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TILLAGE OPERATION AND FERTILIZER MANAGEMENT EFFECT ON YIELD OF *BORO* RICE IN SALINE PRONE ZONE OF BANGLADESH

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Abstract

A field experiment was conducted at Shyamnagar Satkhira during *Boro* season in two consecutive year 2019-20 and 2020-21 to find out the suitable tillage operation as well proper doses of farmyard manure (FYM) for increasing yield of rice under natural salinity condition. The experiment was laid out in split plot design assigning tillage operations in the main plot and FYM in the sub plot with three replications. Four tillage operations and six doses of FYM were used. Among the treatments, land ploughed at 20 cm depth with five times produced the highest grain yield (6.63 t ha^{-1}) and application of FYM at the rate of 5.0 t ha^{-1} produced the highest grain yield (5.89 t ha^{-1}) in 2019-20. Land ploughed at 20 cm depth with five times produced the highest grain yield (6.65 t ha^{-1}) where FYM at 5 t ha^{-1} produced the highest grain yield (6.21 t ha^{-1}) in 2020-21. The effect of tillage 20 cm depth five times and FYM 5.0 t ha^{-1} produced the highest grain yield (6.84 t ha^{-1}) in both the season 2019-20 and 2020-21. This study showed that tillage operation and application of farmyard manure (FYM) at suitable dose amends the saline soil and increase the yield and yield attributes of *Boro* rice in saline soil.

Keywords: Tillage operation, Fertilizer management, Saline prone, Grain yield, Rice.

Introduction

Rice *(Oryza sativa L.),* one of the most important crops, provides a stable source of food for more than half of the world's population. In 2019, there were 501 megatons of milled rice produced in the world. The world production of milled rice was projected to rise to 508.4 megatons in 2020 (FAO 2020).

The average yield of rice in Bangladesh is 4.5 t ha^{-1} (BRRI, 2019). Rice production needs to be increased by 50% or more above the current production level to fill up the rice demand by 2030 (Sunyob *et al.,* 2015). Production of enough food to feed the rapidly growing world population remains a serious concern (Searchinger *et al*., 2019). Salinity is the most alarming environmental factors limiting the productivity of rice. The severity of salinity problem in Bangladesh increases with the desiccation of the soil. Maximum salinity was observed during (March and April) at maximum tillering stage to flowering stage of *Boro rice*. Increasing salinity is an alarming issue to the peoples of coastal region of Bangladesh (Searchinger *et al*., 2019). The total amount of severe salinity affected land in Bangladesh was 83.3 million hectares in 1973, which increased up to 102 million hectares in

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2000 and the amount has raised to 105.6 million hectares in 2009 and continuing to increase the severe salinity (Soil Resources Development Institute SRDI, 2010). The coast of Bangladesh consists of 19 districts, covers 32 percent of our country and accommodation of more than 35 million people. Total 105 million hectares of land at coastal Bangladesh were affected by soil salinity at different degrees. It is estimated that a net reduction of 0.5 million MT of rice production would take place in coastal areas of Bangladesh in *boro* season (Shahid *et al*., 2018). The factors which contribute significantly to the development of salinity, tidal flooding (June-October), direct inundation by saline water and upward or lateral movement of saline ground water during dry season (November-May). It affects rice plants depending on degree of salinity at the critical stages of rice growth, which reduces yield and in severe cases yield might be lost totally (Hoque, 2013). Proper soil fertility management in saline soil is one of the prime importance in an endeavor to increase crop productivity (Islam *et al.*, 2016). The best means of maintaining soil fertility, productivity and salt tolerance could be through soil management such as tillage operation and adding of soil amendments such as farmyard manure and gypsum etc. (Hasan *et al.*, 2014). Considering the above facts, a study was planned to develop amendment strategy with tillage operations and application of gypsum and farmyard manure for improving the physical and chemical properties of salt affected soils and obtaining maximum yield of *Boro* rice.

Materials and methods

Experimental Site and Weather

The experiment was conducted at the field of Shyamnagar, Satkhira (22.3306°N 89.1028°E) during *boro* season in two consecutive year 2019 and 2020. The climatic parameters during the growing seasons of *boro* rice in different time are presented in Fig. 1.

