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IMPACT OF ORGANIC MATTER, LIME AND GYPSUM ON GRAIN YIELD OF WHEAT IN SALT AFFECTED SOILS IRRIGATED WITH DIFFERENT GRADES OF BRACKISH WATER

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A field experiment was conducted on the grain yield of three cultivars of wheat (Kanchan, Agrani and Akbar) in three coastal saline soils (Gopinathpur, Magura and Benerpota) irrigated with different grades of brackish water (0.7, 6.0 and 12.0 dSm^{-1}). The grain yield of wheat decreased significantly with the increase of salinity of irrigation water irrespective of treatments. Kanchan showed the best performance as compared to Agrani and Akbar. Use of organic matter (cowing/straw), gypsum and lime produced significantly higher yield irrespective of varieties, soils and quality of brackish water. Liming produced better results in acid saline soil (Magura) whereas gypsum proved its superiority in saline soil (Gopinathpur) and saline sodic soil (Benerpota). Addition of these ingredients in various combinations could reduce the salinity resulting higher yield. However, the reduction of grain yield due to saline water irrigation resisted more when organic matter was incorporated in the soil.

Keywords : Brackish water; Gypsum; Lime; Organic matter; Saline soil.

Introduction

Bangladesh has got a significant area (2.8 m ha) of coastal saline soil[1] with a very low productivity. Management of such soils with organic matter, lime, gypsum together with subsurface drainage has found to be beneficial to improve crop yield[2-4]. The coastal saline soils remain fallow during Rabi season due to high soil salinity and scarcity of quality irrigation water[5]. Kumar[6] reported that salt tolerant limit of wheat cultivars vary widely. Similar views are reported by Aich *et al*[7]. During November to February, the salinity of surface soil varies from 3 to 12 dSm^{-1} and might be suitable for cultivation of wheat[8]. Literature indicates that report on such amendments in Bangladesh is meagre. Thus, an experiment was designed to evaluate the effect of organic matter, gypsum, lime on grain yield of three cultivars of wheat in three salt affected soils irrigated with different grades of brackish water.

Materials and Methods

Experiments were conducted in three locations namely Gopinathpur, Magura and Benerpota under field condition in the Rabi season using wheat as a test crop. The land of each site was divided into two blocks. The blocks as well as the sub-blocks were surrounded by 1 m wide fallow land. In sublock, the plots (3mx2m plot) were separated from each other by 50 cm gap. A total of eighty one treatment combinations were arranged according to 3^4 factorial split plot design with two replications. The treatment combinations 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) : MOo, CD and Str representing (O 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}.

Table 1. Fertility status of 3 coastal saline soils.

Location	Depth (cm)	ECe (dSm^{-1}) at 25° c	pH 1:2.5	Organic 'c' (%)	Total N (%)	CEC (meq $100g)^{-1}$	Exchangeable bases (meq $100g)^{-1}$				Available nutrients						Active		Fe/ Mn	ESP
							Na	K	Ca	Mg	N mg $100g^{-1}$	SO_4 meq L^{-1}	Olsen's 'p'	B	Zn	Cu	Fe % (%)	Mn ($Mgkg^{-1}$)		
														$mgkg^{-1}$						
	0-15	5.48	8.0	0.88	0.08	23.6	3.4	0.5	10.2	9.4	7.6	25.3	9.2	1.40	0.4	0.3	0.49	570	8.6	14.4
S_1	15-30	5.96	8.2	0.83	0.07	24.8	3.8	0.4	12.2	9.1	5.1	28.1	7.8	1.31	0.7	0.1	0.49	600	8.2	15.3
	30-60	6.33	8.4	0.75	0.06	25.8	4.1	0.7	10.3	10.5	3.4	17.8	6.5	1.3	0.6	Tr	0.46	533	8.7	15.8
	0-15	5.18	5.9	1.18	0.12	30.1	4.4	0.9	10.5	14.2	7.2	22.5	13.0	1.96	1.0	0.4	0.37	40	92.5	14.6
S_2	15-30	2.83	6.2	1.06	0.10	30.8	4.9	0.6	10.8	14.3	7.1	13.0	9.8	1.68	0.9	0.2	0.15	27	55.5	15.9
	30-60	2.02	6.8	0.46	0.06	32.2	5.9	0.6	10.6	14.5	3.5	10.5	7.5	1.56	0.8	Tr	0.14	18	77.5	18.3
	0-15	3.37	8.0	0.94	0.11	28.9	4.8	0.6	12.6	10.8	4.9	12.5	10.8	1.20	0.4	0.2	0.36	150	24.0	16.6
S_3	15-30	2.18	8.0	0.20	0.09	29.4	5.0	0.4	12.4	11.5	4.2	7.5	6.4	0.88	0.2	0.2	0.35	130	26.9	17.0
	30-60	2.58	8.4	0.63	0.07	31.3	5.5	0.3	13.9	11.6	4.8	10.9	5.2	1.04	0.2	Tr	0.26	200	13.0	17.5

S_1 = Gopinathpur; S_2 = Magura and S_3 = Benerpota.

