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PHYSICO-CHEMICAL CHARACTERISTICS OF SALINE SOIL UNDER WHEAT AS INFLUENCED BY GYPSUM, RICE-HULL AND DIFFERENT SALINITY LEVELS

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ABSTRACT

A pot experiment was conducted on saline soil of Sonagazi, Bangladesh to determine the effect of different levels of salinity, gypsum and rice-hull on soil properties under wheat culture. p^H value of soil slightly increase with the increase of salinity. EC value of soil significantly ($p \leq 0.05$) increased with application of saline water but decreased with the application of gypsum and rice hull alone or in combination. Available nitrogen content 16.18% and phosphorous content 19.23% increased in soil at maturity stage with increase level of salinity, but available sulfur content 18.33% decrease with the increase level of salinity as compared with control.

KEYWORDS: Wheat, Gypsum, Rice-Hull, Salinity, Physico-Chemical Characteristics of Soil

INTRODUCTION

The availability of land for growing crops in Bangladesh is limited. This requires the utilization of marginal and problem soils and improvement of yield potentiality of wheat per unit of land where soil stresses of different kinds and degrees exist. Problem soil offer great opportunity in this regard(1). The problem of salinity is spreading all over the globe. Bangladesh is not free from this threat as the saline zones are creeping outwardly. Salinity covers about one-fifth of the total area (26,000 km^2) of Bangladesh which lies around the northern apex of the Bay of Bengal(2). In Bangladesh, the saline soils have the potential of contributing substantially to increase wheat production. Among the factors that influence vertical expansion in food production, the use of inorganic fertilizers, and soil amending materials deserves special attention. Gypsum increases yield and acts as an amending material of saline soil(3). Many research reported that the application of saline water with gypsum increased the removal of Na from the soil profile, appreciably decreased the soil pH, improved water infiltration rate and raised crop yield(4). Rice hull also improved water holding capacity of soil. It also increased organic matter content of the soil and subsequently increased crop yield. The present investigation therefore is an attempt to study the dynamics of physic-chemical characteristics of coastal saline soil under wheat as influenced by gypsum and rice-hull.

METHODS

A pot experiment was conducted with BARI-20 (Gourave) high yielding wheat cultivar. The soils used in the experiment representing plough layer depth (0-15 cm) were collected from Sonagazi thana of Feni. One kg of soil sample was kept in the plastic container for chemical analysis. The physical and chemical characteristics of the soils were determined by following standard methods and the results are presented in the Table 1. As a basal dose half of Urea and TSP fertilizers were mixed with the soil of each pot as respectively 240 kg ha^{-1} and 450 kg ha^{-1}. After sowing the wheat seeds soils were irrigated with tap water by sprinkler process when required. Weeding was done after 15 days of seedling. Another half of Urea and TSP were given in the pot on that day. Irrigation with saline water started after 55 days of seedling. Each pot required 300 ml of saline water. Growth parameter-Plant heights were collected at three stages of the plant growth –early stage (15 days after seedling), middle stage (55 days after seedling) and maturity stage (100 days after seedling). Soil samples were also collected in polythene bags for analyzing nutrient elements.

Table 1: Some Physical and Chemical Characteristics of the Soil Used in Pot Experiment

Properties	Sonagazi Saline Soil
Moisture content(5)	3%
Textural class (Hydrometer Method)	Silty Clay Loam
Soil pH (1:2.5, soil: water)	7.6
ECe (Saturation extract)	4.6 mS cm^{-1}
Organic matter	1.11%
Total N (Micro Kjeldahl Method)	0.12%
C/N ratio	9.6
Available N (mg kg^{-1}) (Micro Kjeldahl Method)	52
Available S (mg kg^{-1}) (Spectrophotometer)	329
Available P (mg kg^{-1}) (6)	2.7
Carbonate(6)	Nil
Bicarbonate(6)	0.06%
CEC(7)	23.03 C mol/ kg^{-1}
Water Soluble Ions: (C mol/ kg^{-1})	
Na^+ (Flame Photometer)	0.45
K^+ (Flame Photometer)	0.07
Ca^{2+} (EDTA Method)	0.50
Mg^{2+} (EDTA Method)	2.12
Exchangeable Cations: (C mol/ kg^{-1})	
Na^+	0.83
K^+	0.32
Ca^{2+}	7.50
Mg^{2+}	3.75

