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Effect of organic amendments and gypsum on yield & yield attributes of rice crop (*Oryza sativa* L.) grown on sodic soil

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Abstract
A field experiment was conducted at Crop research Farm Daleepnagar CSAU&T, Kanpur (U.P.), during *Kharif* season 2017 to study the effect of organic amendments and gypsum in rice grown on sodic soil. The 7 treatments were tested in Randomized Block Design with three replications consisted of T_1: Control RDF (120:60:60), T_2: 50%GR, T_3: 25% GR+RS@3tha^{-1}, T_4: 25% GR+GM@5tha^{-1}, T_5: 25% GR+GM@5tha^{-1}+MB Culture, T_6: 25% GR+PM@3tha^{-1}, T_7: 25% GR+FYM@5tha^{-1}. On the basis of the results emanated from present investigation, it could be concluded that application of 25%GR +PM@3tha^{-1} applied in rice to significantly increases growth and yield parameter i.e. plant height at maturity, length of panicle, number of effective tillers hills^{-1}, number of grain panicle^{-1}, test weight, grain and straw yields per plot.
It was observed that the treatment T_6 gave the significantly better growth of plant yield contributing characters. These amendments were also brought significant improvement in protein content in grain and straw.

Keywords: Amendments, rice, yield, gypsum, sodic soil

Introduction
Rice (*Oryza sativa* L.) is the most important staple food for three fourth of the Indian population and has become an item of commerce since last two decades. The rice production recorded such commendable growth that we achieved self-sufficiency and contained imports. It is principal food and cereal crop of south eastern Asia and about 90% of all rice grown in the world is produced and consumed by Asian countries. In Asia, over two billion people obtain 60-70% of their energy intake from rice and its products. Rice is primarily a high energy or high caloric food while protein content is less than wheat. The protein content of rice about 6-7%. The biological value of rice protein is high. The fat content of rice is low about 2.0-2.5% and much of fat is lost during milling. It has low percent of calcium. It contains as much as B group of vitamins as wheat.
In the global content India stands first in area with 43.5mha, second in production with 110.15mt in 2017-18 (Food Corporation of India, and GOI Budget). Over increasing population of India, it is assumed that we must produce about 140 million tones rice by 2025 AD. For achieving the goal of food grain requirement satisfactory which can be achieved only by increasing the rice production by over 2.0 million tones every year in coming decade.
Addition of FYM, Green manure, Rice straw and Poultry manure improve the hydraulic properties, there by facilitating leaching of salts, helping mobilize Ca in calcareous alkali soils through decomposition products, serving as source of plant nutrients and invigorating microbiological activity. Application of organic materials in conjunction with gypsum has been found very beneficial.
FYM, Green manure, Rice straw and Poultry manure improves the physical condition of soil by increasing water holding capacity for maximum utilization of water, aeration, tilth and soil structure. It also improves the chemical and biological condition of soil by increasing CEC and providing various vitamins, hormones and organic acids which are very important for soil aggregation and for beneficial micro-organism which are involved in various biochemical processes and release of nutrient. Gypsum ($CaSO_4.2H_2O$) is considered for one of the most commonly used amendment for sodic-soil reclamation, primarily because of its low cost. As a by-product from phosphate industry, it is often produced in high quantities,

and the costs for transporting, crushing process, and broadcasting are relatively low (Gharaibeh *et al*. 2009) [3]. Reclamation of sodium affected soils requires soluble Ca^{2+} for exchange of absorbed Na^{+} and adequate flow of water through and beyond the root zone. As it removes Na^{+} from saline-sodic soils, $SO4^{2-}$ in the gypsum can decrease the pH of alkali soils in reclaimed tidal land (Lim *et al*., 2011) [5] and improve bulk density, macro porosity, hydraulic conductivity (Emami and Astaraei, 2012) [2] and other physical properties (Singh *et al*., 2014) [8]. Conjunctive use of chemicals and organic amendments speed-up the process of reclamation of sodic soil (Somani, 1990) [9].

Materials and Methods

The experiment was conducted at crop research farm Daleepnagar, C. S. Azad University of Agri. and Tech., Kanpur, during *kharif* season of 2017. It is situated at an elevation of 124 meters above the sea level in the alluvial belt of Gangetic plains of central Uttar Pradesh. The mean ambient temperature and relative humidity during the experiment ranged from 20.6 ^{0}C to 34.5 ^{0}C and 55.83% to 81.66%, respectively. The soil of the experimental site was sandy clay loam in texture, sodic soil (pH 9.50) and had 0.21% organic carbon, nitrogen 167 kg ha^{-1}, phosphorus 9.25 kg ha^{-1} and potassium 162 kg ha^{-1}. The experiment was carried out in a randomized block design with three replications. The treatments consisted of viz T_1: Control RDF (120:60:60), T_2: 50%GR, T_3: 25% GR+RS@3tha^{-1}, T_4: 25% GR+GM@5tha^{-1}, T_5: 25%GR+GM@5tha^{-1}+MBCulture, T_6:25%GR+PM@3tha^{-1}, T_7: 25% GR+FYM@5tha^{-1}. (Note– Uniform dose of N: P: K @ 120:60:40 kgha^{-1} applied to all plots including control.) Rice straw - 0.45% N, 0.16% P and 1.16% K, FYM 0.52% N, 0.21% P and 0.5% K, Poultry manure 2.5% N, 1.5% P and 1.4% K, GM (Sesbania aculeata) 2.10% N, 0.60% P and 1.20% K, MB Culture Mixture of *Bacillus polymyxa* and *Trichoderma viridi.* The rice (var. CSR-36) was transplanted in first week of July. The full dose of phosphorus and potassium and half dose of nitrogen were applied as basal at the time of sowing and remaining half of nitrogen in two splits each at tillering and milking stage. Growth parameters viz., plant height at maturity, length of panicle, number of effective tillers hills^{-1}, number of grain panicle^{-1}, were recorded at the time of harvest from five randomly selected plants. The grain yield and straw yield were estimated later.