Table 2. Influence of organic matters, gypsum and lime on grain yield (t ha^{-1}) of wheat in Gopinathpur soil irrigated with different grades of brackish water in field.

Brackish Irrigation water (Eciw dSm^{-1})		Low (0.70)			Medium (6.0)			High (12.0)		
t ha^{-1}	Varieties	GoLo	Go.5	Lo.5	GoLo	Go.5	Lo.5	GoLo	Go.5	Lo.5
	Akbar	2.48	2.71	2.82	1.92	1.99	2.53	1.70	2.01	2.23
OMo	Agrani	2.88	3.38	3.14	2.37	2.40	2.44	1.80	2.28	2.31
	Kanchan	3.31	3.44	3.32	2.90	3.13	2.88	1.84	2.18	2.59
	Akbar	2.60	3.38	3.20	2.41	2.40	2.56	2.17	2.27	2.31
CD_{10}	Agrani	2.95	3.44	3.55	2.56	2.48	2.82	2.19	2.40	2.31
	Kanchan	3.51	3.51	3.51	2.99	3.13	3.02	2.40	2.36	2.90
	Akbar	2.44	2.69	3.10	2.36	2.21	2.94	2.16	2.26	2.28
Str_{10}	Agrani	3.25	3.57	3.37	2.53	2.65	2.36	2.88	2.41	2.35
	Kanchan	3.54	3.62	3.84	3.12	3.27	3.05	2.31	2.38	2.80

L.S.D. (0.5)=0.27

Table 3. Influence of organic matters, gypsum and lime on grain yield (t ha^{-1}) of wheat in Magura soil irrigated with different grades of brackish water in field.

Brackish Irrigation water (Eciw dSm^{-1})		Low (0.70)			Medium (6.0)			High (12.0)		
t ha^{-1}	Varieties	GoLo	Go.5	Lo.5	GoLo	Go.5	Lo.5	GoLo	Go.5	Lo.5
	Akbar	2.86	3.05	3.05	2.85	3.07	2.80	2.12	2.32	2.44
OMo	Agrani	3.06	3.30	3.06	2.79	3.24	2.82	2.04	2.28	2.49
	Kanchan	3.18	3.25	3.65	3.04	3.24	3.22	2.37	2.44	2.43
	Akbar	3.67	3.90	3.78	3.22	3.42	3.31	2.47	2.66	2.62
CD_{10}	Agrani	3.67	4.19	4.09	3.17	3.44	3.58	2.32	2.69	2.96
	Kanchan	3.51	4.10	4.90	3.28	3.76	3.64	2.50	2.76	2.82
	Akbar	3.61	3.90	4.05	3.11	3.29	3.20	2.30	2.48	2.37
Str_{10}	Agrani	3.62	4.81	3.75	3.19	3.32	3.42	2.34	2.42	2.48
	Kanchan	3.71	3.85	3.95	3.02	3.11	3.24	2.42	2.44	2.92

L.S.D. (0.5)=0.22

GoLo = Gypsumand lime (Ot ha^{-1}); G = Gypsum and L = lime

OM_o = Organic matter (Ot ha^{-1}); CD = Decomposed cowdung, Str = Decomposed straw

Table 4. Influence of organic matters, gypsum and lime on grain yield (t ha^{-1}) of wheat in Benerpota soil irrigated with different grades of brackish water in field.

Brackish Irrigation water (Eciw dSm^{-1})		Low (0.70)			Medium (6.0)			High (12.0)		
t ha^{-1}	Varieties	GoLo	Go.5	Lo.5	GoLo	Go.5	Lo.5	GoLo	Go.5	Lo.5
OMo	Akbar	3.10	3.21	3.38	2.61	2.97	3.00	1.58	2.19	2.02
	Agrani	3.10	3.12	3.56	2.71	2.98	2.97	2.24	2.26	2.36
	Kanchan	3.15	3.26	3.60	2.94	3.00	2.95	2.38	2.38	2.39
CD_{10}	Akbar	3.35	3.35	3.52	3.02	3.06	3.40	2.56	2.25	2.36
	Agrani	3.40	3.46	3.50	2.88	3.12	3.07	2.53	2.53	2.66
	Kanchan	3.61	3.50	3.75	3.10	3.18	3.11	2.78	2.57	2.95
Str_{10}	Akbar	3.20	3.21	3.36	2.58	2.81	3.02	2.26	2.25	2.34
	Agrani	2.95	3.40	3.37	2.60	3.12	3.16	2.30	2.60	2.50
	Kanchan	3.56	3.60	3.60	2.86	3.12	2.98	2.65	2.68	2.82

L.S.D. (0.5)=0.18
GoLo = Gypsumand lime (Ot ha^{-1}); G = Gypsum and L = lime
OM_o= Organic matter (Ot ha^{-1}); CD = Decomposed cowdung, Str = Decomposed straw

The organic matters 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 dose at the time of final land preparation. The remaining two third of N was top dressed equally, one at crown root (20 days after sowing) and the other at panicle initiation stage (40 days after sowing) of growth.