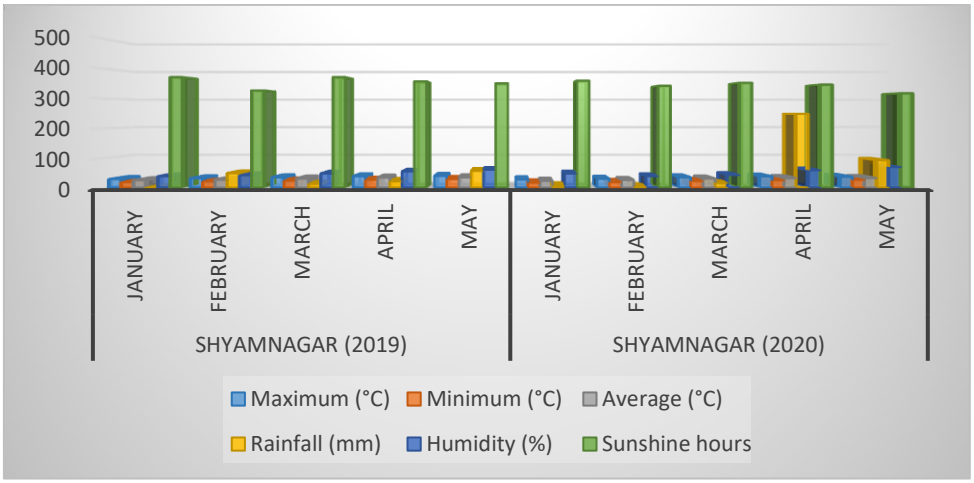

Fig. 1: The climatic parameters during the growing period of *Boro* rice in 2019-20 and 2020-21

Treatments and Cultural Practices

The experiment was carried out with Binadhan-10 as test crop. It's a high yielding variety. It can tolerate soil salinity level up to EC 8-10 dSm^{-1}. According to Kibria *et al*. (2017) Binadhan-10 showed higher salt tolerance among salt-tolerant varieties like BRRI dhan47, Binadhan-8 and in all measured physiological parameters. The varieties were evaluated under effect of tillage operations i.e., T_0: Control, T_1: Plough 3 times, T_2: Plough 4 times,T_3: Plough 5 times and application of FYM. i.e. C_0: Control, C_1: FYM 2.5 t ha^{-1}, C_2: FYM 3.75 t ha^{-1}, C_3: FYM 5 t ha^{-1}, C_4: FYM 6.25 t ha^{-1}, C_5: FYM 7.5 t ha^{-1}. The experiment was laid out in a split plot design with three replications.

Seedlings Raising

Seedlings were raised in well prepared wet seed bed at the sub-station Satkhira farms. Before sowing, seeds were immersed in water for 24 hours and then taken out and kept in jute sacks in dark condition for 48 hours. Seedling nurseries were prepared by puddling the soil.

Land Preparation

The land preparation was started one month prior to transplant of the seedlings. Subsequently the land was sufficiently irrigated and ploughed and cross ploughed according to study's requirement with country plough followed by laddering to have a good tilth. All kinds of stubble and residues of previous crop were removed from the field. After uniform leveling, the experimental plots were laid out according to the requirement of the treatment.

Fertilization and Manuring

The plots of *Boro* rice were fertilized with N85 kg ha^{-1}, P_20_5 43.5 kg ha^{-1}, K_2O 60 kg ha^{-1}, Gypsum 150 kg ha^{-1}, Silicon (sodium metasilicate) 5 kg ha^{-1}, Zinc sulphate monohydrate 7kg $ha^{-1}$and Boron 2kg ha^{-1}. Farm Yard Manure (FYM.) i.e., C_0: Control, C_1: FYM 2.5 tha^{-1}, C_2: FYM 3.75 t ha^{-1}, C_3: FYM 5 t ha^{-1}, C_4: FYM 6.25 t ha^{-1}, C_5: FYM 7.5 t ha^{-1} were applied at the time of land preparation. The whole amount at triple super phosphate, muriate of potash except zinc sulphate were applied to the soil at the time of final land preparation. Urea was applied in three equal splits. One split of urea was applied with other fertilizers as basal dose and the other two splits were applied at 21 and 45 DAT. Thirty two days old seedlings were uprooted carefully from nursery for transplanting in the experimental plots. Only selected healthy seedlings were translated in the experimental plots in 20cm apart line maintaining a distance of 15cm from hill to hill with three seedlings $hill^{-1}$.