Table 2: Treatment Combinations of the Experiment Used are Shown below Systematically

Sonagazi Soil	
Pot No.	**Treatment**
T_1	$EC_0G_0H_0$
T_2	$EC_6G_0H_0$
T_3	$EC_{12}G_0H_0$
T_4	$EC_0G_{200}H_0$
T_5	$EC_6G_{200}H_0$
T_6	$EC_{12}G_{200}H_0$
T_7	$EC_0G_{300}H_0$
T_8	$EC_6G_{300}H_0$
T_9	$EC_{12}G_{300}H_0$
T_{10}	$EC_0G_0H_4$
T_{11}	$EC_6G_0H_4$
T_{12}	$EC_{12}G_0H_4$
T_{13}	$EC_0G_0H_8$
T_{14}	$EC_6G_0H_8$
T_{15}	$EC_{12}G_0H_8$
T_{16}	$EC_0G_{200}H_4$
T_{17}	$EC_6G_{200}H_4$
T_{18}	$EC_{12}G_{200}H_4$

Table 2: Contd.,

T_{19}	$EC_0G_{200}H_8$
T_{20}	$EC_6G_{200}H_8$
T_{21}	$EC_{12}G_{200}H_8$
T_{22}	$EC_0G_{300}H_4$
T_{23}	$EC_6G_{300}H_4$
T_{24}	$EC_{12}G_{300}H_4$
T_{25}	$EC_0G_{300}H_8$
T_{26}	$EC_6G_{300}H_8$
T_{27}	$EC_{12}G_{300}H_8$

EC_0, EC_6, EC_{12} represent salinity level 0, 6, 12 mS cm^{-1}.
G_0, G_{200}, G_{300} represent 0, 200, 300 kg ha^{-1} gypsum.
H_0, H_4, H_8 represent 0, 4, 8 t ha^{-1} rice hull.

RESULTS AND DISCUTIONS

Soil p^H

The p^H of all the soils were examined and presented in table3. There was slightly changes in soil p^H at different stage of crop growth. Soil p^H value increased with the saline water irrigation. The highest value of p^H was found 8.3 in T_3 ($EC_{12}G_0$) and lowest value was found 7.2 in T_7 (EC_0G_{300}) after harvest (table 3). Soil p^H decreased slightly with the application of gypsum and rice-hull. Soil p^H decreased more with gypsum at the rate of 300 kg ha^{-1} than gypsum at the rate of 200 kg ha^{-1}. The combined application of gypsum 200 kg ha^{-1} with rice-hull 4 or 8 t ha^{-1} are more effective to reduce soil p^H than the combined application of gypsum 300 kg ha^{-1} with rice-hull 4 or 8 t ha^{-1}. Al most similar results were reported by several scientists. Ahmed *et al.,* 1983 observed higher p^H values of saline water irrigated soil[(8)]. Ahmed and Rahman (1986) reported that the application of gypsum in saline soil decreased the p^H of the soil[(9)].

