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IMPACT OF SOIL AMENDMENTS AND BRACKISH WATER ON MACRONUTRIENTS (Na, K, Ca, Mg, N, P and S) CONTENTS OF WHEAT GRAIN GROWN IN COASTAL SALINE SOIL

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Macronutrients contents of wheat grain grown in coastal saline soil of Gopinathpur as influenced by application of lime, gypsum, cowdung and straw irrigated with brackish waters (0.7 – 5.0 dSm^{-1}) have been studied. Contents of Na, Mg, N, P and S increased while those of K and Ca decreased significantly with the increase in brackishness of irrigation waters. Lime and gypsum alone played role to decrease the content of Na in grain. However, their combinations with organic matters could not contribute much to modify the content of K, Ca, Mg, N and S contents of grain.

Keywords: Brackish water; Coastal saline soil; Macronutrients; Soil amendments; Wheat.

Introduction

Salt tolerant limit of wheat cultivars vary widely[1] and the differential uptake of ions has been observed to be associated with soil salinity. Sharma[2] reported that salt tolerance of wheat is indicated by lower concentrations of Na and Cl and higher concentration of K in the plant. The content of K in rice straw decreased with increasing Na content of soil suggesting an antagonism between Na and K content of rice[3,4]. Yadav and Girdhar[5] found higher Mg content in wheat plant irrigated with high Mg containing brackish water and significantly depressed the uptake of both K and Ca. Aich *et al.*[4] observed that the content of N,P,Mg, S and Na in wheat grain increased significantly whereas those of K and Ca were found statistically unchange with increase in salinity of soils. Investigators working in this field used gypsum, lime and organic matter and found their beneficial impact resulting increased yield of wheat and rice[6-8]. This might be due to the fact that addition of these soil amendments could stimulate the mineral nutrients status of grain of wheat producing higher yield. Thus, an experiment was designed to see whether the application of organic matters, gypsum and lime could possibly supress the uptake of Na and help to enhance the accumulation of other macronutrients in grain of three cultivars of wheat in a salt affected soil irrigated with three grades of brackish water.

Materials and Methods

The field experiment was conducted at Gopinathpur saline soil of Satkhira in Rabi season using wheat as a test crop. The experimental plot was divided into two blocks. The blocks were again divided into subblocks. Each subblock was surrounded by 1 m wide buffer zone. In sub block, the plots (3 m x 2m) were separated from each other by 50 cm gap. A total of eighty one treatments were arranged according to 3^4 factoral strip split plot design with two replications. The treatments used were as follows.

Brackish irrigation water (ECiw): Low, medium and high representing 0.7, 6.0 and 12.0 dSm^{-1} respectively.

Organic matter (OM): OMo, CD and Str representing (0 t ha^{-1}), decomposed cowdung (10 t ha^{-1}) and decomposed straw (10 t ha^{-1}) respectively.

Gypsum (G) = 0,0.5 t ha^{-1} and lime (L) = 0, 0.5 t ha^{-1}

Wheat cultivars: Akbar, Agrani and Kanchan.

Cowdung and straw were added to the soil three days prior to sowing. Gypsum, lime, PK (80: 60 Kg ha^{-1}) and one third of 90 kg N ha^{-1} were applied as basal doses at the time of final land preparation. The remaining two third of N was top dressed equally at crown root (20 days after sowing, DAS) and panicle initiation stage (40 DAS) of growth.

The land was prepared in the field condition with spade and the big clops were smashed with wooden hammer. This operation was repeated three times. Seeds were sown finally in lines of 25 cm apart from each other at the rate of 150 kg ha^{-1}. On the following day, water (ECiw 1.2 dSm^{-1}) was sprinkled on the lines. Normal cultivation practices (weeding, hand hoeing and spraying) were followed althrough till harvesting. Irrigation was given as per schedule at 20, 40, 60 and 80 days after sowing with 5 cm depth of water each time. Nutrient contents (Na, K, Ca, Mg, P, N and S) of grain were determined by standard method.

