Research Paper Published: 11.03.2015, Vol. 03 (02): 65-72

Effect of Farm Yard Manure, Gypsum and Nitrogen on Growth and Yield of Rice in Saline Soil of Satkhira District, Bangladesh

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Abstract

A field experiment was conducted at the sub-station farm of Bangladesh Institute of Nuclear Agriculture (BINA), Satkhira, to observe the effect of Farm yard manure (FYM), Gypsum and Nitrogen levels on growth and yield of rice (cv. Binadhan-8). The experiment was laid out in a RCBD split-plot design with three replications. Treatments consisted of five FYM and Gypsum combinations in main plot, which were S_0: Control, S_1: FYM 5 tha^{-1} + Gypsum 140 $kgha^{-1}$, S_2: FYM 5 tha^{-1} + Gypsum 210 $kgha^{-1}$, S_3: Gypsum 210 $kgha^{-1}$ and S_4: FYM 5 tha^{-1}. Four nitrogen levels were assigned in sub-plots viz. N_1: 50 kg Nha^{-1}, N_2: 75 kg Nha^{-1}, N_3: 100 kg Nha^{-1} and N_4: 125 kg Nha^{-1}. The study revealed that different FYM and Gypsum combinations along with different N levels have significant effect on growth and yield of rice. Mean effect of FYM and Gypsum combinations found the highest for grain (3.69 tha^{1}) and straw (6.60 tha^{-1}) yield where plot received FYM @ 5 tha^{-1} +Gypsum 210 $kgha^{-1}$. Considering the mean effect of different N levels, when the plant received 125 kg Nha^{-1} then the maximum grain and straw yield of rice were observed as 3.81 and 6.91tha^{-1}, respectively. Due to the interaction effect of both FYM and Gypsum combinations and N levels, the maximum grain yield of rice was found as 4.39 tha^{-1} under the treatment combination of S_2N_4, i.e., FYM @ 5 tha^{-1} and Gypsum 210 $kgha^{-1}$along with 125 kg Nha^{-1}.

Key words: *FYM, Nitrogen, Gypsum, Rice and Saline soil*

I. Introduction

Bangladesh is a deltaic country with the area of 147,570 m^2 in size of which includes more than 30% of net cultivable land; about 20% of the total area is covered by the coastal region which is almost 2.85 million hectare, out of this area about 0.83 million hectare lands can be utilized for crop production (Rasel *et al*., 2013). Salinity is one of the major problems in the agricultural aspects of Bangladesh; it is considered that salinity may generate due to the change in climate and rise of the sea levels especially in the southern area of the country (Ziaul and Zaber, 2013). Salinity creates an adverse environment and hydrological condition that retards crop growth and development and causes reduced yield; it is considered that, the development of soil salinity is caused by two vital reasons, one of them is direct tidal flooding during wet season and another is capillary upward movement of saline ground water during dry season (Haque, 2006). In the past, salinity in the country received very little attention but due to increasing pressure of growing population and demand for more food it has become very important to explore the possibilities of increasing the potentiality of these (saline) lands for sustainable crop production. Saline soils can be made to yield a good crop through proper management practices. In this respect, the development of the most suitable reclamation technology or a combination of technologies is important to optimize farm management and better crop yields. Addition of organic amendments to soil improves soil properties and it is highly accepted by the farmers (Prapagar *et al*., 2012). Gypsum is the most commonly used amendment due to its availability at low cost. Joachim *et al*. (2007) attributed the beneficial effect of combined use of farm yard manure and Gypsum on the reclamation of sodic soils. Fertilizers containing nitrogen has a significant role in crop production, and both environmental and economic impact (UN-DSD, 2000). Over fertilization with N may contribute to soil salinization and increase the negative effects of soil salinity on plant performance (Villa-Castorena *et al.*, 2003). This experiment was undertaken to observe the effect of different FYM and Gypsum combinations with nitrogen levels and their interaction on the growth and yield of BINA released rice variety (cv. Binadhan-8) under saline soil.