Electrical Conductivity

The electrical conductivity of soil (EC_e) significantly ($p \leq 0.05$) increased with the increase of salinity of irrigation water and marked increased was observed with the highest salinity level (12 mS cm^{-1}). With the advent of plant growth, EC_e value slightly decreased at earlier stage and finally increased (table 3). After harvest the maximum value of soil EC_e was found 5.4 mS cm^{-1} in T_3 ($EC_{12}G_0$) and minimum value was found 4.0 mS cm^{-1} in T_7 (EC_0G_{300}) (table 3). Soil EC value decreased highly with the application of gypsum at the rate of 300 kg ha^{-1} than gypsum 200 kg ha^{-1}. The combined application of gypsum at the rate of 300 kg ha^{-1} and rice-hull (4 t ha^{-1} and 8 t ha^{-1}) decreased EC_e value more than the combined application of gypsum at the rate of 200 kg ha^{-1} and rice-hull (4 t ha^{-1} and 8 t ha^{-1}). Kumar *et al.,* (1984) reported that the EC of the soil increased with the EC of irrigation water[(10)]. The present results are partially well with the findings of Khan *et al.,* (1996). Khan *et al.,* reported that the EC value of soil decreased with the higher dose of gypsum added in the soil[(11)].

Table 3: Physico-Chemical Properties (EC and pH) of Sonagazi soil at Different Stage of Growth of Wheat (BARI-20) as Influenced by Gypsum and Rice-Hull in Association with Alternate Saline Water Irrigation

Treatment Denotation	Pot no	pH			EC (mS cm^{-1})		
		ES	MS	Mat.	ES	MS	Mat.
EC_0G_0	T_1	7.5	7.5	7.4	2.86	3.2	4.6
EC_6G_0	T_2	7.6	7.7	7.8	2.87	3.2	4.8
$EC_{12}G_0$	T_3	7.7	7.8	8.3	2.87	3.3	5.4
EC_0G_{200}	T_4	7.4	7.5	7.3	2.86	3.1	4.2

Table 3: Contd.,

EC_6G_{200}	T_5	7.5	7.4	7.4	2.86	3.2	4.7
$EC_{12}G_{200}$	T_6	7.6	7.4	7.6	2.87	3.3	5.1
EC_0G_{300}	T_7	7.3	7.3	7.2	2.85	3.1	4.0
EC_6G_{300}	T_8	7.5	7.2	7.5	2.86	3.1	4.7
$EC_{12}G_{300}$	T_9	7.6	7.2	7.5	2.86	3.2	4.9
EC_0H_4	T_{10}	7.6	7.6	7.6	2.85	3.2	4.6
EC_6H_4	T_{11}	7.6	7.7	7.8	2.87	3.2	4.8
$EC_{12}H_4$	T_{12}	7.7	7.8	8.0	2.87	3.3	5.1
EC_0H_8	T_{13}	7.5	7.6	7.6	2.86	3.3	4.7
EC_6H_8	T_{14}	7.6	7.7	8.2	2.86	3.3	4.9
$EC_{12}H_8$	T_{15}	7.7	7.8	8.3	2.86	3.4	5.3
$EC_0G_{200}H_4$	T_{16}	7.5	7.4	7.4	2.85	3.3	4.5
$EC_6G_{200}H_4$	T_{17}	7.5	7.4	7.5	2.86	3.3	4.8
$EC_{12}G_{200}H_4$	T_{18}	7.6	7.4	7.8	2.86	3.4	5.2
$EC_0G_{200}H_8$	T_{19}	7.5	7.3	7.4	2.86	3.3	4.5
$EC_6G_{200}H_8$	T_{20}	7.6	7.2	7.4	2.87	3.3	4.8
$EC_{12}G_{200}H_8$	T_{21}	7.6	7.3	7.4	2.87	3.3	5.1
$EC_0G_{300}H_4$	T_{22}	7.4	7.2	7.4	2.85	3.2	4.6
$EC_6G_{300}H_4$	T_{23}	7.5	7.1	7.5	2.85	3.2	4.7
$EC_{12}G_{300}H_4$	T_{24}	7.5	7.2	8.1	2.87	3.3	4.9
$EC_0G_{300}H_8$	T_{25}	7.4	7.1	7.4	2.86	3.3	4.5
$EC_6G_{300}H_8$	T_{26}	7.5	7.1	7.5	2.86	3.2	4.7
$EC_{12}G_{300}H_8$	T_{27}	7.5	7.2	8.0	2.87	3.3	4.9

EC_0, EC_6, EC_{12} represent salinity level 0, 6, 12 mS cm^{-1}.
G_0, G_{200}, G_{300} represent 0, 200, 300 kg ha^{-1} gypsum.
H_0, H_4, H_8 represent 0, 4, 8 t ha^{-1} rice hull.