Results and Discussion

The macronutrient contents of wheat grains of three cultivars grown in saline soil was determined and the results thus obtained have been presented in Tables 1-7.

Results showed that Na content of wheat grain varied from 0.018-0.020% in low brackish water control to 0.022-0.025% in high brackish water irrigation and the differences were found to be significant (Table 1). However, both gypsum and lime alone declined the accumulation of Na in grains irrespective of grades of brackish water and varieties used. Addition of gypsum or lime in the presence of organic matter did not differ very much.

The content of K and Ca in wheat grain decreased significantly with the increase of brackishness of irrigation waters (Tables 2-3). Incorporation of organic matters enhanced the K content in grain of wheat but addition of gypsum or lime along with organic matters (cowdung and straw) could not make any difference in most of the cases. The content of Mg in wheat grain increased significantly with the increase of brackishness of irrigation waters irrespective of treatments and varieties but in each water grade, gypsum, lime and organic matters alone or in combination could not contribute anything to the Mg content (Table 4). Generally, N content in grain increased significantly with brackishness of irrigation waters (low, 2.41-2.46%; medium, 2.4-2.5% and high 2.56-2.68%). This had happened haply due to the stunted growth and low yield caused by excessive Na^+ ion. However, addition of gypsum or lime in the presence of organic matters (cowdung or straw) did not show any appreciable variation in N content of grain (Table 5).

The situation of P content of grain has followed the same trend (low, 0.33-0.34%; medium, 0.34-0.35% and high, 0.36-0.40%) as was found in N content (Tables 5-6) and same explanation is applicable in this case also. Addition of lime or gypsum alone showed comparatively lower P content than that of the untreated ones. Sulpher content of wheat grain varied from 0.13 to 0.16% in low brackish water irrigation control as against 0.19-0.20% in high brackish water irrigation control and the differences were found to be statistically significant (Table 7). Addition of gypsum alone showed slight increase in S content of grain irrespective of varieties and irrigation waters used. However, incorporation of organic matters and lime alone and in combination did not influence very much to modify the S content of grain.

The content of Na in grain increased with the brackishness of irrigation water. This situ-

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

Brackish irrigation Water (EC iw dSm^{-1})		Low (0.7)			Medium (6.0)			High (12.0)		
t ha^{-1}	Varieties	G_0L_0	$G_{0.5}$	$L_{0.5}$	G_0L_0	$G_{0.5}$	$L_{0.5}$	G_0L_0	$G_{0.5}$	$L_{0.5}$
	Akbar	0.02	0.018	0.018	0.022	0.021	0.020	0.025	0.023	0.023
OMo	Agrani	0.018	0.016	0.016	0.020	0.019	0.018	0.024	0.020	0.022
	Kanchan	0.018	0.016	0.015	0.021	0.019	0.018	0.022	0.020	0.020
	Akbar	0.018	0.015	0.015	0.020	0.020	0.018	0.021	0.020	0.020
CD_{10}	Agrani	0.016	0.015	0.014	0.018	0.016	0.017	0.020	0.018	0.019
	Kanchan	0.014	0.013	0.013	0.018	0.016	0.018	0.021	0.019	0.019
	Akbar	0.017	0.015	0.014	0.019	0.017	0.016	0.022	0.021	0.021
Str_{10}	Agrani	0.016	0.015	0.015	0.018	0.015	0.016	0.020	0.020	0.020
	Kanchan	0.015	0.014	0.014	0.016	0.016	0.015	0.022	0.018	0.020

L.S.D. (0.05) = 0.002

Table 2 Influence of organic matters, gypsum and lime on K content (%) in grain of wheat irrigated with different grades of brackish water

