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IMPACT OF ORGANIC MATTER, LIME, GYPSUM AND BRACKISH WATER ON GRAIN YIELD OF RICE IN COASTAL SALINE SOIL

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ABSTRACT

Impact of brackish waters (ECiw 0.7, 2.5 and 5.0 dSm^{-1}), organic matters (cowdung/straw, 10t ha^{-1}), gypsum (0.5 t ha^{-1}) and lime (0.5 t ha^{-1}) individually or combinedly on the grain yield of three cultivars of rice (BR3, BR15 and Iratom 24) in salt affected soil of Gopinathpur was studied. All the cultivars of rice whether treated with cowdung, straw, gypsum and lime or not, the yield declined successively with increase of brackishness of irrigation waters. Nevertheless, the decline was resisted more significantly when organic matter (cowdung or straw) was incorporated than lime or gypsum. The decline in grain yield was roughly 30 and 66% due to medium and high brackish water. In all brackish water irrigated condition, addition of gypsum in presence of organic matter performed better than that of lime. There is a positive retardation in decline in yield of rice from treated soil when medium brackish water was used instead of low brackish water.

INTRODUCTION

The dry season salinity affected area is about 0.87 m ha in the southern districts of Bangladesh (Saheed, 1992). Plant growth vis-a-vis low yield in saline soil due to the prevalence of excess salt is quite conceivable. These soils are mostly monocropped with wetland rice grown during monsoon and remain generally fallow during rest of the year due to high soil salinity and scarcity of fresh water. A number of investigations on saline soil used organic matter from different sources and got more yield of rice (Bandyopadhyay and Bandyopadhyay, 1984; Saravanan *et al.*, 1991). Experiments were also conducted to counterbalance the injurious impact of salinity by the application of lime or gypsum and found encouraging results (Bandyopadhyay, 1986; Singh and Singh, 1989; Ahmed *et al.*, 1990; Sekhan and Bajwa, 1993). Aich *et al.* (1996) reported

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that yield of rice, (BR3) grown in saline soils could be boosted up by using these amendments under low (ECiw 1.2 dSm^{-1}) brackish water irrigation water. However, no information is available regarding their interactions under different grades of brackish water irrigation on yield of rice. So a green house experiment was designed to find out the impact of organic matter, gypsum and lime on grain yield of three cultivars of rice in saline soil irrigated with low, medium and high brackish water.

MATERIALS AND METHODS

A pot culture experiment was conducted in coastal saline soil collected from Gopinathpur of Satkhira District. The pots (35 cm × 30 cm) were filled up with air dried soil (0-15 cm, 15 kg, 2 mm sieve) and the soil was irrigated with water of three different EC, mixed with organic matter (decomposed cowdung and straw), gypsum and lime, and three cultivars of rice 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-thirds of N was top dressed in two equal splits: one at active (30 DAT*) and the 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 = O t organic matter ha^{-1}, CD = Decomposed cowdung (10 t ha^{-1}), Str = Decomposed straw (10 t ha^{-1}).

Gypsum (G) and Lime (L), GoLo= Gypsum and Lime O t ha^{-1}; $G_{0.5}$ = Gypsum 0.5 t ha^{-1}; $L_{0.5}$ = Lime 0.5 t ha^{-1}.

Rice Cultivars : BR3, BR15 and Iratom 24.

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.

* DAT = Days after transplantation

Seedlings of three cultivars 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 (EC 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. Some physico-chemical properties of soil before initiation of experiment (Table I) and chemical composition of decomposed cowdung and straw (Table II) were determined by standard methods. The grain yield was recorded.

RESULTS AND DISCUSSION

Water type suppressive yield effect and treatments boosting effect on yield of rice are laid down below (Table III).

In low brackish water irrigated pots, BR3, BR15 and Iratom 24 showed their varietal yield differences (35.0 to 39.4 g pot^{-1}). Of course, BR3 (38.39 g pot^{-1}) and Iratom 24 (39.4 g pot^{-1}) did not show much difference in yield and same trend persisted even when gypsum and lime were incorporated. It is noticeable that gypsum created impact on three varieties giving significantly higher yield and this impact is more pronounced in BR3 (43.75 g pot^{-1}) and BR15 (40.5 g pot^{-1}) than Iratom 24(41.8 g pot^{-1}) whereas, in fact, lime influenced the yield positively but not significantly (37.8 - 40.6 g pot^{-1}).