Available Nitrogen

Available nitrogen content in the soil increased with increased level of salinity, which indicates uptake of nitrogen decreased with the increased salinity (Figure 1). On the other hand, available nitrogen content in soil decreased with the addition of gypsum and rice hull, which might be due to better growth of plants. The maximum value 77 mg kg^{-1} was found in T_{12} ($EC_{12}H_4$) and minimum value 20 mg kg^{-1} was found in T_{25} ($EC_0G_{300}H_8$) at the maturity stage which is 64.914% less as compared with control T_1 (EC_0G_0). Gypsum at the rate of 300 kg ha^{-1} was more effective in the case of decreasing available nitrogen content in the soil. Rice-hull of 8 t ha^{-1} was also more effective to reduce more available nitrogen content than 4 t ha^{-1}. Within the combinations of rice-hull and gypsum, rice-hull of 8 t ha^{-1} with gypsum of 300 kg ha^{-1} was more effective than other combinations in the case of reducing available nitrogen content in the soil.

Available Phosphorous

The availability of phosphorous in soil increased with the increased level of salinity that means uptake of phosphorous decreased with the increased of Salinity (Figure 2). With the addition of gypsum and rice-hull decreased phosphorous content in soil, which indicates plant uptake increased. The maximum value 4.24 mg kg^{-1} was found in T_3 ($EC_{12}G_0$) and the minimum value 3.60 mg kg^{-1} was found in T_{25} ($EC_0G_{300}H_8$) at the maturity stage which is 13.46% less as compared with control T_1 (EC_0G_0). The application of gypsum at the rate of 300 kg ha^{-1} was more effective to reducing availability of phosphorous in soil than gypsum at the rate of 200 kg ha^{-1}. Rice-hull 8 t ha^{-1} was also more effective to reduce available phosphorous in soil than rice-hull 4 t ha^{-1}. Among all the combinations of rice-hull and gypsum, rice-hull 8 t ha^{-1} and gypsum 300 kg ha^{-1} is more effective to reduce available phosphorous in soil.

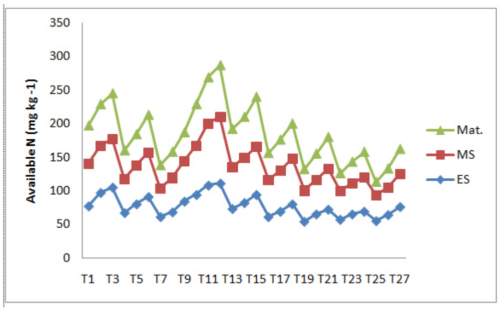

Figure 1: Amount of Available N (mg kg^{-1}) in Sonagazi Soil at Different Stages of Growth of Wheat as Influenced by Gypsum and Rice-Hull in Association with Alternate Saline Water Irrigation

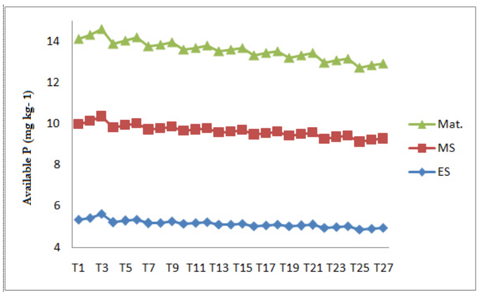

Figure 2: Amount of Available P (mg kg^{-1}) in Sonagazi Soil at Different Stages of Growth of Wheat as Influenced by Gypsum and Rice-Hull in Association with Alternate Saline Water Irrigation