Results and Discussion

Yield attributes

The growth parameters such as plant height at maturity, number of effective tillers hill^{-1}, length of panicle, number of grains penicle^{-1} and 1000 grain weight (Test weight) of rice varied with the application of different levels of gypsum and organic amendments in sodic soil (Table 1).

During the course of study, it was found that addition of gypsum @ 25% GR with organic amendments significantly increased the plant height(116.33cm), number of effective tillers hill^{-1}(15.32), length of panicle(23.45cm), number of grains penicle^{-1}(153.64) and test weight (26.36) of rice by 7.31, 69.11, 53.56, 8.71 and 20.53% respectively, over control. Application of gypsum might have considerable improvement in the soil condition and thus resulted in significant increase in growth parameters over control. The results are in agreement with Saeed *et al.* (2007) [6] who reported that application of gypsum increased the growth as well as yield attributers in rice by improving the soil conditions.

Application of 25% GR + PM @ 3 t ha^{-1} resulted maximum plant height, number of effective tillers hill^{-1}, length of panicle, number of grain panicle^{-1} and test weight in rice under sodic soil which was significantly higher over control. The result is in agreement with Baishya *et al.* (2015) [8]

Table 1: Yield attributes as influenced by application of organic amendments & gypsum in rice grown on sodic soil.

Treatments	Plant height (cm.)	No. of effective tillers hill^{-1}	Panicle Length (cm)	No.of grain panicle^{-1}	Test Weight (gm.)
T_1 Control	108.40	09.00	15.27	141.32	21.87
T_2 50% GR	112.60	12.31	18.52	149.00	23.32
T_3 25% GR+RS @5 t ha^{-1}	110.90	11.37	18.16	148.00	22.15
T_4 25% GR + GM @5 t ha^{-1}	113.33	12.66	19.16	149.65	24.16
T_5 25% GR+GM @5 t ha^{-1} + MB culture	115.20	14.00	21.15	151.66	25.40
T_6 25% GR + PM @3t ha^{-1}	116.33	15.32	23.45	153.64	26.36
T_7 25 GR + FYM @ 5 t ha^{-1}	114.06	13.34	22.11	150.00	25.11
SE (±)	0.91	0.93	1.15	1.42	0.68
CD (5%)	2.01	2.03	2.53	3.10	1.45

Table 2: Grain and straw yield as influenced by application of organic amendments & gypsum in rice grown on sodic soil.

Treatments	Grain Yield (q ha^{-1})	Straw Yield (q ha^{-1})
T_1 Control	24.50	29.12
T_2 50% GR	36.49	43.65
T_3 25% GR+RS @5 t ha^{-1}	34.29	43.65
T_4 25% GR + GM @5 t ha^{-1}	38.36	46.18
T_5 25% GR+GM @5 t ha^{-1} + MB culture	40.42	48.20
T_6 25% GR + PM @3t ha^{-1}	42.13	51.41
T_7 25 GR + FYM @ 5 t ha^{-1}	39.37	47.10
SE (±)	0.72	0.86
CD (5%)	1.57	1.94

Yield

A perusal of the data Table:2 revealed that grain and straw yield of rice were significantly influenced by the application of organic amendments and gypsum. On an average the highest grain yield (42.13 q ha^{-1}) computed 71.85% higher over control and straw yield (51.41 q ha^{-1}) computed 76.57% higher over control was recorded with the treatment 25% GR + PM @ 3 t ha^{-1}(T_6). It is obvious that grain and straw yield of rice responded significantly and conspicuously with application of gypsum with organic amendments. The significant response of rice to these nutrients in present investigation might be attributed to its deficiency in the experimental field. These results lie in the line findings Saeed *et al.* (2007) [6], Ghosh (2007) Sangeetha *et al*. (2013) [7].

Conclusion

On the basis of experimental finding, it can be concluded that, application of organic amendments and gypsum significantly influenced growth, yield attributes and yield of rice crop. The highest yield and yield attributes can be obtained with the combined application of 25%GR + PM @3tha^{-1}.

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