Intercultural Operation

Intercultural operation were done in order to ensure and to maintain the normal growth of the plant as and when needed. After one week of transplanting, dead seedlings were replaced carefully by transplanting fresh seedlings from the same source. The

experimental plots were infested with some common weeds which were removed twice by hand weeding. During booting and flowering stage six irrigation were needed to maintain 5-6 cm standing water in each plot. Finally the field was drained out 7 days before harvest. Observations were regularly made with frequent intervals.

Harvesting and Data Collection

The maturity of crops was determined when some 80% of the seeds became attain their characters color. Grain and straw yields plot were recorded after threshing by a pedal thresher winnowing and drying in the sun properly including the grains and straws of the sample plants. The weight of grains was adjusted to 14% moisture content. Grain and straw yield were then converted to t ha^{-1}. From the 10 randomly harvested hills, the following data were recorded, plant height, number of total tillers $hill^{-1}$, number of effective tillers $hill^{-1}$, number of non-effective tillers $hill^{-1}$,number of grains $panicle^{-1}$, number of sterile spikelets $panicle^{-1}$, 1000 grains weight, grain yield (t ha^{-1}), straw yield (t ha^{-1}).

Chemical Analysis of Soil Sample

Soil samples were analyzed for both physical and chemical characteristics. The soil samples were analyzed following methods as follows.

Table 1. Chemical properties of the soil at the experimental field

Chemical properties	
$pH_{1.5}$	7.1
$EC_{1.5}$ (dS m^{-1})	8.2
Na^{+} (meq L^{-1}	58
K^{+} (meq L^{-1})	0.30
Ca^{2+} (meq L^{-1})	5.9
Mg^{2+} (meq L^{-1})	10.5
HCO_3^{-} (meq L^{-1})	7.3
Cl^{-} (meq L^{-1})	45.6
SO_4^{2-} (meq L^{-1})	25.2
SAR	18.3
ESP (%)	32.1

Data Processing and Analysis

Data recorded for different parameters were subjected to analysis of variance (ANOVA) and the treatment means were compared using the least significant different test. The statistical analysis was done by using the software Statistix10.

Results and Discussion

Tillage frequency and FYM dose had significant effect on most of the plant parameters and yield attributes (Table 2). The plant height was the highest (110.8 cm) in

control where effective tillers hill^{-1} (10.7), filled grains panicle^{-1} (114.3) and grain yield (6.63 t ha^{-1}) were the highest in land ploughed at 20 cm depth by 5 times. On the other hand, plant height was the lowest (108.9 cm) in land ploughed at 20 cm depth by 4 times and effective tillers hill^{-1} (8.5), filled grains panicle^{-1} (98.8) and grain yield (5.07 t ha^{-1}) were the lowest in control tillage condition. Azhar *et al*. (2001) stated that tillage operation in combination with gypsum application have great benefit regarding yield in saline soil. In case of application of FYM, the plant height (106.7), effective tillers hill^{-1} (9.4), filled grains panicle^{-1} (98.7) and grain yield (4.53 t ha^{-1}) were the lowest in control condition but effective tillers hill^{-1} was the highest (10.2) in FYM 7.5 t ha^{-1}, filled grains panicle^{-1} was the highest (111.4) in FYM 3.75 t ha^{-1} and grain yield was the highest in FYM 5.0 t ha^{-1} during the *Boro* season 2019-20 (Table 2). The interaction of land ploughed at 20 cm depth by 5 times and application of FYM 5 t ha^{-1} showed the highest grain yield (6.68 t ha^{-1}) and was the lowest in control of tillage and FYM (4.42 t ha^{-1}) in the *Boro* season 2019 (Table 3). This result is supported by the findings of Rizwan *et al*. (2019) and Mohamed *et al*. (2019). Shaaban *et al*. (2013) reported that FYM along with inorganic amendments increased rice yield in salt affected soil. Application of gypsum and farmyard manure helped in improvement of soil properties and leaching of excessive ions to the deeper layer, concentration of salts was decreased in the upper layers which favored the growth of plant and ultimately a significant increase in rice grain was observed (Ghafoor *et al*., 2008).