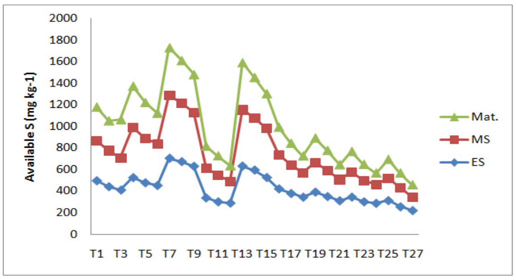

Figure 3: Amount of Available S (mg kg^{-1}) in Sonagazi Soil at Different Stages of Growth of Wheat as Influenced by Gypsum and Rice-Hull in Association with Alternate Saline Water Irrigation

Available Sulfur

The maximum value of available sulfur 442 mg kg^{-1} was found in T_7 (EC_0G_{300}) and minimum value 107 mg kg^{-1} was found in T_{24} ($EC_{12}G_{300}H_4$) at the maturity stage in the soil. Availability of sulfur content in soil decrease with the increased levels of salinity, that means uptake of sulfur increase with the increased levels of salinity (Figure 3). On the other hand, available sulfur content increased with the addition of gypsum and rice-hull that indicate plant uptake decreased. Gypsum dose 300 kg ha^{-1} alone and rice-hull dose 8 t ha^{-1} alone was more effective than any other dose. Within the combinations of rice-hull and gypsum, rice-hull 4 t ha^{-1} with gypsum 200 kg ha^{-1} was more effective than other combinations in the case of increasing available sulfur content in the soil.

CONCLUSIONS

The findings suggest that the application of gypsum and rice-hull on saline soil reduced the salinity level (maximum 15%) as compared with control. It also decreased the p^H value and improve the N, P and S status of that soil.

The highest dose of gypsum at 300 kg ha^{-1} plus rice-hull of 8 t ha^{-1} was found to be the best among the treatments which revealed that the more higher doses of gypsum and rice-hull may be more effective in order to improve the physico-chemical condition of the saline soil and to boost up the wheat production under saline environments. However, further research is needed.

REFERENCES

1. Khan HR, Faiz SMA, Islam MN, Adachi T, and Ahmed IU 1992. Effects of Salinity, Gypsum and Zn on Mineral Nutrition of Rice. Intern. J. Trop. Agric 10(2): 147-159.
2. Karim Z, Shaheed SM, Salauddin ABM, Alam MK, and Hoq A 1982. Coastal saline soils and their management in Bangladesh. BARC Publ. No. 8.
3. Naeem S, Siddiqui MS, and Yousuf-zai AHK 1987. A super sulphate formulation for amelioration of alkaline-saline soils. Pak. J. Scl. Indus. Res. 29: 338-342.
4. Gupta IC 1990. Use of saline water in agriculture. Oxford and IBH Publishing Co., New Delhi, 306p.
5. Black C A, 1965: Methods of soil analysis. Part II, American Society of Inc. Madison, Wisconsim, USA.
6. Jakson ML, 1973: Soil Chemical Analysis. Prentice hall of India Pvt. Ltd., New Delhi.
7. Chapman HD, 1965: Cation exchange capacity. *In:* Methods of soil analysis, Part 2, Ed. C. A. Black, American Society of Agronomy. Inst. Pub., Madison, WI, USA. Pp. 891-900.
8. Ahmed IU, Rahman S, and AKhand MS 1983. Grading of brackish water for irrigation and its influence on change of soil properties associated with crop management. *In:* Annual report (1981-82), Soil and Irrigation Division, Bangladesh Agriculture Research Council (BARC), Dhaka. pp. 107-180.
9. Ahmed IU, and Rahman S 1986. Seasonal variation in soil and water salinity. In: Bangladesh J. of Agric. II: 55-57.
10. Kumar V, and Singh VP 1984. Effect of different sodium salts on the chemical composition and uptake of nutrients by wheat crop. Curr. Agric. 5: 76-80.
11. Khan HR, Ahmed IU, and Blum HP 1996. Effects of gypsum and Zn on uptake ratio of Na, K, K and growth-yield of rice grown on a coastal saline soil. Z. P flanzenernahr. Bodenk. 159: 351-356.