Effect of different amendments on the properties of sodic Vertisols and yield of sorghum in the Purna Valley, Maharashtra

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Abstract

Field experiments were conducted on Sodic Haplusterts during *kharif* 1996, 1997 and 1998 to study the ameliorative effects of adding gypsum @ 0, 50 and 100% of GR, FYM @ 5 and PMC @ 2.5 t ha^{-1} alone and in combination with gypsum @ 50% GR with FYM or PMC on soil pHs, ECe, SAR and hydraulic conductivity and yield of sorghum. The significantly higher grain and fodder yield of sorghum and net monetary returns were noticed due to the combined effect of gypsum @ 50% GR and PMC followed by gypsum @ 50% GR and FYM. These treatments also reduced initial pHs, ECe and SAR and increased the HC of soil.

A highly significant positive relationship between grain yield of sorghum and HC (r=0.976**) and a highly significant but negative relationship was noticed with pHs (r=–0.875**), ECe(r=–0.920**) and SAR (r=–0.975**). The multiple linear regression model Y=–88.98 + 10.77 pHs + 1.66 ECe + 135.08 HC – 0.204 SAR (R^2=0.993**) was found to be best in predicting the grain yield of sorghum grown in Sodic Vertisols.

Additional keywords : Gypsum, FYM, pressmud cake, soil properties

Introduction

The salt affected Vertisols have severe limitations for their sustainable use owing to the development of adverse physical conditions especially poor drainage even at 5 ESP (Balpande *et al.* 1996). The correlation between yield of crops grown in Sodic Vertisols and hydraulic conductivity/ionic Ca was highly significant and positive, indicating that yield of crops in these soils are mainly governed by HC and ionic Ca in soil solution (Rewatkar 1998). The incorporation of farm yard manure (FYM) and pressmud cake (PMC) improved the physical and chemical characteristics of sodic soil (Patel and Singh 1991). The Purna Valley in Vidarbha is the basin of native salinity/sodicity although salinity/sodicity mainly confined to subsurface soil (Sagare *et al.* 1991; Nimkar *et al.* 1992; Balpande *et al.* 1996). However, the cultural practices to improve and manage these sodic soils are yet to be rationalized. Therefore, an attempt has been made to study the ameliorative effect of gypsum, FYM and PMC on yield of sorghum and changes in properties of Sodic Vertisols.

Materials and methods

The field experiments were conducted for three consecutive *kharif* seasons (1996-97 to 1998-99) on Sodic Vertisols (Very-fine, smectitic, isohyperthermic Sodic Haplusterts) of the Purna Valley of Vidarbha region (pH of soil paste 8.8, ECe 2.8 dSm^{-1}, SAR 18, ESP 20 and G. R. value 5 t ha^{-1}) with sorghum (cv. CSH-9) as a test crop. The rainfall during growing period of 1996-97, 97-98 and 98-99 were 742, 542 and 663 mm, respectively.

There were seven treatments comprising of control (To), gypsum @ 50% GR (T_1) and 100% GR (T_2), FYM 5t ha^{-1} (T_3), PMC 2.5 t ha^{-1} (T_4), gypsum @ 50% GR + FYM 5 t ha^{-1} (T_5) and gypsum @ 50% GR + PMC 2.5 t ha^{-1} (T6). Each treatment was replicated thrice in randomised block design. Amendments were applied in the upper 15 cm soil and mixed thoroughly before sowing of sorghum. A basal dose of fertilizers (100 kg N, 50 kg P_2O_5, 40kg K_2O ha^{-1}) were applied through urea, superphosphate and muriate of potash, respectively. pHs, ECe, SAR and saturated hydraulic conductivity (HC) were determined as described by Richards (1954). The statistical significance and relationship between yield and soil parameters were also studied (Panse and Sukhatme 1985).

Results and discussion

Yield of Sorghum : The grain yield of sorghum increased significantly over control due to the application of gypsum @ 50 and 100% GR, FYM and PMC alone or in combination (Table 1). The influence of both the levels of gypsum was superior to that of FYM or PMC. However, the combined effect of gypsum @ 50% GR and FYM or PMC further increased the grain yield of sorghum over their individual response. The treatments 50% GR + PMC and 50% GR + FYM resulted in 58 and 53 per cent increase in grain yield over their respective control. The significantly higher increase in fodder yield of sorghum was also recorded by these treatments with the highest monetary returns. The increase in yield of sorghum could be attributed to the improvement in physical and chemical properties of these soils in terms of HC, pH, ECe, and SAR (Table 2).