Table 2. Effect of tillage operation and FYM on yield and yield contributing characters of *Boro* rice in saline prone zone Shyamnagar, Satkhira during 2019-20

Treatments	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Filled grains panicle^{-1} (no.)	Unfilled grains panicle^{-1} (no.)	1000 grains weight (g.)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Tillage operation									
Control (T_0)	110.8	9.8	8.5	25.1	98.8	12.1	23.6	5.07	6.76
Plough 3 times (T_1)	110.7	12.1	9.8	25.6	107.4	8.8	23.6	5.43	7.05
Plough 4 times (T_2)	108.9	12.9	10.3	25.6	110.9	7.0	23.8	5.87	7.62
Plough 5 times (T_3)	109.1	13.0	10.7	25.5	114.3	7.1	23.7	6.63	8.04
$LSD_{.05}$	NS	0.7	0.7	NS	5.5	2.6	NS	0.67	0.27
Farm yard manure levels									
Control (C_0)	106.7	11.5	9.4	25.2	98.7	8.2	23.6	4.53	7.20
FYM 2.5 t ha^{-1} (C_1)	110.4	11.9	9.8	25.6	111.0	8.1	23.5	5.10	7.25
FYM 3.75 t ha^{-1} (C_2)	109.1	11.9	9.8	25.6	111.4	9.1	23.6	5.56	7.40
FYM 5.0 t ha^{-1} (C_3)	112.0	11.9	9.9	25.5	110.2	9.4	23.9	5.89	7.36
FYM 6.25 t ha^{-1} (C_4)	110.2	11.8	9.8	25.3	104.5	8.9	23.7	5.81	7.47
FYM 7.5 t ha^{-1} (C_5)	110.9	12.6	10.2	25.5	101.3	8.9	23.6	5.73	7.52
$LSD_{0.05}$	NS	0.3	0.5	0.4	NS	NS	NS	0.87	NS
CV (%)	2.7	6.8	6.6	3.8	6.0	19.5	4.2	4.33	4.47

Table 3. The interaction effect of tillage operation and FYM application on yield and yield contributing characters of *boro* rice in saline prone zone Shyamnagar, Satkhira during 2019-20