Brackish irrigation Water (EC iw dSm^{-1})		Low (0.7)			Medium (6.0)			High (12.0)		
t ha^{-1}	Varieties	G_0L_0	$G_{0.5}$	$L_{0.5}$	G_0L_0	$G_{0.5}$	$L_{0.5}$	G_0L_0	$G_{0.5}$	$L_{0.5}$
	Akbar	0.38	0.40	0.42	0.38	0.35	0.36	0.36	0.36	0.34
OMo	Agrani	0.37	0.38	0.42	0.36	0.36	0.36	0.36	0.37	0.35
	Kanchan	0.41	0.40	0.42	0.40	0.40	0.41	0.38	0.42	0.39
	Akbar	0.47	0.44	0.44	0.44	0.45	0.46	0.40	0.38	0.36
CD_{10}	Agrani	0.47	0.48	0.51	0.44	0.42	0.44	0.40	0.37	0.38
	Kanchan	0.49	0.47	0.49	0.46	0.46	0.44	0.39	0.42	0.42
	Akbar	0.46	0.47	0.43	0.42	0.43	0.40	0.42	0.39	0.40
Str_{10}	Agrani	0.46	0.45	0.44	0.44	0.43	0.40	0.41	0.40	0.39
	Kanchan	0.47	0.47	0.49	0.44	0.45	0.43	0.42	0.43	0.42

L.S.D(0.05) = 0.014

Table 3. Influence of organic matters, gypsum and lime on Ca content (%) in grain of wheat irrigated with different grades of brackish water.

Brackish irrigation Water (EC iw dSm^{-1})		Low (0.7)			Medium (6.0)			High (12.0)		
T ha^{-1}	Varieties	G_0L_0	$G_{0.5}$	$L_{0.5}$	G_0L_0	$G_{0.5}$	$L_{0.5}$	G_0L_0	$G_{0.5}$	$L_{0.5}$
	Akbar	0.041	0.043	0.042	0.040	0.043	0.042	0.038	0.040	0.041
OMo	Agrani	0.042	0.044	0.043	0.040	0.043	0.042	0.039	0.042	0.043
	Kanchan	0.044	0.046	0.046	0.043	0.044	0.045	0.041	0.042	0.042
	Akbar	0.046	0.051	0.053	0.046	0.048	0.050	0.043	0.046	0.043
CD_{10}	Agrani	0.046	0.050	0.054	0.045	0.050	0.049	0.042	0.050	0.046
	Kanchan	0.048	0.054	0.056	0.043	0.052	0.052	0.046	0.049	0.046
	Akbar	0.046	0.050	0.052	0.044	0.047	0.049	0.043	0.044	0.046
Str_{10}	Agrani	0.045	0.049	0.052	0.044	0.046	0.048	0.042	0.044	0.044
	Kanchan	0.047	0.048	0.053	0.046	0.047	0.050	0.045	0.044	0.047

L.S.D(0.05) = 0.006

Table 4 Influence of organic matters, gypsum and lime on Mg content (%) in grain of wheat irrigated with different grades of brackish water.

Brackish irrigation Water (EC iw dSm^{-1})		Low (0.7)			Medium (6.0)			High (12.0)		
t ha^{-1}	Varieties	G_0L_0	$G_{0.5}$	$L_{0.5}$	G_0L_0	$G_{0.5}$	$L_{0.5}$	G_0L_0	$G_{0.5}$	$L_{0.5}$
	Akbar	0.16	0.16	0.17	0.17	0.18	0.18	0.22	0.18	0.18
OMo	Agrani	0.16	0.15	0.16	0.18	0.19	0.19	0.19	0.19	0.20
	Kanchan	0.15	0.14	0.16	0.18	0.18	0.20	0.21	0.19	0.20
	Akbar	0.18	0.16	0.18	0.18	0.20	0.20	0.20	0.19	0.20
CD_{10}	Agrani	0.18	0.18	0.18	0.19	0.18	0.21	0.21	0.20	0.20
	Kanchan	0.18	0.18	0.18	0.19	0.18	0.20	0.20	0.20	0.21
	Akbar	0.17	0.17	0.18	0.20	0.20	0.21	0.21	0.22	0.21
Str_{10}	Agrani	0.18	0.18	0.19	0.22	0.21	0.20	0.22	0.22	0.23
	Kanchan	0.18	0.18	0.18	0.21	0.22	0.20	0.22	0.22	0.22

