Shiveshwar Pratap SINGH[1], Sanjay TIWARI[1], Shiv Nath SUMAN[1], Yogeshwar SINGH[4], Shankar JHA[1], Shiv Shankar PRASAD[1], Mukesh KUMAR[1] and Krishna Murari SINGH[1]

Sustainable management of calcareous sodic soil through combined application of chemical and organic amendments in Bihar, eastern India

[1]Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, India; [2]Rani Lakshmi Bai Central Agricultural University, Jhanshi, India

Introduction

In the state, Bihar, about 4 lakh ha is suffering from different levels of sodicity/salinity and mostly calcareous in nature having excess free $CaCO_3$ associated with Na rich minerals. For calcareous sodic soils, pyrites are superior amendment over gypsum both in respect of both yield and soil properties (Singh et al., 2011). The availability of pyrite is very limited. Therefore, the other cheaper available amendment, gypsum, could be a good option among the farmers. Thus, to evaluate the response of gypsum alone and with pressmud and green manure (*Dhaincha)* in calcareous sodic soils, trials were conducted in farmer's fields.

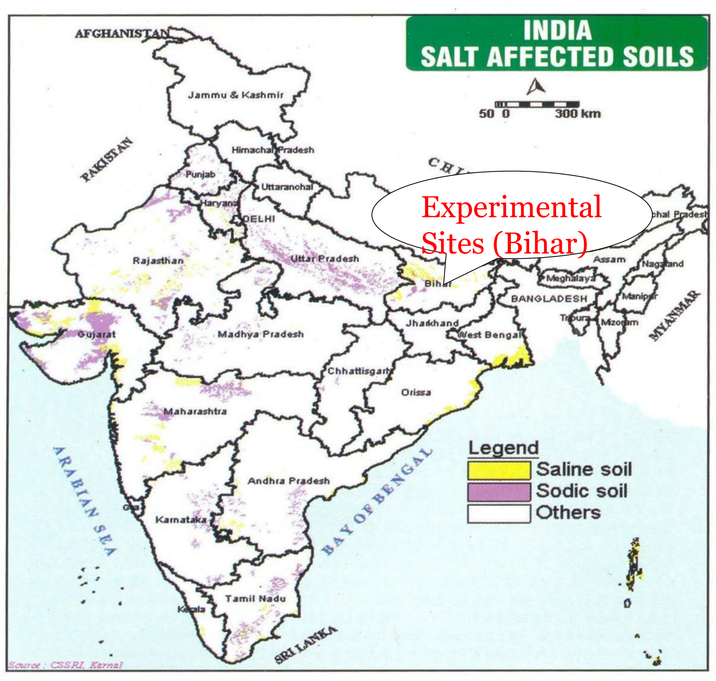

Figure 1: Location of experimental site

Methodology

Trials were conducted in 10 ha area of 49 farmers of Muzaffarpur district (Bihar), India (fig 1). Six combinations viz. T_1 – Untreated control, T_2 – gypsum @ 4 Mg ha^{-1}, T_3 – Sulphitation Press Mud (SPM) @10 Mg ha^{-1}, T_4 – gypsum @ 4 Mg ha^{-1} + PM @10 Mg ha^{-1} , T_5 – gypsum @ 4 Mg ha^{-1} + Green manure *(dhaincha)* and T_6 – gypsum @ 4 Mg ha^{-1} + PM @ 10 Mg ha^{-1} + Green manure (dhaincha) were applied and mixed in surface soil. After leaching of salts with irrigation water, the Dhaincha was sown and incorporated in to the soils after 35 days. The first crop salt-tolerant rice (Usar Dhan-3) was grown after reclamation. Initial as well as in final values of pH, EC, organic carbon, available P, available K, SAR and ESP in soils after harvest of each crop were analyzed using standard procedures. The initial status of the surface soil (0-15 cm) is depicted in table 1.

Table 1: Initial soil properties of the experimental site

S.No.	Parameter	Range	Mean
1	pH	8.8-9.2	9.02
2	EC (dSm^{-1})	1.49-2.8	2.14
3	ESP	49.98-52.0	51.21

Table 2: Effect of different amendments on average grain yield of rice and wheat (t ha^{-1})

Factor	Rice	Wheat
T1: Untreated Control	1.9	3.4
T2: Gypsum at 4 Mg ha^{-1}	2.3	4.2
T3: Sulphitation Press Mud (SPM) at 10 Mg ha^{-1}	2.6	4.6
T4: Gypsum at 4 Mg ha^{-1} + SPM at 10 Mg ha^{-1}	2.9	4.8
T5: Gypsum at 4 Mg ha^{-1} + Dhaincha	3.2	5.2
T6: Gypsum at 4 Mg ha^{-1} + SPM at 10 Mg ha^{-1} + Dhaincha	3.8	5.8
LSD (p ≤ 0.05)	0.2	.3