Treatments	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Filled grains panicle^{-1} (no.)	Unfilled grains panicle^{-1} (no.)	1000 Grains weight (g.)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Tillage frequency ×Farm yard manure levels									
$T_0 C_0$	108.0	9.5	7.9	24.7	96.0	11.0	23.3	4.42	6.23
$T_0 C_1$	110.0	9.3	8.2	25.5	104.3	10.1	23.5	5.46	6.78
$T_0 C_2$	111.4	10.1	8.6	25.8	99.9	12.5	23.1	5.13	6.68
$T_0 C_3$	112.4	9.7	8.9	24.7	104.0	14.7	24.0	5.28	6.47
$T_0 C_4$	112.4	9.7	8.6	24.7	101.7	12.0	23.9	5.24	6.86
$T_0 C_5$	110.9	10.4	9.0	25.5	100.0	12.3	23.6	5.68	6.98
$T_1 C_0$	109.0	11.7	9.5	25.5	93.0	8.4	23.9	4.58	6.32
$T_1 C_1$	112.5	12.3	10.1	25.9	109.1	8.3	23.0	5.33	6.71
$T_1 C_2$	110.1	11.9	9.8	25.4	113.2	10.1	24.0	5.48	7.10
$T_1 C_3$	113.1	12.2	9.4	25.8	110.0	6.2	23.7	5.47	7.14
$T_1 C_4$	110.1	11.6	9.3	25.4	113.2	9.9	23.8	5.52	7.36
$T_1 C_5$	109.2	13.0	10.5	25.4	110.0	10.2	23.3	5.58	7.28
$T_2 C_0$	107.0	12.5	9.8	25.7	97.7	11.7	24.0	5.57	6.98
$T_2 C_1$	107.7	12.7	10.6	25.7	116.8	6.7	23.6	5.61	7.54
$T_2 C_2$	106.9	12.7	10.2	25.5	115.7	7.1	23.9	5.83	7.79
$T_2 C_3$	112.0	12.6	10.7	25.4	116.3	6.9	24.1	5.88	7.74
$T_2 C_4$	109.0	12.9	10.1	25.8	118.7	7.4	23.7	5.82	7.79
$T_2 C_5$	111.0	13.9	10.3	25.6	120.0	7.2	23.4	5.79	7.51
$T_3 C_0$	102.9	12.4	10.6	25.0	94.2	13.2	23.2	4.68	6.91
$T_3 C_1$	111.3	13.3	10.2	25.4	113.9	7.2	24.1	6.39	7.99
$T_3 C_2$	108.3	13.0	10.6	25.5	116.7	6.8	23.6	6.61	8.06
$T_3 C_3$	110.3	13.1	10.5	25.9	110.6	9.8	23.8	6.68	8.08
$T_3 C_4$	109.2	12.9	11.2	25.4	116.2	6.3	23.5	6.28	7.86
$T_3 C_5$	112.7	13.1	11.2	25.9	118.3	5.9	23.9	6.06	7.33
$LSD_{0.05}$	3.1	0.6	1.1	0.8	4.9	4.3	NS	0.81	0.18
CV(%)	2.7	6.8	6.6	3.8	6.0	19.5	4.2	4.33	4.47

NB: C_0: Control, C_1: FYM 2.5 t ha^{-1}, C_2: FYM 3.75 t ha^{-1}, C_3: FYM 5 t ha^{-1}, C_4: FYM 6.25 t ha^{-1}, C_5: FYM 7.5 t ha^{-1}

Similar effects were found when FYM and gypsum was applied, on yield components of rice under saline sodic soil (Bekele 2022). Haq *et al.* (2001) reported that the most effective treatment to produce the highest rice yield in combination of gypsum, press mud and farmyard manure in saline sodic soil. Silicon was found beneficial in improving yield of rice under salinity condition (Sultana *et al.*, 2021; Khanam *et al.*, 2020 and Ahmed *et al.*, 2019).

During the *boro* season 2020, tillage operation and application of FYM also had significant effect on most of the plant parameters. The plant height was the highest (99.4 cm) in land ploughed 3 times where effective tillers hill^{-1} (10.3) & grain yield (6.65 t ha^{-1}) were the highest in land ploughed at 20cm depth by 5 times. The filled grains panicle^{-1} showed the highest value (115.5) in land ploughed at 20 cm depth by 4 times. On the other hand, plant height was the lowest (97.2 cm) in land ploughed at 20 cm depth by 5 times and effective tillers hill^{-1} (8.4), grains panicle^{-1} (105.3) and grain yield (5.06 t ha^{-1}) were the lowest in control tillage condition. In case of application of FYM, the plant height (99.8) and grains panicle^{-1} (113) were the highest in FYM 6.25 t ha^{-1} but effective tillers hill^{-1} was the highest (10.1) in FYM 7.5 t ha^{-1} and grain yield (6.21 t ha^{-1}) was the highest in FYM 5 t ha^{-1} (Table 4).

Table 4. Effect of tillage operation and FYM on yield and yield contributing characters of *Boro* rice in saline prone zone Shyamnagor, Satkhira during 2020-21