L.S.D(0.05) = 0.008

Table 5. Influence of organic matters, gypsum and lime on N content (%) in grain of wheat irrigated with different grades of brackish water.

Brackish irrigation Water (EC iw dSm^{-1})		Low (0.7)			Medium (6.0)			High (12.0)		
$t\ ha^{-1}$	Varieties	G_0L_0	$G_{0.5}$	$L_{0.5}$	G_0L_0	$G_{0.5}$	$L_{0.5}$	G_0L_0	$G_{0.5}$	$L_{0.5}$
	Akbar	2.36	2.37	2.40	2.40	2.45	2.41	2.56	2.58	2.63
Ofdo	Agrani	2.41	2.39	2.34	2.46	2.58	2.60	2.58	2.65	2.60
	Kanchan	2.46	2.41	2.46	2.50	2.54	2.60	2.68	2.72	2.60
	Akbar	2.45	2.47	2.46	2.46	2.52	2.47	2.67	2.76	2.69
CD_m	Agrani	2.41	2.48	2.48	2.60	2.59	2.67	2.72	2.67	2.72
	Kanchan	2.54	2.61	2.52	2.65	2.69	2.62	2.78	2.74	2.76
	Akbar	2.41	2.46	2.46	2.72	2.58	2.61	2.63	2.65	2.60
Str_m	Agrani	2.44	2.51	2.49	2.63	2.60	2.65	2.70	2.76	2.76
	Kanchan	2.51	2.56	2.56	2.68	2.69	2.79	2.70	2.79	2.73

L.S.D(0.05) = 0.06

Table 6. Influence of organic matters, gypsum and lime on P content (%) in grain of wheat irrigated with different grades of brackish water.

Brackish irrigation Water (EC iw dSm^{-1})		Low (0.7)			Medium (6.0)			High (12.0)		
$t\ ha^{-1}$	Varieties	G_0L_0	$G_{0.5}$	$L_{0.5}$	G_0L_0	$G_{0.5}$	$L_{0.5}$	G_0L_0	$G_{0.5}$	$L_{0.5}$
	Akbar	0.34	0.33	0.33	0.35	0.35	0.35	0.40	0.36	0.38
Ofdo	Agrani	0.33	0.32	0.31	0.34	0.35	0.33	0.36	0.36	0.36
	Kanchan	0.33	0.32	0.32	0.35	0.35	0.34	0.37	0.35	0.35
	Akbar	0.38	0.35	0.34	0.39	0.37	0.36	0.40	0.39	0.38
CD_m	Agrani	0.38	0.36	0.37	0.40	0.38	0.37	0.42	0.40	0.39
	Kanchan	0.39	0.37	0.38	0.40	0.38	0.37	0.42	0.40	0.40
	Akbar	0.37	0.35	0.35	0.39	0.38	0.37	0.41	0.39	0.40
Str_m	Agrani	0.36	0.34	0.36	0.38	0.37	0.36	0.40	0.39	0.38
	Kanchan	0.37	0.35	0.36	0.38	0.35	0.36	0.42	0.40	0.39

L.S.D(0.05) = 0.013

Table 7. Influence of organic matters, gypsum and lime on P content (%) in grain of wheat irrigated with different grades of brackish water.

