum @ 2.5 t ha^{-1}	13.70	20.20
T4	BBF+ FYM @ 5 t ha^{-1} + Gypsum @ 1.25 t ha^{-1}	14.03	23.10
	SE(m) ±	0.27	0.56
	CD at 5 %	0.78	1.62
	C.V	4.30	6.33

The highest soybean yield (14.03 q ha^{-1}) was obtained with the application of gypsum @1.25 t ha^{-1} + farm yard manure @ 5 t ha^{-1} on broad bed furrow. Similarly considerable amount of yield was noticed in treatments where farm yard manure @ 5 t ha^{-1} and gypsum 2.5 t ha^{-1}. The familiar enhancement observed in both cases grain and straw in same treatments. From the results of present investigation it becomes apparent that although gypsum is widely used as amendment for sodic soils on farm available organic amendments can be a better option for improving soil health as well as crop productivity. In view of the problems of availability of gypsum, the farm yard manure can serve as potential alternative for reclamation of calcareous sodic soil. The results are in conformity with the findings of Kumar *et al*. (2011) [12]. Application of 100% RDF significantly improved yield attributes and yield over the application of 75% RDF. The increase in grain and stover yield due to 100% RDF was 11.66 and 6.77, respectively over application of 75% RDF. Application of 100% RDF probably ensured sufficient supply of N and P to plants for development of yield attributes, which ultimately resulted into higher grain and stover yield. Similar results have also been reported by Ambhore (2004). The application of FYM at 5t/ha significantly increased yield attributes as well as yield of greengram over no application of FYM. The respective increase in grain and stover yield due to FYM application was 11.24 and 11.27 per cent over no FYM application. This perhaps was caused by favourable effects of FYM application on growth attributes, which contributed higher photosynthates for the reproductive parts of the plants.

Conclusion

Management practices which can be adopted to reduce negative effects of salts on plant growth includes leaching salts from soil profile, use of amendments such as gypsum, use of farmyard manure facilitating appropriate drainage through BBF. After determining the soil status before and after harvesting and comparing yields between with amendments and without amendments we came to know that Combined utilization of land configuration technique and soil amendments worked mutually when sodium is replaced by other cation, preferably calcium sodium was easily by drainage water which is facilitated by BBF. In other hand these BBF works as in situ soil moisture conservator and it provides congenial environments for the more root nodulation. Likewise we are concluding that our treatments had played vital role in improving soil health especially with organic amendments and in soil reclamation as well as more yields of soybean in salt affected soils of purna valley in Vidarbha.

The relationship between salinity or sodicity and mineral nutrition of plants are complex and a full understanding of these interactions still required more studies.

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