Soil treated singly with cowdung showed an enhanced production of grain significantly and more than what was obtained with gypsum though the apparent difference is not significant. In this case, BR15(41.4 g pot^{-1}) and Iratom 24 (41.0 g pot^{-1}) came at par as in the case of gypsum. Cowdung with gypsum and lime conjugated pots resulted increased yield significantly. However, BR15 and Iratom 24 responded more with gypsum than lime. The average increase with cowdung alone was approximately 13%.

Table I. Some physico-chemical properties of soil before initiation of experiment (0-15 cm).

ECe dSm^{-1}	p^H	Organic matter (%)	Total N (%)	CEC meq $100g^{-1}$	Exchangeable bases (meq $100g^{-1}$)				ESP
					Na	K	Ca	Mg	
14.3	8.3	1.55	0.09	23.8	3.6	0.6	10.3	9.2	15.1

Available nutrients						Mechanical composition			Texture
N mg $100g^{-1}$	SO_4 meq L^{-1}	mg kg^{-1}				Sand	Silt	Clay	
		Olsen's P	B	Zn	Cu	%	%	%	
6.5	21.3	9.8	1.6	0.6	0.3	29	42	29	Clay Loam

Table II. Mineral composition of decomposed cowdung (CD) and decomposed straw (Str.)

Parameters	CD	Str.	Parameters	CD	Str.
Organic Carbon (%)	37.8	12.5	Zinc (mg kg^{-1})	75.5	65.5
Total N (%)	1.68	0.85	Copper (mg kg^{-1})	18.0	16.0
Total P (%)	0.18	0.07	Iron (mg kg^{-1})	165	148
Total K (%)	2.35	0.59	Manganese (mg kg^{-1})	330	310
Total S (%)	0.18	0.15	Moisture(%)	62.5	54.8
Calcium (%)	0.58	0.52	Available N (mg 100 g^{-1})	28.6	16.2
Magnesium (%)	0.75	0.28			

Table III Influence of organic matters, gypsum and lime on grain yield (g pot^{-1}) of rice in Gopinathpur soil irrigated with different grades of brackish water in pot.

Brackish irrigation water (ECiw dSm^{-1})		Low (0.7)			Medium (2.5)			High (5.0)		
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	$G_{0.5}$	$L_{0.5}$
OM_0	BR3	38.3	43.75	40.4	26.4	32.0	28.7	13.5	15.5	14.8
	BR15	35.0	40.5	37.8	25.9	29.9	27.7	12.6	13.4	12.2
	Iratom24	39.4	41.8	40.6	26.4	31.1	30.0	11.2	13.6	11.6
CD_{10}	BR3	45.3	46.3	46.2	35.9	41.2	40.1	16.9	17.5	16.3
	BR15	41.4	43.3	40.2	29.5	31.5	30.6	15.4	16.1	16.2
	Iratom24	41.0	44.4	40.4	29.3	39.9	30.9	15.9	17.2	16.3
Str_{10}	BR3	38.9	45.3	44.0	32.3	42.2	35.5	16.9	17.3	16.3
	BR15	38.3	45.8	42.6	27.1	33.0	31.6	13.5	16.1	14.3
	Iratom24	40.6	43.4	37.4	31.5	36.6	31.6	13.8	16.6	14.9

L. S. D. (0.05) = 3.53

OM_0 = Organic matter (0 t ha^{-1}); CD = Cowdung; Str = Straw.

G_0L_0 = Gypsum and lime (0 t ha^{-1}); G= Gypsum; L = Lime.

Organic matter in the form of straw alone could not alter the yield much in comparison with the controls; but the yield increase bounds up when gypsum and lime were added together with straw, the yields were approximately at par with cowdung-gypsum or cowdung-lime. The overall situation showed that in low brackish water irrigated controls, organic matters (cowdung or straw) in association with gypsum and lime give significantly higher yield.

