Inorganic and Organic Amendments and Irrigation Water Quality affect P Losses in Saline-sodic soil

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INTRODUCTION

Integrated application of gypsum and city waste compost is recommended for reclamation of saline-sodic soils. After application of amendments leaching is advocated to remove the soluble salts which are generated during exchange reactions. Besides neutralization of sodicity, use of amendments has profound influence in P retention because the process of reclamation alters the P retention capacity and thereby increasing risk of P losses. The P losses also differ with application of variable water qualities. Therefore, study of P losses from soils is important for evaluating agronomic efficacy of P as well as environmental point of view.

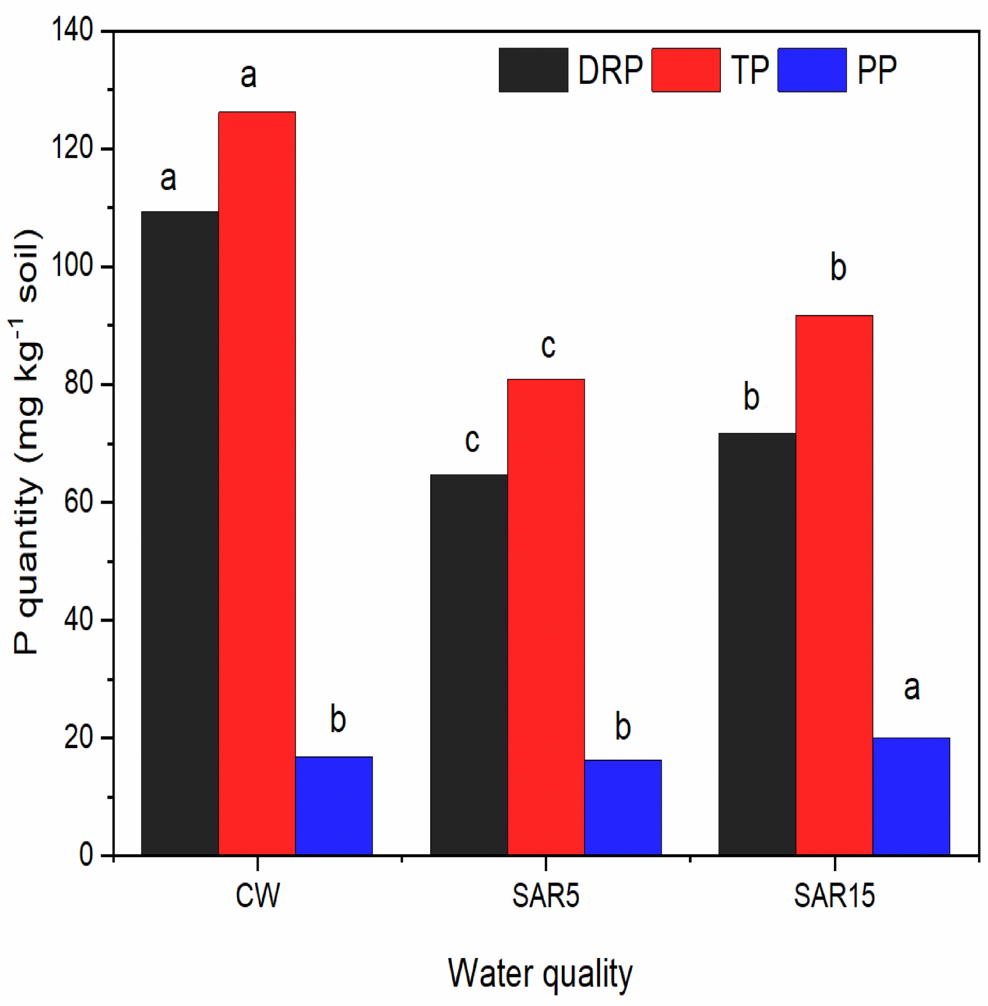
METHODOLOGY

A laboratory study was conducted at CSSRI, Karnal, India with sodic soils having pH_s 10.0, EC_e 12.2 dS m^{-1} and exchangeable sodium per cent (ESP) 77% and gypsum requirement (GR100) 22.7 Mg ha^{-1}. The unamended (control) and amended soil was incubated in 60% field capacity with 25, 50% recommended doses of gypsum, GR25 and GR50 and integrated treatments 25GR + 10 Mg ha^{-1} FYM (GR25F10); 25GR + 10 Mg ha^{-1} of Karnal (GR25KC10) and Delhi compost (GR25DC10) for 30 days (**Fig 1.**). After completion of incubation, soil was packed in columns with 1.66 kg air-dried soil to a depth of 15 cm. Further, soil was intensively leached upto ten pore volumes separately with different water qualities normal canal water (CW), and saline-SAR water with fixed salinity of 6.0 dS m^{-1} with two-level of SAR of 5.0 and 15 $mmol^{1/2}L^{-1/2}$. Soluble and total P was analysed in individual pore volumes of soil leachates. After completion of leaching, soil columns were broken and air dried for analyzing soil P fractions.

Fig 1. Soil column leaching experiment

RESULTS

Gypsum (Gyp) applied at the rate of 25GR or 50GR had lower dissolved reactive P (DRP) in leachates compared to control. The quantity of P in leachates was greater in the form DRP than particulate P (PP) (Fig 2). Addition of gypsum and compost 25GRF10 reduced (81%) the P losses in form of DRP upto fifth pore volumes followed by 25GRK10(76%). Overall, cumulative P losses decreased by amending 50GR Gyp than control (P< 0.05). Irrespective of treatments, the cumulative P losses through DRP were greater (109.4 mg kg^{-1}) when leaching with CW compared to SAR 15 (71.7 mg kg^{-1}) and SAR 5 (64.6 mg kg^{-1}). Organic, NaHCO3 extractable and water extractable P in soil were greater in 50GR Gyp followed by 25GRK10/D10/F10.