II. Materials and Methods

The experiment was conducted at BINA substation farm, Benorpota, Satkhira (22^o45'N latitude and 89^o4'6E longitude) during the Boro season of 2013 (January to April, 2013). The land belongs to AEZ 13, Ganges Tidal Floodplain and the soil was silty clay in texture, having pH 8.0, total N 0.10%, available P 7.0 mg kg^{-1}, available K 0.082 meq/100g and available S 13.5 mg kg^{-1} (Table 01). The salinity value of initial soil is 6.2 dsm^{-1}; this is considered as very slight saline to slight saline soil (SRDI, 2010). The experiment was laid out in a split-plot design with three replications, where five FYM and Gypsum combination treatments were assigned in main plots viz. S_0: Control, S_1: FYM 5 tha^{-1} + Gypsum-140 $kgha^{-1}$, S_2: FYM 5 tha^{-1} + Gypsum 210 $kgha^{-1}$, S_3: Gypsum 210 $kgha^{-1}$ and S_4: FYM 5 tha^{-1} and nitrogen levels were assigned in sub-plots viz. N_1: 50 kg Nha^{-1}, N_2: 75 kg Nha^{-1}, N_3: 100 kg Nha^{-1} and N_4: 125 kg Nha^{-1}. The test rice variety was Binadhan-8, which was released from BINA as a salt tolerant Boro rice which can tolerate 10 dsm^{-1} of EC value (Sinha *et al.*, 2014). Total amount of TSP, MoP and Gypsum were added as broadcast during final land preparation (BARC, 2012). N fertilizer was applied as urea in three equal splits as i) at three days of transplanting, ii) 28 days of transplanting (tillering stage) and iii) 50 days of transplanting (panicle initiation stage). Intercultural operations were done as when required. The yield parameters - plant height, panicle length, number of plant $hill^{-1}$, number of grains $panicle^{-1}$ and grain and straw yield data were recorded at maturity during rice harvest. The analysis of variance for various crop characters was done following the F-statistics. Mean comparisons of the treatments were made by Duncan Multiple Range Test (DMRT) test.

Table 01. Initial soil status of experimental field at Satkhira, Bangladesh

Parameter	Test Value	Analytical Methods
% Sand	8.00	Hydrometer Method (Black, 1965)
% Silt	55.00	
% Clay	37.00	
Texture	Silty clay	
% OM	1.13	Wet Oxidation (Nelson And Sommers, 1982)
pH	8.00	Glass Electrode Method (Jackson, 1962)
EC	6.2 dS/m	EC meter
% N	0.10	Micro-Kjeldahl (Jackson, 1962)
P	7.0 $mgkg^{-1}$	Olsen method (Olsen *et al.* 1954)
% K	0.082 meq/100g soil	Flame Photometer (Page *et al.*,1982)
S	13.5 mg kg^{-1}	Turbidity Method (Page *et al.*,1982)

III. Results and Discussion

Mean effect FYM and Gypsum combinations on growth and yield of rice (cv. Binadhan-8)

The mean effect of different FYM and Gypsum combinations showed significant resultson plant height, number of effective tiller hill^{-1}, number of grains panicle^{-1}, grain and straw yield of rice (Table 02). The tallest plant (105.50cm) was observed from the treatment S_2, where the plant received FYM 5 tha^{-1} + Gypsum 210 kgha^{-1} and the shortest plant of 97.00cm height was found in control treatment. Similar findings were noted from the study of Abro and Mahar (2007). In case of panicle lengthand number of effective tiller hill^{-1} in rice did not show any significant resultsdue to application of FYM and Gypsum combinations. The number of grains panicle^{-1} was significantly influenced by the application of different FYM and Gypsum combinations. The highest number of grains panicle^{-1} (151.80) were observed in S_2 (FYM 5 tha^{-1} + Gypsum 210 kgha^{-1}) treatment, whereas the lowest value of 118.50 grains panicle^{-1} was found in control treatment. Grain and straw yield of Binadhan-8 responded significantly to the application of different FYM and Gypsum combinations in the field before rice transplanting (Table 02). The maximum grain yield (3.69 tha^{-1}) was recorded under the treatment of S_2 (FYM 5 tha^{-1} + Gypsum 210 kgha^{-1}), whereas the minimum yield of 2.82 tha^{-1} was observed in S_0 (control) treatment. Regarding the straw yield of rice, similar trends were observed and the highest (6.60tha^{-1}) and lowest (5.06 tha^{-1}) yield were obtained from the treatment S_2 (FYM 5 tha^{-1} + Gypsum 210 kgha^{-1}) and S_0 (control), respectively. From the study of Zakir *et al.* (1997), it was noted that application of FYM with Gypsum was the best in obtaining highest number of filled grains which might be occurred by the reduction of sodium ion concentration in these treatment over control. Again, use of gypsum and FYM in saline soil may be used as suitable amendment that may reduce the plant injury from the injurious level of salts present in soil (Suriyan *et al.*, 2011) may enhance physiological growth and increased the grain and straw yield of rice.