In the medium brackish water irrigated pots, the yield declined significantly (roughly 30%) as supposed to be and all varieties leveled off their differences in yield (25.9 to 26.4 g pot^{-1}). Addition of gypsum and lime geared up the yield by about 15-22% and 7-14% respectively over the medium brackish water controls. So it is obvious from the data that gypsum as in low brackish water was found to be more effective (8% higher) than lime. Addition of cowdung helped to increase the yield (5-18%; average 13% higher than the control) significantly than that of gypsum or lime treated ones. Though the varietal differences almost disappeared in the control but cropped up again when treated with gypsum and lime along with cowdung and had the same sequence as in low brackish water just like gypsum and lime; cowdung could not mar the difference between BR3 and BR15 or Iratom 24. However, BR3 gave the highest yield (35.9g pot^{-1}). This varietal trend persisted even when gypsum/lime were added with cowdung.

Addition of cowdung along with gypsum or lime produced higher yield. The yield recorded by the application of gypsum, cowdung and cowdung + lime were nearly concurrent in all varieties but BR3 was found more responsive than BR15 and Iratom 24 to cowdung and cowdung + lime. The yield obtained with cowdung was found almost at par with that of gypsum applied ones although both gypsum and lime in association with cowdung rendered positive influence on yield, but the differential (5-12%) impact of gypsum and lime in presence of cowdung was also glaringly apparent. Here also gypsum was found to be more effective than lime.

Addition of straw was found to boost up the grain yield over the medium brackish water control, but not so much in

comparison with cowdung (4-22% vs 11-36%). In presence of straw, the potency of gypsum and lime were found to be different as before (gypsum was more effective, 27-59% than lime, 9-22%). The overall picture was that the difference in influence between cowdung and straw disappeared when both were supplemented with gypsum and lime. This indicates that in medium brackish water there is a possibility of getting high yield by the application of organic matters and gypsum or lime together.

It reveals that the yield of rice provided with medium brackish water irrigation in saline soil supplied with organic mattters together with Ca containing materials was nearly at par to that of the control in low brackihsh water irrigated soil.

In high brackish water, the yield was further reduced about 1/3 as compared with low brackish water irrespective of treatments. Gypsum and lime raised the harvest up from the high brackish water control (gypsum 6-21%; lime 3-10%), though not upto the expectation (gypsum 27-59%, lime 9-22% as in medium brackish water). Gypsum was found more effective than lime irrespective of treatments. Cowdung as in low brackish water surpassed the impact of gypsum and lime (gypsum 6-16%; lime 3-8% and cowdung 22-42%). Supply of gypsum and lime in addition to cowdung increase the yield (gypsum + cowdung 28-54% and lime + cowdung 21-46%) almost equally as in medium brackish water (gypsum + cowdung 22-56% and lime + cowdung 18-52%).

Straw alone also enhanced the yield (7-25%) but not so much as cowdung (22-42%); nevertheless, both gypsum and lime along with straw rendered nearly the same yield.

So far as the varieties are concerned, all of them performed almost equally (11.2 to 13.5 g pot^{-1}) but BR3 was found better than others if the soil was supplied with organic matters, gypsum, lime and other combinations.

Many workers (a few of them) worked with salt affected soil by incorporating different kinds of organic matters and chemical amendments and found beneficial results (Bandyopadhyay and Bandyopadhyay, 1984; Dravid and Goswami, 1987; Saravanan

et al., 1991; Shivakant and Rajkumar, 1992; Swarup, 1992). However, they did not use combination of organic matter and liming materials under different grades of brackish water irrigation management. Results obtained from gypsum treatment were in accord with that of Singh and Singh (1989) where the use of gypsum has been found to produce higher yield of wheat. Sekhan and Bajwa (1993) used the combined treatment for rice, wheat and maize in sodic soil and found significantly higher yield. Similar views were reported by Aich *et. al.* (1996). The retardation of yield might be due to Na in soil and the Na in irrigation water added. These two toghether make preponderance of Na which might have repressed the ionization when no treatment was given.

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