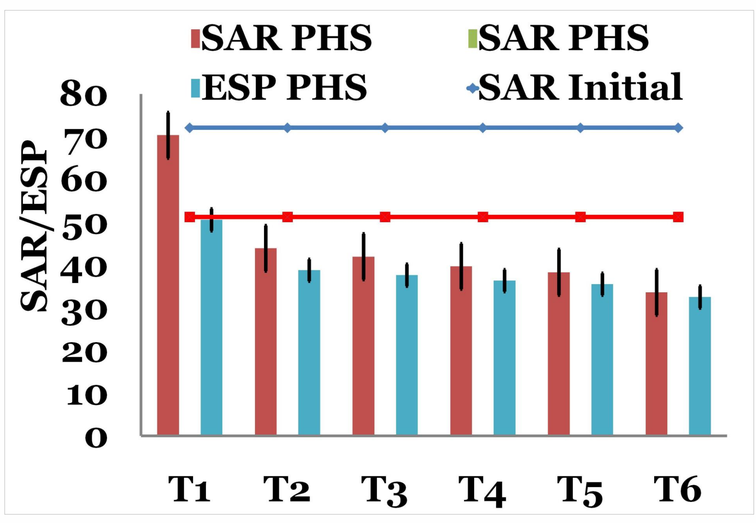

Figure 2: Effect of different amendments on percent changes in SAR (sodium adsorption ratio) and ESP (exchangeable sodium percentage) of the post harvest soil (0-15 cm)

Results and Discussion

Application of gypsum alone or in combination with organics significantly improved the crop yield of both rice and wheat over untreated control. The two years mean rice grain yield was recorded maximum in treatment T_6 (3.8 t ha^{-1}) followed by T_5 (3.2 t ha^{-1}), T_4 (2.9 t ha^{-1}), T_3 (2.6 t ha^{-1}), T_2 (2.3 t ha^{-1}) and T_1 *i.e.* unfertilized control (1.9 t ha^{-1}). While, wheat grain yield was maximum in treatment T_6 (4.5 t ha^{-1}) followed by T_5 (3.9 t ha^{-1}), T_4 (3.6 t ha^{-1}), T_3 (3.1 t ha^{-1}), T_2 (3.0 t ha^{-1}) and T_1 *i.e.* unfertilized control (1.9 t ha^{-1}) (table 2). The physico-chemical properties of soils were improved due to application of both chemical and organic amendments (fig 2).

Application of chemical (gypsum) along with organics (sulphinated pressmud and green manure) amendments gave more pronounced impact on crop production and soil fertility in comparison to alone application of gypsum.

Figure 3: Field visit and awareness among farmers

Organic amendments not only enhance the organic carbon but also increase the efficiency of chemical amendment by releasing organic acid which helps in enhancing solubility of insoluble calcium (Singh *et al.*, 2011). The exchangeable Na^+ ions are replaced by Ca^{2+} and improved soil aggregation and water infiltration. The crop roots also provide channels in soils through which amendments could move downward and enhance the ameliorating effect (Brady and Weil, 2002).

Conclusions

The current findings indicate that the calcareous sodic soil improved much better with application of organics than the gypsum. The farmers of calcareous soils in eastern India may get maximum benefit by opting the application of gypsum (@4 Mg ha^{-1}) along with sulphinated pressmud (@ 10 Mg ha^{-1}) and green manure (*Dhaincha)* followed by gypsum (@4 Mg ha^{-1}) + *Dhaincha*; gypsum (@10 Mg ha^{-1}) with sulphinated pressmud; sulphinated pressmud (10 Mg ha^{-1}) and gypsum (@Mg ha^{-1}).

References

[1] Brady, Nyle C. & Weil, Ray R. 2002. The Nature and Properties of Soils, Thirteen Edition, Pearson Education (Singapore) Pte. Ltd., Indian Branch, 482 F.I.E. Patparganj, Delhi 10092, India

[2] Singh, Shiveshwar Pratap., Tiwari, S., Suman, S.N., Singh, Y., Singh, M. P., Singh, V. P. & Jha, S. 2011. Response of gypsum in reclamation of sodic soils in Muzaffarpur district of Bihar. *Journal of Soil Salinity and Water Quality,* 3(2): 88-92.

Acknowledgements

Authors are very much thankful to the farmers of village Birahima, Mathaiya, Tajpur, Babutola and Sirsia of Motipur block of Muzaffarpur district, Bihar (India) for their kind co-operation during execution of research work. We are also thankful to the FCI-Aravali Gypsum Limited, Jodhpur, Rajasthan (India) for the financial support and Dr. Rajendra Prasad Central Agricultural University, India for conducting the experiment.

International Network of Salt-Affected Soils

Managing salt-affected soils for sustainable future