Mean effect of different levels of Nitrogen on the growth and yield of rice

Different levels of N showed a significant result on the growth (plant height, panicle length, number of effective tiller hill^{-1}, number of grains panicle^{-1}) and yield of rice (Table 03). Among the different levels of N, the tallest rice plant of 105.00cm was noticed in the plot where 125 kg Nha^{-1} was applied and the shortest plant was observed under control plot where only 50kg Nha^{-1} was applied. The increase in plant height due to application of increased level of nitrogen might be associated with stimulating effect of nitrogen levels on various physiological processes including cell division and cell elongation of the plant (Alim, 2012). Due to the application of different levels of N the panicle length of rice was also varied significantly and the maximum panicle length (25.48cm) obtained in N_4 treatment (125 kg Nha^{-1}) which was also statistically similar to N_3 (100 kg Nha^{-1}) with value 24.8cm and the minimum panicle length (23.67cm) observed by N_1 treatment (50 kg Nha^{-1}). Salahuddin *et al.* (2009) reported that nitrogen nutrient takes part in panicle formation as well as panicle elongation; as a result, length of panicle increases with the increasing level of nitrogen up to the rate 150 kgha^{-1}. In case of number of effective tiller hill^{-1} different levels of nitrogen varied significantly which ranged from 12.57 in N_4 treatment to 14.63 in N_1 treatment (Table 03). Similar result was found from the research findings of Khan *et al.* (2010); they stated that the highest number of effective tillers hill^{-1} was produced by high rate of nitrogen and the lowest number of effective tillers hill^{-1} was produced by the low rate of nitrogen. Regarding the number of grains panicle^{-1} in rice there was a marked influence was noticed by the application of different levels of nitrogen. The highest number of grains panicle^{-1} (137.70) was observed in N_4 where nitrogen was applied as 125 kgha^{-1}and the lowest (130.50) number was found in N_1 (50 kg Nha^{-1}) treatment. The vegetative growth of the plant was increased by the application of high rate of nitrogen. Carbohydrate assimilation was increased due to the maximum photosynthesis from maximum vegetative growth of the plant. As a result, the number of grain panicle^{-1} was highest due to the high rate of nitrogen (Khan *et al.*, 2010). Results also showed that there was a marked influence on grain yield by the application of different doses of nitrogen. The highest grain yield (3.81tha^{-1}) was observed in N_4 (125 kg Nha^{-1}) which was statistically similar to N_3 (100 kg Nha^{-1}) that obtained 3.44 tha^{-1} but the lowest grain yield (2.42 tha^{-1}) was obtained from N_1 (Table 03). From the study it revealed that yield contributing characters, i.e., panicle length, number of effective tiller $hill^{-1}$, number of grains $panicle^{-1}$ increased with the higher rate of nitrogen application may lead to higher grain yield. Grain yield of rice increases with the increasing N rate up to a certain level, similar result also reported by Salahuddin *et al*. (2009).

