J.Phytol. Res. 11(2) : 85-90, 1998

EFFECT OF SOIL AMENDMENTS ON MINERAL COMPOSITION (Na,K,Ca, Mg, P,N AND S) OF RICE PLANT GROWN IN SALINE SOIL OF GOPINATHPUR, SATKHIRA

A.C. AICH*, R.MANDAL and A.H.M. AHMED*****

Benerpota Salinity Research Station, BWDB, Satkhira, Bangladesh.

* Dy. Chief Agronomist, BMEU, CAD Project, BWDB, Dhaka-1000, Bangladesh.

**Professor, Department of Soil Science and

*** Professor,Department of Chemistry, University of Dhaka, Dhaka-1000, Bangladesh.

Application of three grades of brackish water (EC 0.7 ; 2.5 and 5.0 dSm^{-1}) caused a significant increase in Na,N,P Mg and S, and decrease in K and Ca content with the increase of salinity in three HYV of rice plant grown in saline soil in a plot culture experiment. Amendments of the soil with lime and gypsum could not boost up the uptake of K rather got hindered instead. Organic matters (straw and cowdung) in low brackish water increased the K content significantly but in higher brackish waters, the situation was quite reverse. The reason might be attributed to the fact that the added Ca from lime and gypsum possibly was not enough for higher uptake of K by copping with Na added through irrigation waters. Generally plants showed higher content of N and P at higher salinity. This might be associated with stunted growth of the plants caused by excessive Na. Moreover, N and P content was found to be independent of the treatments except salinity. Gypsum alone caused a slight increase and combinedly with organic matters showed no significant change in S content rather imparted negative impact on Mg content of the plant.

Keywords : Amendments; Mineral Composition; *Rice; Salinity.*

Introduction

The mineral content of straw may possibly indicate the uptake and availability status of the nutrients of soils and the index can fortale the mineral deficiencies, toxicity or imbalance in the plant caused thereby. The mineral uptake in saline soil gets complicated due to presence of large abundance of Na in the soil, and the situation aggravated due to the added Na through irrigation water used. Yadav and Girdhar[1] observed significant decrease in uptake of K and Ca and increase in that of Mg in wheat plant due to irrigation with high Mg containing brackish water. Similarly, Aich *et al*[2] reported the increased concentration of N,P,S,Mg and Na in some dry land crops with increasing salinity of irrigation water. The situation may be improved by the addition of gypsum, lime and organic matters[3-5]. However, no such information is available on rice plant grown in coastal embankment area of Bangladesh. So, an experiment was designed to see whether the application of organic matters alone and in conjunction with lime and gypsum could possibly suppress the uptake of Na and help to enhance and improve the accumulation of other macronutrients of straw of three HYV of rice grown in saline soil of Satkhira.

Materials and Methods

A pot culture experiment was conducted in coastal saline soil collected from Gopinathpur of Satkhira District. The pots (35cm × 30 cm) were filled up with air dried soil (0-15 cm, 15 kg, 2 mm sieve) and the soil was irrigated with the water of three different EC and mixed with organic matters (decomposed cowdung and straw), gypsum and lime. Three cultivars of rice namely BR3, BR15 and Iratom 24 were grown. P and K (80 and 60 kg ha^{-1}) and one-third of the N (90 kg ha^{-1}) were applied as basal dose and the rest two-third of N was top dressed in two equal splits: one at active (30 DAT) and other at maximum tillering stages (60 DAT) of growth. The treatment combinations used were as follows:

Brackish irrigation water (Eciw) : Low (0.7 dSm^{-1}), medium (2.5 dSm^{-1}) and high (5.0 dSm^{-1}). Organic matter (OM); OMo = 0 t ha^{-1}, CD = Decomposed cowdung (10 t ha^{-1}), Str = Decomposed straw (10 t ha^{-1}). GoLo=Gypsum and lime (0 t ha^{-1}), G=Gypsum 0.5 t ha^{-1}; L=Lime (0.5 t ha^{-1}).

The organic matters were added on the potted soil 7 days prior to transplantation and kept at field moisture condition. Gypsum and lime were applied on the surface soil of the pot at the time of final preparation. Seedling of rice were raised in nonsaline soil and irrigated with low brackish water(0.7 dSm^{-1}). Eighty one treatments, in triplicate, were arranged into a 3^4 factorial strip split design. Thirty-five days old healthy seedlings of uniform size were transplanted on 15 cm squarely set hills (3 seedlings $hill^{-1}$) in each pot. The irrigation water(Eciw 1.2-1.5 dSm^{-1}) was applied for 10 days for seedling survival followed by submergence (2-5 cm) with standing water of different Ec for rest of the growing period. The crop was harvested at maturity and straw was preserved for chemical analysis of Na, K, Ca, Mg, P, N and S.