Treatments	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Filled grains panicle^{-1} (no.)	Unfilled grains Panicle^{-1} (no.)	1000 grains weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Tillage operation									
Control (T_0)	98.1	11.4	8.4	23.7	105.3	10.8	23.68	5.06	6.37
Plough 3 times (T_1)	99.4	12.0	9.6	24.4	110.7	8.6	23.94	5.77	6.70
Plough 4 times (T_2)	99.3	12.8	10.1	24.9	115.5	7.6	23.64	6.19	7.13
Plough 5 times (T_3)	97.2	12.8	10.3	24.7	114.1	8.1	23.64	6.65	7.48
$LSD_{.05}$	2.5	1.8	0.7	0.4	3.3	1.2	0.42	0.57	0.69
Farm yard manure levels									
Control (C_0)	97.2	11.5	9.0	24.1	109.3	7.8	23.83	5.04	6.69
FYM 2.5 t ha^{-1} (C_1)	97.9	11.8	9.4	24.6	110.8	8.6	23.83	5.83	6.82
FYM 3.75 t ha^{-1} (C_2)	97.7	12.4	9.7	24.4	112.4	9.2	23.70	5.96	6.89
FYM 5.0 t ha^{-1} (C_3)	98.7	12.3	9.8	24.3	110.3	9.2	23.81	6.21	6.97
FYM 6.25 t ha^{-1} (C_4)	99.8	12.6	9.8	24.6	113.0	9.0	23.71	6.05	7.04
FYM 7.5 t ha^{-1} (C_5)	99.8	12.9	10.1	24.5	112.8	8.8	23.48	6.09	7.12
$LSD_{0.05}$	1.7	0.6	0.3	0.4	2.1	1.4	0.44	0.12	0.24
CV (%)	3.7	5.9	8.3	2.9	6.0	8.8	2.10	5.92	12.00

The interaction of land ploughed at 20 cm depth by 5 times and application of FYM 5 t ha^{-1} showed the highest grain yield (6.84 t ha^{-1}) and the lowest was in control (5.06 t ha^{-1}) in the *boro* season 2020 (Table 5). The result is supported by Rizwan *et al.* (2019). Beneficial effects of gypsum and tillage implements on reclamation process has been reported by several researchers (Ahmed *et al.* 2015; Rizwan *et al.* 2018). Hasan *et al.* (2020) found salinity stress in rice can be ameliorated through the application of gypsum. Amanullah *et al.* (2007) have shown that organic, inorganic amendments and management practices enhanced the yield of rice against soil salinity. According to Haque *et al.* (2015), due to the interaction effect of both FYM and gypsum combinations and N levels, the

maximum grain yield of rice was found where plot received FYM @ 5 t ha^{-1} with gypsum 210 kg ha^{-1} combined with 125 kg N/ha. Variation in number of panicle m^{-2}, grains $panicle^{-1}$ and individual grain weight in different rice varieties in saline soils was also reported by Joseph and Mohanan (2013). Chowdhury *et al.* (2019) found soil amendments with FYM and poultry manure significantly increased the growth, and grain and straw yields of all rice cultivars under saline conditions.

Table 5. Effect of tillage operation and FYM application on yield and yield contributing characters of *boro* rice in saline prone zone Shyamnagor, Satkhira during 2020-21