Interaction effect of FYM and Gypsum combinations and Nitrogen on growth and yield of rice

From the Table 04, it was observed that the interaction effect of different FYM and Gypsum combinations along with the different levels of nitrogen fertilizer showed a significant result on the growth and yield of rice cultivated in saline soil (Table 04). Among the different treatment combinations, the tallest rice plant of 109.00cm was found under the treatment combination of S_2N_4, where nitrogen fertilizer was applied (125 $kgha^{-1}$) along with the Gypsum (210 kg ha^{-1}) and FYM (5 tha^{-1}). The shortest plant of 94.53cm was observed as under the treatment combination of S_0N_1. Regarding the panicle length of rice, the interaction effect of different FYM and Gypsum combination and nitrogen levels also showed significant result and the maximum length of rice panicle (26.33cm) was found under the treatment combination of S_1N_4 (FYM 5 tha^{-1} + Gypsum 140 $kgha^{-1}$ with 125 kg Nha^{-1}). Hence, the minimum length rice panicle (12.00cm) was recorded from the treatment S_4N_1. In case of the number of effective tiller $hill^{-1}$, the value ranged from 12.00 inS_4N_1 to 15.60 in S_2N_4 treatment. Considering the number of grains $panicle^{-1}$, highest (155.00) number was found under the treatment combination of S_2N_4 which was statistically identical to S_1N_4 (with value 153.30) but the lowest (112.20) number of grains $panicle^{-1}$ was obtained in S_0N_1 (Control with 50 kg Nha^{-1}) combination (Table 04). Like other parameters, the grain yield of Binadhan-8 rice significantly influenced by the interaction of both FYM and Gypsum combinations and different levels of nitrogen (Figure 01). The maximum grain yield of 4.39 tha^{-1} was obtained from S_2N_4 (FYM 5 tha^{-1} + Gypsum 210 $kgha^{-1}$ with 125 kg Nha^{-1}) which was also statistically identical (4.25 tha^{-1}) to the S_2N_3 treatment and the minimum yield of 1.98 tha^{-1} was found in S_0N_1 (Control with 50 kg Nha^{-1}) treatment. Similarly, the highest and lowest straw yield of rice was noticed as 7.72 and 3.63 tha^{-1} from the treatment combination of S_2N_4 and S_0N_1, respectively (Figure 02).

Table 02. Effect of FYM and Gypsum combinations on yield and yield contributing characters of rice (cv. Binadhan-8)

Soil amendments	Plant height (cm)	Panicle length (cm)	No. of effective tiller $hill^{-1}$	No. of grain $panicle^{-1}$	Grain yield (tha^{-1})	Straw yield (tha^{-1})
S_0	97.00b	24.82	13.02	118.50d	2.82d	5.06e
S_1	103.10a	25.15	13.77	141.70b	3.20b	6.10b
S_2	105.50a	24.40	13.98	151.80a	3.69a	6.60a
S_3	103.40a	24.65	13.42	133.30c	3.09bc	5.88c
S_4	99.01b	23.82	13.23	127.00c	3.01c	5.68d
Level of Significance	*0.05*	*NS*	*NS*	*0.05*	*0.05*	*0.05*
LSD	*2.723*	*1.370*	*1.804*	*6.699*	*0.163*	*0.084*

S_0 = No amendment, S_3 = Gypsum 210 $kgha^{-1}$, S_1 = FYM (5 tha^{1}) + Gypsum 14 $kgha^{-1}$, S_4 = FYM (5 tha^{1}), S_2 = FYM (5 ha^{1}) + Gypsum 210 $kgha^{-1}$

Table 03. Effect of nitrogen levels on yield and yield contributing characters of rice (cv. Binadhan-8)

Nitrogen levels	Plant height(cm)	Panicle length(cm)	No. of effective tiller $hill^{-1}$	No. of grain $panicle^{-1}$	Grain yield (tha^{-1})	Straw yield (tha^{-1})
N_1=50 kg Nha^{-1}	98.20d	23.67c	12.57b	130.50d	2.42c	4.47d
N_2= 75 kg Nha^{-1}	100.80c	24.25bc	13.23b	133.70c	2.97bc	5.45c
N_3=100 kg Nha^{-1}	102.80b	24.87ab	13.51b	135.90b	3.44ab	6.62b
N_4=125 kg Nha^{-1}	104.70a	25.48a	14.63a	137.70a	3.81a	6.91a
Level of Significance	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
LSD	*1.566*	*0.680*	*1.111*	*1.638*	*0.573*	*0.088*

Table 04. Interaction effect of FYM and Gypsum combinations and nitrogen on yield contributing characters of rice (cv. Binadhan-8)