Results and Discussion

The analytical data of rice straw mainly on Na, K, Ca, Mg, N, P and S have been presented in Tables 1 to 4. The Na content of straw significantly decreased with increased levels of brackishness of irrigation water (Table 1). However, the application of gypsum and lime reduced the uptake of Na in straw tosomeextent (gypsum 0.24=0.30% lime 0.26-0.28 %as against control of 0.27-0.34%) but not significantly when low brackish irrigation water was used. The reason might be due to the fact that the amount of Ca as well as S in the ameliorating treatments possibly was not sufficient enough to counter balance the Na present in the soil including the added Na coming through the irrigation water. All the treatments (low, medium and high brackish irrigation waters) helplessly subjugated to high prevalence of Na. This happened because the ratio of Na/Ca+Mg+K got increase from its previous values rather than decreased (Table 4).

Progressive increase of Na in the straw was recorded due to the presence of Na in irrigation water. However, the concentration of K decreased significantly (low 0.58-0.66%, medium 0.52-0.58% and high 0.49-0.55%) with a few variations. Moreover lime also (low 0.43-0.87, medium 0.42-0.60% and high 0.39-0.55%) could not boost up in any way the K content rather got hindered instead (Table 1).

A surplus of Na was shown to reduce K deficiency in wheat plants growing in sal hich was manifested in higher Na/K ratio in the plants with increasing salinity[6]. Sharma[7] reported that more tolerant crop cultivars (rice and wheat) are more efficient users of K under saline conditions. Whatever may be the degree of salinity of irrigation water cowdung or straw have shown the same consequence (in low brackish water, cowdung 0.55-0.70%, and straw 0.59-0.64%; in high brackish water, cowdung 0.46-0.60% and straw 0.43-0.60%). Application of gypsum and lime in presence of organic matters (cowdung or straw) increased the accumulation of K significantly in some cases (in low brackish water, 0.42-0.74%) but the reverse was true in medium (0.42-0.64%) and high brackish water (0.39-0.60%). That means, the amount of ameliorating agents in the treatments (gypsum or lime) possibly could not make the soil atmosphere conducive for higher uptake of K by balancing the large scale of Na.

So far Ca content is concerned, the added Ca in the form of gypsum or lime could not show the competence in competing with Na in low brackish irrigation water (Table 2).

Table 1. Influence of organic matters, gypsum and lime on Na and K content (%) in straw of rice irrigated with different grades of brackish water.

Brackish irrigation Water (ECiw dSm^{-1})		Low (0.7)			Medium (2.5)			High (5.0)		
t ha^{-1}	Varieties	$G_0 L_0$	$G_{0.5}$	$L_{0.5}$	$G_0 L_0$	$G_{0.5}$	$L_{0.5}$	$G_0 L_0$	$G_{0.5}$	$L_{0.5}$
	BR3	0.29 (0.60)	0.24 (0.57)	0.26 (0.57)	0.54 (0.58)	0.49 (0.60)	0.50 (0.55)	0.84 (0.54)	0.70 (0.55)	0.78 (0.49)
OM_0	BR15	0.34 (0.58)	0.30 (0.49)	0.28 (0.43)	0.58 (0.56)	0.47 (0.42)	0.50 (0.54)	0.88 (0.55)	0.71 (0.39)	0.74 (0.42)
	Iratom24	0.27 (0.58)	0.27 (0.62)	0.26 (0.57)	0.52 (0.52)	0.49 (0.57)	0.50 (0.58)	0.84 (0.49)	0.75 (0.54)	0.78 (0.44)
	BR3	0.27 (0.70)	0.26 (0.68)	0.27 (0.72)	0.52 (0.64)	0.49 (0.63)	0.48 (0.57)	0.78 (0.60)	0.72 (0.54)	0.63 (0.53)
CD_{10}	BR15	0.27 (0.55)	0.25 (0.63)	0.24 (0.60)	0.55 (0.58)	0.51 (0.51)	0.50 (0.53)	0.84 (0.49)	0.80 (0.49)	0.80 (0.50)
	Iratom24	0.29 (0.68)	0.26 (0.67)	0.26 (0.58)	0.56 (0.64)	0.48 (0.59)	0.54 (0.58)	0.88 (0.46)	0.65 (0.47)	0.78 (0.55)
	BR3	0.30 (0.61)	0.30 (0.74)	0.28 (0.72)	0.54 (0.60)	0.51 (0.59)	0.53 (0.58)	0.83 (0.60)	0.70 (0.56)	0.73 (0.54)
Str_{10}	BR15	0.32 (0.59)	0.30 (0.66)	0.30 (0.64)	0.61 (0.49)	0.52 (0.48)	0.53 (0.49)	0.80 (0.43)	0.72 (0.45)	0.78 (0.43)
	Iratom24	0.28 (0.64)	0.28 (0.68)	0.28 (0.67)	0.54 (0.54)	0.50 (0.57)	0.50 (0.58)	0.86 (0.49)	0.72 (0.50)	0.80 (0.48)