Treatments	Plant height (cm)	Total tillers $hill^{-1}$ (no.)	Effective tillers $hill^{-1}$ (no.)	Panicle length (cm)	Filled grains $panicle^{-1}$ (no.)	Unfilled grains $panicle^{-1}$ (no.)	1000 grains weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Farm yard manure levels									
$T_0 C_0$	96.2	10.6	7.5	23.7	104.0	8.0	23.55	5.06	6.29
$T_0 C_1$	99.9	10.8	7.9	24.4	106.0	9.8	23.81	5.22	6.42
$T_0 C_2$	96.9	11.3	8.5	24.0	105.7	11.7	23.42	5.24	6.33
$T_0 C_3$	100.0	12.0	8.8	23.2	104.0	12.7	23.98	5.40	6.24
$T_0 C_4$	97.3	11.7	8.8	23.7	106.0	11.5	23.87	5.26	6.42
$T_0 C_5$	98.3	12.2	8.8	23.5	106.3	11.0	23.47	5.36	6.54
$T_1 C_0$	97.5	11.5	8.9	24.3	110.7	8.5	24.18	5.44	6.46
$T_1 C_1$	98.6	11.9	9.7	24.2	109.1	8.8	23.80	5.69	6.55
$T_1 C_2$	98.8	11.9	9.6	24.2	111.5	9.4	24.22	5.85	6.69
$T_1 C_3$	99.9	12.2	9.7	24.7	110.0	6.9	24.09	5.72	6.83
$T_1 C_4$	101.6	12.3	9.5	24.5	113.2	8.7	23.82	5.80	6.79
$T_1 C_5$	100.1	12.4	9.3	24.5	110.0	9.1	23.54	6.11	6.85
$T_2 C_0$	97.8	12.0	9.8	24.7	112.3	7.7	24.25	5.76	6.68
$T_2 C_1$	97.2	12.3	9.9	25.1	114.1	7.5	23.59	6.00	6.95
$T_2 C_2$	98.8	13.0	9.1	24.9	115.7	7.1	23.58	6.06	7.14
$T_2 C_3$	97.7	12.7	9.1	24.8	116.3	7.3	23.37	6.11	7.30
$T_2 C_4$	102.5	13.2	9.3	25.1	116.4	8.1	23.67	6.24	7.32
$T_2 C_5$	101.7	13.4	10.5	24.5	118.3	8.0	23.41	6.28	7.40
$T_3 C_0$	97.3	9.9	8.7	23.8	104.2	6.9	23.35	5.64	7.34
$T_3 C_1$	95.8	10.3	9.0	24.6	113.9	8.2	24.12	6.23	7.35
$T_3 C_2$	96.2	12.5	10.5	24.5	112.7	8.5	23.59	6.31	7.39
$T_3 C_3$	97.2	13.4	12.1	24.5	117.9	7.1	23.81	6.84	7.52
$T_3 C_4$	97.9	13.1	10.5	24.9	111.2	7.7	23.47	6.27	7.63
$T_3 C_5$	98.9	13.5	10.8	25.6	109.7	7.1	23.49	6.10	7.67
$LSD_{0.05}$	3.3	1.2	0.6	0.9	4.0	2.9	0.88	0.24	0.29
CV (%)	3.7	5.9	8.3	2.9	6.0	8.8	2.10	5.92	12.00

Fig. 2: Grain yield of *Boro* rice in different tillage operation in 2019-20 and 2020-21

Grain yield at Different Depth of Tillage and FYM

In 2019-20, grain yield (6.63 t ha^{-1}) were highest in land ploughed at 20 cm depth by 5 times. Whereas grain yield was 5.87 t ha^{-1}, 5.43 t ha^{-1} and 5.07 t ha^{-1} when land ploughed by 4 times, 3 times and no plough (Control) consecutively. Similarly in 2020, the highest grain yield (6.65 t ha^{-1}) were obtained in land ploughed at 20 cm depth by 5 times. Consecutive grain yield of land ploughed by 4 times, 3 times and no plough (Control) was 6.19 t ha^{-1}, 5.77 t ha^{-1} and 5.06 t ha^{-1} respectively.