FYM and Gypsum combination	Nitrogen levels	Plant height (cm)	Panicle length (cm)	No. of effective tiller $hill^{-1}$	No. of grain $panicle^{-1}$
S_0	N_1	94.53h	23.60de	12.27b	112.20p
	N_2	96.83gh	24.47bcd	13.00abc	117.40o
	N_3	98.47fgh	25.4abc	13.07abc	122.00n
	N_4	98.40fgh	25.73ab	13.73abc	122.40n
S_1	N_1	100.60efg	24.40bcd	12.67abc	137.90gh
	N_2	101.90def	24.73a-d	13.80abc	140.20fg
	N_3	103.40cde	25.13a-d	13.60abc	143.20ef
	N_4	106.50abc	26.33a	15.00ab	145.40de
S_2	N_1	100.50efg	23.87cde	13.13abc	147.90cd
	N_2	105.20a-d	24.20bcd	13.00abc	150.90bc
	N_3	107.50ab	24.60a-d	14.20abc	153.30ab
	N_4	109.00a	24.93a-d	15.60a	155.00a
S_3	N_1	100.60efg	24.00b-e	12.80abc	130.30jkl
	N_2	101.80def	24.40bcd	13.33abc	133.20ijk
	N_3	104.80bcd	24.73a-d	13.47abc	133.60ij
	N_4	106.60abc	25.47abc	14.07abc	136.10hi
S_4	N_1	94.82h	22.47e	12.00c	124.30mn
	N_2	98.33fgh	23.47de	13.00abc	126.80lm
	N_3	99.93efg	24.40bcd	13.20abc	127.40lm
	N_4	103.00cde	24.93a-d	14.73abc	129.60kl
Level of Significance		*0.05*	*0.05*	*0.05*	*0.05*
LSD		*3.501*	*1.521*	*2.484*	*3.451*

S_0 = No amendment, S_1 = FYM (5 tha^1)+ Gypsum 14 $kgha^{-1}$, S_2 = FYM (5 ha^1) + Gypsum 210 $kgha^{-1}$, S_3 = Gypsum 210 $kgha^{-1}$, S_4 = FYM (5 tha^1), N_1=50 kg Nha^{-1}, N_2= 75 kg Nha^{-1}, N_3=100 kg Nha^{-1}, N_4=125 kg Nha^{-1}

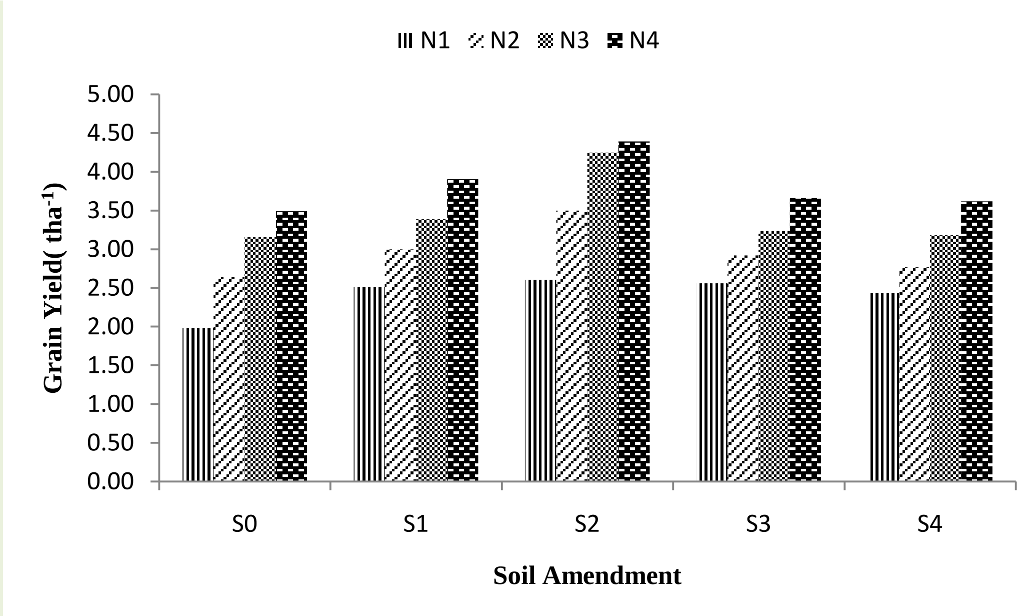

Figure 01. Interaction effect of FYM and Gypsum combinations and Nitrogen on Grain yield of rice (cv. Binadhan-8)