L.S.D. (P=0.05) = 0.07; (0.006)
OM_0=Organic matter (0 t ha^{-1}); CD=Cowdung; Str=Straw; G=Gypsum; L=lime; and G_0L_0=Gypsum and Lime (0 t ha^{-1}).
Figures in parenthesis represent K.

Table 2. Influence of organic matters, gypsum and lime on Ca and Mg content(%) in straw of rice irrigated with different grades of brackish water.

Brackish irrigation Water (ECiw dSm^{-1})		Low (0.7)			Medium (2.5)			High (5.0)		
t ha^{-1}	Varieties	$G_0 L_0$	$G_{0.5}$	$L_{0.5}$	$G_0 L_0$	$G_{0.5}$	$L_{0.5}$	$G_0 L_0$	$G_{0.5}$	$L_{0.5}$
	BR3	0.30 (0.30)	0.33 (0.28)	0.34 (0.29)	-.20 (0.26)	0.23 (0.30)	0.24 (0.30)	0.19 (0.36)	0.23 (0.30)	0.22 (0.33)
OM_0	BR15	0.24 (0.30)	0.26 (0.26)	0.26 (0.26)	0.20 (0.32)	0.22 (0.27)	0.24 (0.26)	0.18 (0.35)	0.23 (0.28)	0.23 (0.28)
	Iratom24	0.24 (0.30)	0.35 (0.28)	0.30 (0.27)	0.23 (0.31)	0.24 (0.28)	0.26 (0.27)	0.21 (0.32)	0.24 (0.30)	0.24 (0.29)
	BR3	0.30 (0.33)	0.33 (0.26)	0.32 (0.26)	0.22 (0.33)	0.24 (0.29)	0.24 (0.29)	0.21 (0.35)	0.24 (0.30)	0.23 (0.30)
CD_{10}	BR15	0.28 (0.32)	0.28 (0.27)	0.29 (0.26)	0.22 (0.34)	0.23 (0.30)	0.23 (0.31)	0.20 (0.35)	0.26 (0.32)	0.25 (0.30)
	Iratom24	0.27 (0.29)	0.23 (0.25)	0.32 (0.29)	0.22 (0.34)	0.28 (0.29)	0.24 (0.31)	0.22 (0.34)	0.26 (0.30)	0.24 (0.27)
	BR3	0.32 (0.33)	0.33 (0.29)	0.34 (0.28)	0.22 (0.34)	0.26 (0.32)	0.24 (0.31)	0.19 (0.34)	0.22 (0.30)	0.23 (0.30)
Str_{10}	BR15	0.28 (0.29)	0.35 (0.27)	0.30 (0.29)	0.29 (0.34)	0.22 (0.27)	0.23 (0.29)	0.18 (0.35)	0.21 (0.28)	0.23 (0.30)
	Iratom24	0.28 (0.28)	0.33 (0.26)	0.32 (0.26)	0.23 (0.32)	0.27 (0.26)	0.28 (0.26)	0.23 (0.35)	0.25 (0.28)	0.25 (0.29)

L.S.D. (P=0.05) =0.05; (0.003)
OM_0=Organic matter (0 t ha^{-1}); CD=Cowdung; Str=Straw; G=Gypsum; L=lime; and G_0L_0=Gypsum and Lime (0 t ha^{-1}).
Figures in parenthesis represent Mg.

Table 3. Influence of organic matters, gypsum and lime on N (%) and P content (mg kg-1) in straw of rice irrigated with different grades of brackish water.