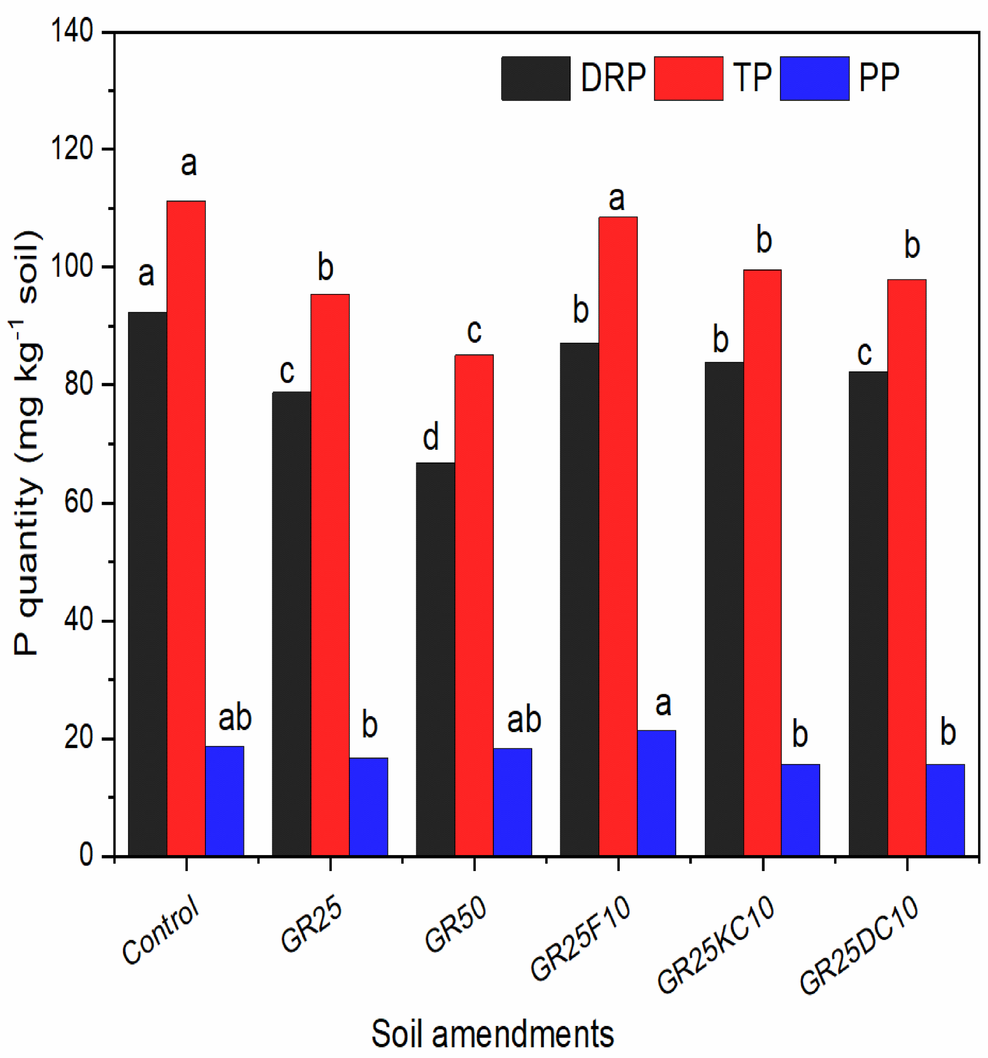


Fig 2. Cumulative loss of P through soil after leaching with different SAR water

[Numbers followed by different uppercase letters (a–d) significantly different at P ≤ 0.05 by Duncan multiple range tests for separation of mean]

Irrespective of soil amendments application, the perchloric acid digestable total P (TP_{HClO_4}) remained higher in soil when leaching with SAR-5 (200.2 mg kg^{-1}) compared to SAR-15 (191.7 mg kg^{-1}) and DW (171.5 mg kg^{-1}) (P< 0.05) (Table 1). Irrespective of water qualities applied for leaching, the TP_{HClO_4} content remained higher in GR50 (196.6 mg kg^{-1}) followed by GR25K (189.3 mg kg^{-1}) ≥ GR25 (187.7 mg kg^{-1}) = GR25D (187.2 mg kg^{-1}) > control (182.0 mg kg^{-1}). Irrespective of soil amendments application, the Olsen's extractable P (P_{Olsen}) was higher for DW than SAR-5/15 (P< 0.05).). The overall water extractable organic P (Pow) concentration was higher (4.0 mg kg-1) than the inorganic P (Piw) concentration (3.0 mg kg-1).

Table 1. Soil P pools (mg kg^{-1}) in intensive leached soil after column study

Treatment	P_{NaHCO3}	Pi_w	Po_w	TP_{HClO4}