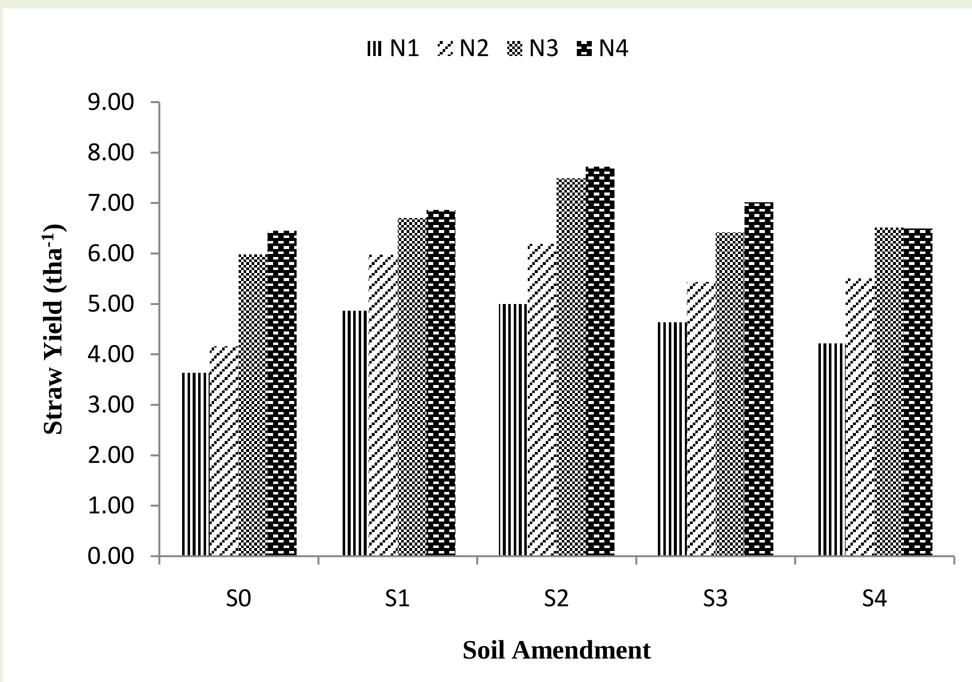

Figure 02. Interaction effect of FYM and Gypsum combinations and Nitrogen on Straw yield of rice (cv. Binadhan-8)

IV. Conclusion

FYM and Gypsum combinations along with different N levels have significant effect on growth and yield of rice in saline area of Satkhira district, Bangladesh. The mean effect of different FYM and Gypsum combinations the highest grain (3.69 tha^{-1}) and straw (6.60 tha^{-1}) yield were obtained where the plot received FYM @5 tha^{-1} with Gypsum 210 $kgha^{-1}$. Mean effect of different N levels, when the plant received 125 kg Nha^{-1} then the maximum grain and straw yield of rice were observed as 3.81 and 6.91 tha^{-1}, respectively. Due to the interaction effect of both FYM and Gypsum combinations and N levels, the maximum grain yield of rice was found as 4.39 tha^{-1} under the treatment combination of S_2N_4 where plot received FYM @5 tha^{-1} with Gypsum 210 $kgha^{-1}$ combined with 125 kg Nha^{-1}.

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Citation for this article (APA Style):

Haque, A. N. A., Haque, M. E., Hossain, M. E., Khan, M. K. & Razzaque, A. H. M. (2015). Effect of Farm Yard Manure, Gypsum and Nitrogen on Growth and Yield of Rice in Saline Soil of Satkhira District, Bangladesh. *Journal of Bioscience and Agriculture Research* 03(02), 65-72.

Retrieved March 11, 2015 from *http://www.journalbinet.com/jbar-volume-03-issue-01.html*