The lands were 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 (weeding, hand hoeing and spraying) practices were followed althrough till harvesting. Irrigation was given as per schedule on 20, 40, 60 and 80 days after sowing with 5 cm depth of water each time. Some physicochemical properties of the soil before initiation of the experiment was determined by standard method (Table 1). Grain yields was recorded at maturity.

Results and Discussion

It is apparent from the results that grain yield of wheat grown in three salt affected soils decreased significantly with the increase in salinity from 0.7 dSm^{-1} to 12.0 dSm^{-1} of irrigated water (Table 2-4). Use of cowdung, straw, lime and gypsum produced significantly higher yield irrespective of the varieties and soils. Liming showed better results in Magura soil whereas gypsum proved its superiorty in Gopinathpur and Benerpota soil. Application of all these ingredients could reduce the salinity resulting higher yield. Cowdung and straw were almost equally effective to modify the salinity. Nevertheless, the decline was resisted more when organic matter was incorporated. Kanchan showed the best performance as compared to Agrani and Akbar.

In Gopinathpur soil, Kanchan appeared to be better than Agrani and Akbar (Table 2). Gypsum was found rather relatively better than lime in increasing yield. But in presence of cowdung, the distinction could

not be made. So also was found in straw treated plots in low brackish water. The increase in yield due to gypsum or lime was statistically significant. Straw and cowdung in combination with gypsum/lime were equally potant except in few treatments.

The yield reduction due to higher salinity, that is in medium brackish water was about 20%. Gypsum/lime treated plot, yield was comparable to that of control of the low brackish water treated ones. So, the application of gypsum/lime appeared to resist the yield decline significantly. Nevertheless, organic matter and lime together could not make any significant difference. Addition of organic matter along with lime is no way significantly better than individual treatments of lime and organic matter.

In high brackish water, the yield decline was about 40% in comparison with the low brackish water control. Application of gypsum/lime lowered the percent decline and the result was nearer. In this case also, application of organic matter along with lime no way was significantly better than lime alone or organic matter alone treated ones.

From the Table 2, it is apparent that in higher salinity range of irrigation water, combination of gypsum/lime and organic matter or Ca bearing materials (gypsum/lime) could do the job nearly to the satisfaction.

In Magura soil, Kanchan again topped the list of the cultivars used and the yield percent on an average was more or less same irrespective of cases as in Gopinathpur soil (Table 2). Barring a few fluctuating data (Table 3), one could have same conclusion as in Gopinathpur soil.

In this soil, gypsum in low brackish water appeared to be better when used alone and in presense of lime, but in presence of organic matter this distinction has virtually disappeared. But in the medium and high salinity water, the yield was significantly better than Gopinathpur soil irrespective of the treatments and that may be due to the inherent property of the soil which could counter itself with the added saline water.

Addition of lime in Magura soil increased yield significantly. The soil of Magura is acid saline soil in nature (Table 1). Bandyopadhyay[9] stated that the appplication of lime increased grain yield of rice in acid saline soils of Sundarbans. Benerpota soil was found to be more suited for wheat cultivation when irrigated with low brackish water irrespective of treatments (Table 4). The rest of the Table (medium and high brackish water) bears lose resembles to that of Gopinathpur and Magura soil. Kanchan in all the three soils can be successfully cultivated using gypsum/lime along with organic matter using saline water irrigation. There are wide varietal difference in wheat with respect to salt injury[7]

The decline in yield with increasing salinity might possibly be due to the Na stress in tissues impairing plant growth. It may be due to the fact that when wheat plants are continuously exposed to saline media, salinity affects panicle initiation, spikelet formation, fertilization of florets and germination of pollen grains and hence causes an increased number of sterile florets[10]. The decrease in grain yield of wheat with increased salinity was also reported by other investigators[2,7,11-17]. Addition of organic matter produced higher yield irrespective of quality of irrigation water and varieties. The manure enchance the suitability of saline water for irrigation has been recognised widely[2-4] Addition of gypsum increased yield of wheat.

Mahajan *et al*[16] reported that gypsum treated soil increased yield of grain and straw of wheat significantly. Similar views were reported by other investigators[17,18]

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