Brackish irrigation Water (EC iw dSm^{-1})		Low (0.7)			Medium (6.0)			High (12.0)		
t ha^{-1}	Varieties	G_0L_0	$G_{0.5}$	$L_{0.5}$	G_0L_0	$G_{0.5}$	$L_{0.5}$	G_0L_0	$G_{0.5}$	$L_{0.5}$
OMo	Akbar	0.12	0.13	0.15	0.17	0.19	0.16	0.20	0.21	0.18
	Agrani	0.14	0.16	0.16	0.16	0.18	0.16	0.19	0.19	0.20
	Kanchan	0.16	0.18	0.17	0.17	0.19	0.17	0.20	0.20	0.21
CD_{10}	Akbar	0.15	0.16	0.17	0.19	0.22	0.20	0.23	0.24	0.19
	Agrani	0.15	0.17	0.18	0.18	0.20	0.18	0.22	0.21	0.21
	Kanchan	0.18	0.20	0.19	0.18	0.20	0.18	0.21	0.21	0.19
Str_{10}	Akbar	0.17	0.16	0.19	0.19	0.19	0.17	0.20	0.21	0.19
	Agrani	0.15	0.16	0.17	0.18	0.18	0.20	0.20	0.20	0.20
	Kanchan	0.18	0.18	0.18	0.19	0.20	0.19	0.19	0.20	0.20

L.S.D(0.05) = 0.019

ation may be harmful for plant nutrients and may cause growth suppression due to the surplus of Na and deficiency of K and Ca. Sharma[2] stated that salt tolerant variety of wheat has the capacity to retard the absorption of high quantity of Na incomparison to K. Similar results were also reported by other investigators[9,10]. The content of K in wheat grain was found to be comparatively low in high brackish water irrigated plants. This indicates a nutritional imbalance with increasing salinity causing ion antagonism. A surplus of Na was shown to induce K deficiency in wheat plants growing in saline medium which was manifested in higher Na/K ratio in the plants with increasing salinity[11]. Lower K:Na ratio disturbed plant metabolic functioning and caused injury to wheat plant[12]. Excess absorption of Mg significantly depressed the uptake of both K and Ca by wheat plants and increase Na/K and Mg/Ca ratios in plant creating a grossly imbalanced nutrient status and consequently growth and yield. Aich *et al.*[1] reported that the growth of wheat became stunted and grain contents of N,P, Mg, S and Na progressively increased with increase in ECe of soil.

On the other hand, the concentration of K and Ca remain unchanged. Higher S content in grain may be attributed to the high concentration of S in irrigation water used. Addition of gypsum alone showed higher S content of grain and may be due to the presence of S in gypsum added to the soil.

References

1. Sharma S K 1983, *Indian J. Exptl. Biol.* **21** 690
2. Sharma S K 1989, *Indian J. Plant Physiol.* **32** (3) 200
3. Akbar M, Khush G S and Hillerislambers D 1986, *Proc. Intem. Rice Gentics Sym.* 27-31 May, 1985. Manila. Philippines. 399
4. Aich A C, Mandal R, Khan E H and Sarker O H 1993, *J. Indian Coastal Agric. Res.* **11** (2) 81
5. Yadav J S P and Girdhar 1 K 1981, *Soil Sci.* **131** 194
6. Verma TS and Tripathi B R 1986, Acta-Agronomics-Hungarica. **35** (1-2) 83
7. Chavan S A, Patil K D, Mehta V B and Chavan K N 1991, *J. Indian Soc. Agric. Res.* **9** (1/2) 303
8. Swarup A 1992, J. Indian Soc. *Soil Sci.* **40** 816
9. Hamdy A 1988, *Proc. 15th ICID European Regional Conf.* **2** 132
10. Maftoun M and Sepaskhah A R 1989, *Agrochimica.* **33** (1-2) 1
11. Finck A 1977, In: H E Dregne (ed): Managing Saline Water for Irrigation. Texas. Tech. Univ., Lubboek, Texas.
12. Gill K S and Dutt S K 1987, *Indian J. Agric. Sci.* **57** (6) 409