Control	12.8^b	2.8	3.8^{abc}	181.9^d
GR25	15.3^{ab}	2.5	4.3^{ab}	187.7^{bc}
GR50	17.6^a	3.4	4.3^{ab}	196.6^a
GR25F	17.2^a	3.5	3.1^c	184.2^{cd}
GR25KC10	13.7^b	2.8	3.4^{bc}	189.3^b
GR25DC10	17.3^a	3.0	4.8^a	187.2^{bc}
WQ1	21.9^A	4.0^A	6.8^A	171.51^C
WQ2	12.8^B	1.7B	1.4^C	200.2^A
WQ3	12.9^B	3.3A	3.7^B	191.7^B
trt*WQ	ns	ns	***	*

[Numbers followed by different uppercase letters (a–d) and (A-C) significantly different at P ≤ 0.05 by Duncan multiple range tests for separation of mean]

Total P leaching in the treated soil was significantly reduced because increasing exchangeable Ca^{2+} in the soil. Low concentration of electrolytes in CW promotes deflocculating which may further enhance the P losses.

CONCLUSIONS

The dissolution of gypsum produces Ca^{2+}_{sol} which occurs precipitation of P as Ca–P. The cumulative DRP concentration in Gyp was lower in the leachate may be formation of Ca–P. Amending soil with 50GR gypsum or integrated application of 25GR and 10 Mg ha^{-1} of compost followed by leaching with low SAR water to prevent soil P loss during reclamation.

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