Brackish irrigation Water (ECiw dSm^{-1})		Low (0.7)			Medium (2.5)			High (5.0)		
t ha^{-1}	Varieties	$G_0 L_0$	$G_{0.5}$	$L_{0.5}$	$G_0 L_0$	$G_{0.5}$	$L_{0.5}$	$G_0 L_0$	$G_{0.5}$	$L_{0.5}$
OM_0	BR3	0.63 (860)	0.75 (886)	0.72 (712)	0.66 (872)	0.78 (916)	0.75 (786)	0.89 (890)	0.82 (0.943)	0.88 (0.940)
	BR15	0.60 (745)	0.58 (891)	0.67 (675)	0.67 (830)	0.60 (862)	0.75 (802)	0.77 (900)	0.63 (912)	0.73 (825)
	Iratom24	0.63 (762)	0.64 (838)	0.71 (692)	0.72 (838)	0.70 (898)	0.80 (735)	0.88 (937)	0.81 (1062)	0.82 (875)
CD_{10}	BR3	0.77 (928)	0.78 (970)	0.72 (892)	0.86 (946)	0.87 (984)	0.77 (1028)	0.97 (1125)	0.94 (973)	0.98 (908)
	BR15	0.70 (762)	0.73 (1021)	0.74 (782)	0.86 (892)	0.70 (1055)	0.91 (837)	0.85 (925)	0.75 (963)	0.90 (892)
	Iratom24	0.75 (810)	0.63 (890)	0.68 (756)	0.66 (884)	0.72 (962)	0.86 (886)	0.77 (888)	0.77 (838)	0.96 (810)
Str_{10}	BR3	0.70 (875)	0.70 (922)	0.76 (890)	0.86 (884)	0.85 (918)	0.83 (906)	0.95 (943)	0.82 (933)	0.84 (909)
	BR15	0.59 (760)	0.69 (891)	0.71 (663)	0.79 (935)	0.76 (789)	0.74 (873)	0.75 (937)	0.76 (878)	0.79 (863)
	Iratom24	0.75 (810)	0.75 (868)	0.84 (732)	0.80 (865)	0.75 (867)	0.86 (836)	0.79 (932)	0.81 (884)	0.89 (883)

L.S.D. (P = 0.05) = 0.09; (48.6)
OM_0=Organic matter (0 t ha^{-1}); CD = Cowdung; Str=Straw; G=Gypsum; L = lime; and G_0L_0 = Gypsum and Lime (0 t ha^{-1}).
Figures in parenthesis represent P.

Table 4. Influence of organic matters, gypsum and lime on S content (%) and molar ratios of Na/Ca+Mg+K in straw of rice irrigated with different grades of brackish water.

Brackish irrigation Water (ECiw dSm^{-1})		Low (0.7)			Medium (2.5)			High (5.0)		
t ha^{-1}	Varieties	$G_0 L_0$	$G_{0.5}$	$L_{0.5}$	$G_0 L_0$	$G_{0.5}$	$L_{0.5}$	$G_0 L_0$	$G_{0.5}$	$L_{0.5}$
OM_0	BR3	0.11 (0.36)	0.12 (0.30)	0.09 (0.32)	0.12 (0.67)	0.13 (0.64)	0.12 (0.67)	0.13 (1.09)	0.14 (0.94)	0.13 (1.07)
	BR15	0.08 (0.44)	0.11 (0.43)	0.08 (0.43)	0.09 (0.79)	0.11 (0.74)	0.10 (0.71)	0.11 (1.16)	0.12 (1.12)	0.10 (1.14)
	Iratom24	0.09 (0.35)	0.10 (0.32)	0.10 (0.34)	0.10 (0.71)	0.12 (0.66)	0.12 (0.67)	0.12 (1.17)	0.14 (1.01)	0.12 (1.15)
CD_{10}	BR3	0.11 (0.35)	0.12 (0.31)	0.11 (0.32)	0.13 (0.63)	0.14 (0.62)	0.12 (0.64)	0.12 (0.97)	0.13 (0.97)	0.14 (0.86)
	BR15	0.09 (0.35)	0.11 (0.32)	0.09 (0.31)	0.10 (0.69)	0.12 (0.71)	0.10 (0.68)	0.12 (1.14)	0.14 (1.09)	0.11 (1.10)
	Iratom24	0.10 (0.35)	0.12 (0.31)	0.08 (0.29)	0.10 (0.68)	0.12 (0.61)	0.10 (0.69)	0.12 (1.13)	0.16 (0.91)	0.16 (1.08)
Str_{10}	BR3	0.10 (0.35)	0.12 (0.34)	0.11 (0.32)	0.12 (0.67)	0.13 (0.63)	0.12 (0.68)	0.12 (1.06)	0.13 (0.94)	0.14 (0.99)
	BR15	0.09 (0.41)	0.11 (0.35)	0.09 (0.36)	0.10 (0.78)	0.12 (0.78)	0.11 (0.75)	0.11 (1.15)	0.13 (1.11)	0.12 (1.10)
	Iratom24	0.08 (0.35)	0.12 (0.33)	0.09 (0.34)	0.10 (0.71)	0.12 (0.68)	0.10 (0.67)	0.11 (1.14)	0.16 (1.02)	0.16 (1.13)

L.S.D. (P = 0.05) =0.016
OM_0=Organic matter (0 t ha^{-1}); CD=Cowdung; Str=Straw; G=Gypsum; L=lime; and G_0L_0=Gypsum and Lime (0 t ha^{-1}).
Figures in parenthesis represent molar ratios of Na/Ca+Mg+K.