Table 1. Effect of various amendments on yield of sorghum (q ha^{-1})

Treatments	Grain yield (average of 3 years)	Fodder yield (average of 3 years)	Net monetary Returns (Rs ha^{-1})	B : C ratio
T_0 – Control	30.52	54.12	12,022	2.63
T_1 – Gypsum @ 50% GR	40.97	73.13	16,080	2.60
T_2 – Gypsum @ 100% GR	43.47	77.24	15,001	2.18
T_3 – FYM @ 5 t ha^{-1}	36.60	63.49	13,788	2.48
T_4 – PMC @ 2.5 t ha^{-1}	37.11	64.33	15,004	2.79
T_5 – Gypsum @ 50% GR + FYM @ 5 t ha^{-1}	46.75	81.36	17,843	2.53
T_6 – Gypsum @ 50% GR + PMC @ 2.5 t ha^{-1}	48.44	85.78	19,747	2.79
CD at 5%	2.86	3.17	–	–

Table 2. Effect of various amendments on pHs, ECe, SAR and HC of soils

Treatments	pHs	ECe (dSm^{-1})	SAR	HC (cm hr^{-1})
T_0 – Control	8.70	2.55	18.1	0.19
T_1 – Gypsum @ 50% GR	7.97	1.90	14.1	0.32
T_2 – Gypsum @ 100% GR	7.70	1.70	13.2	0.37
T_3 – FYM @ 5 t ha^{-1}	8.20	2.10	16.1	0.27
T_4 – PMC @ 2.5 t ha^{-1}	8.10	1.80	15.2	0.29
T_5 – Gypsum @ 50% GR + FYM @ 5 t ha^{-1}	7.80	1.57	9.7	0.38
T_6 – Gypsum @ 50% GR + PMC @ 2.5 t ha^{-1}	7.92	1.60	10.3	0.38
CD at 5%	0.70	0.63	1.5	0.07

* G. R. Gypsum requirement

Changes in soil properties : The incorporation of amendments alone or in combination decreased pHs, ECe and SAR and increased the HC of soil upto 60 cm of depth. The maximum reduction in pHs, ECe and SAR were recorded due to the combined influence of gypsum @ 50% GR + FYM. These results are in accordance with those reported by

Patel and Singh (1991). The beneficial effect of FYM and PMC in the reduction of sodicity can be related to their Ca^{++} content and mobilization of soil native Ca (Minhas *et al.* 1995).

Relationship between yield and soil characteristics : A highly significant positive relationship between grain yield of sorghum and HC (r = 0.976**) was noticed (Table 3). Regression studies further supported that each unit increase in HC, there was 87.2 unit increase in sorghum yield. The correlation between grain yield of sorghum with pHs (r = –0.875**), ECe (r = –0.920**) and SAR (r = –0.975**) was significantly negative. The R^2 values indicated that magnitude of negative effect of parameters followed as SAR>ECe> pHs and a decrease in grain yield by 2.0, 16.8 and 16.7 unit was predicted per unit increase in these parameters, respectively (Table 4). These results are in accordance with findings of Khandelwal and Lal (1991).

Table 3. Relationship between yield (Y) and soil characteristics (x)

Parameters	Regression Equations	'r'	R^2
pHs	Y = 174.68 – 16.65** pHs	–0.875**	0.765**
ECe	Y = 72.34 – 16.83** ECe	–0.920**	0.848**
SAR	Y = 68.48 – 2.02* SAR	–0.975**	0.950**
HC	Y = 13.14+87.19** HC	0.976**	0.953**

*Significant at 5% level **Significant at 1% level

Table 4. Multiple regression equations

Equations	R^2
Y = –109.94+13.003** pHs+145.540** HC	0.993**
Y = –111.49 + 12.735** pHs + 1.215 ECe + 150.04** HC	0.994**
Y= –88.98 + 10.77* pHs + 1.661* ECe + 135.08* HC – 0.204 SAR	0.993**

*Significant at 5% level **Significant at 1% level

Regression equations based on individual characteristics of soil are less valid as the soil is a medium defined by a set of interactions among various soil parameters and therefore, multiple linear regression (MLR) equation was developed. The regression equation Y = –88.98 + 10.77 pHs + 1.66 ECe + 135.08 HC – 0.204 SAR (R^2 = 0.993**) was found best in predicting the yield of sorghum as it explains 99% variability in the yield of sorghum in the area.

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