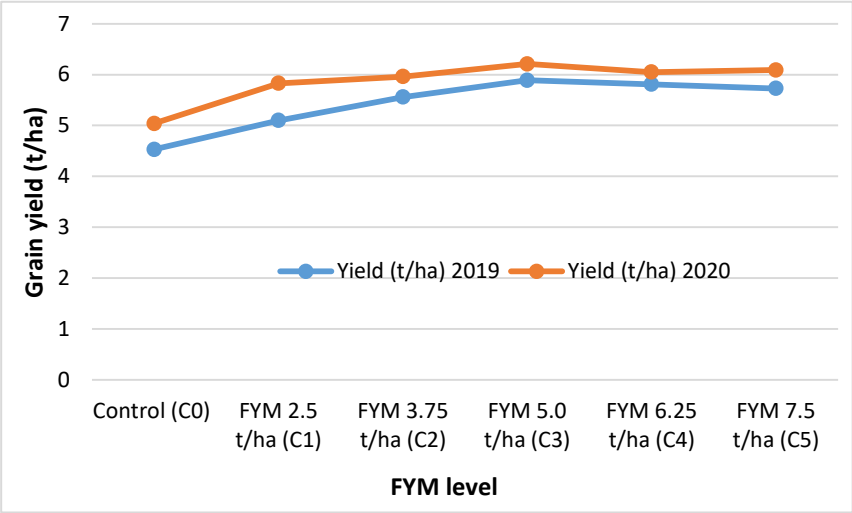

Fig. 3: Grain yield of *boro* rice in different FYM level in 2019 and 2020

In case of application of FYM in 2019, grain yield (5.89 t ha^{-1}) was the highest with application of FYM 5.0 t ha^{-1}. Whereas grain yield was 5.81 t ha^{-1}, 5.73 t ha^{-1} , 5.56 t ha^{-1}, 5.10 t ha^{-1} and 4.53 t ha^{-1} when FYM 6.25 t ha^{-1}, FYM 7.5 t ha^{-1}, FYM 3.75 t ha^{-1}, FYM 2.5 t ha^{-1} and no FYM (control) were applied consecutively. Similarly in 2020, highest grain yield (6.21 t ha^{-1}) were obtained in land with FYM 5.0 t ha^{-1} application .Consecutive grain yield was 6.09 t ha^{-1}, 6.05 t ha^{-1}, 5.96 t ha^{-1}, 5.83 t ha^{-1} and 5.04 t ha^{-1} when FYM 7.5 t ha^{-1}, FYM 6.25 t ha^{-1}, FYM 3.75 t ha^{-1}, FYM 2.5 t ha^{-1} and no FYM (control) were applied respectively.

Water and Soil Salinity Dynamics

What was the salinity condition in your experimental field during the cropping period

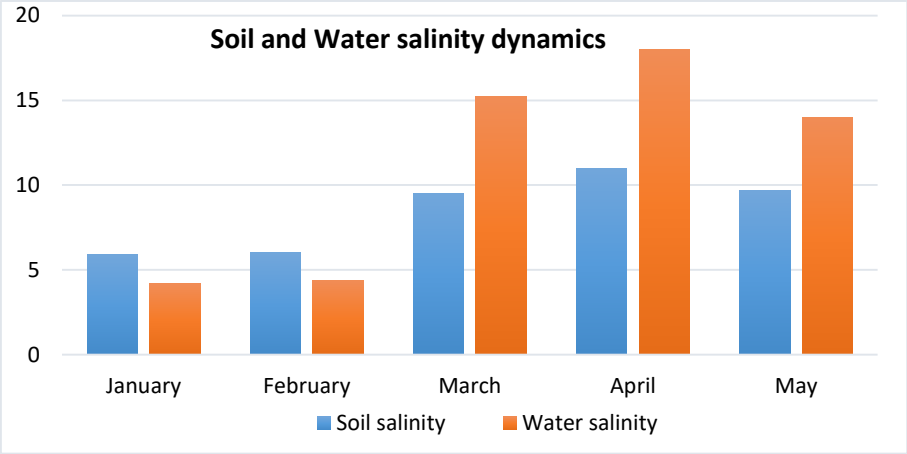

Fig. 4: Soil and Water dynamics during January to May

Salinity causes unfavorable environment and hydrological situation that hinders the normal crop growth and development. The factors which contribute significantly to the development of saline soil are, tidal flooding during wet season (June to October), direct inundation by saline water, and lateral movement of saline ground water during dry season (November to May). The severity of salinity problem in Bangladesh increases with the desiccation of the soil. It affects crops depending on degree of salinity at the critical stages of growth, which reduces yield and in severe cases total yield is lost. Maximum salinity was observed during (March and April) at maximum tillering stage to flowering stage.

Conclusions

Binadhan-10 was evaluated among four types of tillage operation and six types of FYM level at saline prone area. The land ploughed at 20 cm depth by 5 times produced the highest grain yield in both the season 2019-20 (6.63 t ha^{-1}) and 2020-21 (6.65 t ha^{-1}). On the other hand, the application of FYM 5 t ha^{-1} showed the highest grain yield in both the season 2019-20 (5.89 t ha^{-1}) and 2020-21 (6.21 t ha^{-1}). The interaction of land ploughed at 20 cm depth by 5 times and application of FYM 5 t ha^{-1} showed the highest grain yield in both the season 2019-20 (6.68 t ha^{-1}) and 2020-21 (6.84 t ha^{-1}).

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Competing Interests

Authors have declared that no competing interests exist.

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