Similar results were obtained in medium and high brackish water. Of course, there is a general decrease of Ca in straw with the increase of brackishness of irrigation water (low 0.24-0.30%; medium 0.20-0.23% and high 0.18-0.21%). In low brackish water, cowdung or straw alone or in combination with gypsum or lime gave almost nearly the same results (cowdung 0.27-0.30%, cowdung +gypsum 0.23-0.32%; straw +gypsum 0.33-0.35% and straw +lime 0.30-0.34%). Similar trend also persisted although in medium and high brackish irrigation water. Thus, one can fairly well presume the high content of Ca in straw as the soil has got the added Ca but the result reflects otherwise. This plausiably be explained assuming that the amount of Ca is far below the required amount for competition with Na.

Peculiarly enough, Mg content in low brackish water as in Ca remained unchanged whatever may be the treatments included (Table 2). The concentration of Mg in plants grown in the control pot remained almost unchanged even though the soil was amended with organic matters. The Mg content in straw was found high in high brackish irrigation water in controls (0.32 - 0.36%) though the treatments and their combination could not make any positive impact rather than negative impact (gypsum alone or in combination with organic matters, (0.28 - 0.32%) and lime alone or in combination with organic matter, 0.28 - 0.33%).

Nitrogen content in straw of rice remained unaffected with respect to the individual treatments, the combinations there of saved except by the brackishness of irrigation waters (Table 3). In general, the N content in straw increased significantly with the brackishness of irrigation water (medium 10-14% and high 28-46%; higher against low brackish water control). This had happened haply due to the stunted growth of the plant caused by excessive Na and possibly the uptake of Na remained the same but the growth was not so much as in low brackish water.

The situation of P in straw has followed the same trend (Table 3) as was found in N content of straw and the same explanation is applicable in this case also (low 745-860 mg kg^{-1}, medium 830-877 mg Kg^{-1} and high 890-937 mg Kg^{1}).That means, N and P is independent of treatment except brackishness of irrigation water.

The content of S of rice straw varied from 0.08 to 0.11% in low brackish irrigation control soils as against 0.11-0.013% in high brackish water irrigation control and the differences were found statistically significant (Table 4). Addition of gypsum alone showed slight increase in S content of straw irrespective of varieties and irrigation waters, but addition of organic matters and lime individually and combinedly did not influence the S content significantly.

Plants take up excessive amounts of Na at the cost of K and Ca grown in saline soil[8]. Yadav and Girdhar[1] reported that the excess absorption of Mg significantly depressed the uptake of both K and Ca by wheat plants creating a grossly imbalanced nutrient status and consequently growth and yield. Girdhar[9] reported that salinity increased the N content of rice plant. Rice grown in saline soil has higher N and lower K content than non saline one[10].

References

1. Yadav J S P and Girdhar I K 1981, *Soil Sci.*31194
2. Aich A C, Mandal R, Khan E H and Sarker O H 1993, *J. Indian Coastal Agric. Res.* **11**(2) 81
3. Verma T S and Tripathi B R 1986, *Acta Agronomica Hungarica.* **35** (1-2) 83
4. Chavan S A,Patil K D, Mehta N B and Chavan K N 1991, *J. Indian Soc. Agric. Res.* **9**(1/2) 303
5. Swarup A 1992, *J. Indian Soc. Soil Sci.* **40** 816
6. Finck A 1977, *Soil salinity and plant nutritional status.* **In**: H.E. Dregne (ed). Managing saline water for irrigation. Texas.Tech. Univ., Lubboek, Texas.

7. Sharma S K 1989, *Indian J.Plant Physiol.* **32** (3) 200

8. Kuiper P J C 1984, *Functioning of plant cell membrane under saline conditions. Membrane lipid composition and ATP ases in salinity tolerance in plants.* (Eds.) R.C. Staples and G.H. Toenniessen. PP. 77-91. Wiley Inter Sciences, New York.

9. Girdhar I K 1988, *J. Indian Soc. Soil Sci.* **36** (2) 324

10. Quresh R and Akbar M 1990, *Plant Fd. Human Nutrin.* **40** 31