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Consequences of Indigenous Organic Amendments and Moisture Conditions on the Growth and Yield of Rice Grown on Saline Soil

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Abstract- A field experiment was conducted with 6 varieties of rice (BRRI-28, BRRI-47, BRRI-60, BRRI-61, BRRI-64, BR-3, Guti Swarna) grown on saline soil at Kuakata in Patuakhali during January to May (Boro Season), 2016. The study was considered to evaluate the effectiveness of rice hull, rice straw and saw dust at the rates of each of 0, 2, 4 t ha^{-1} under different moisture conditions (moist and standing water condition). Plant heights, tillers, straw dry matter production of rice varieties were observed to be increased significantly ($p < 0.05$) by the individual application of rice straw, rice hull and saw dust under field moist (FM) and standing water (SW) conditions. The increased doses and the combination of the organic amendment were found to be more effective than those of the individual treatments. The highest plant heights of BRRI-47 (83 cm in FM and 94 cm in SW) were recorded during maturity stage of rice in the $RH_4SD_4RS_4$ (T_{27}) treatment, while the lowest plant heights (67 cm in FM and 71 cm in SW) were observed for the control condition ($RH_0SD_0RS_0$) where no treatment was applied. The straw yields of BRRI-47 rice variety demonstrated that the treatment T_{27} ($RH_4SD_4RS_4$) ranked first followed by the T_{26} ($RH_4SD_4RS_2$) treatment under in FM and SW conditions. The grain yields were attained maximum in BRRI-47 variety followed by the sequence of Guti Swarna>BRRI-28>BRRI-61>BRRI 60>BRRI-3 under FM and SW conditions. The highest grain yields (6.2 t ha^{-1} in FM and 7.4 t ha^{-1} in SW) of BRRI-47 were obtained at maturity stage of rice in the T_{27} ($RH_4SD_4RS_4$) which received the highest doses of these organic amendments followed by the T_{26} ($RH_4SD_4RS_2$). The application of rice hull, rice straw, sawdust individually or in combinations were found to be exerted better response in relation to plant growth and the improved the studied coastal saline soil. These effects were more pronounced with their higher rates and also striking under standing water condition than that of the field moist condition.

Keywords- *Grain and Straw Yield of Rice, Rice Hull, Rice Straw, Sawdust, Saline Soil*

I. INTRODUCTION

For the production of foods, fibers and extension of acreage for feeding the projected increase of population of about ten billion by the 21st century, forceful efforts are made world-wide. There is a constant pressure from the members of the Food and Agriculture Organization of the United Nations to increase food production by 40-50% to meet future requirements. But there is limitation in availability of land for growing crops and it is very essential to utilize marginal and problem soils or to improve the yield potential for rice per unit land under various soil stresses [1]. This hypothesis is very much acceptable for Bangladesh because of its large population and also being a developing country. The country has not attained self-sufficiency in its food production. Moreover, recent evaluation of land quality, especially in the coastal areas is very essential due to climate change. About 70% of the people are directly dependent on the agricultural resources. Moreover, crop production in the coastal areas is very low (cropping intensity: 100-140%), somewhere the lands are unproductive due to salinity.

The problem of salt-affected soils has gained ever-increasing importance in science, technology, ecology and society during the last decades. Salt affected coastal areas in Bangladesh mainly include the problematic saline (>20%) and acid sulfate (>3%) soils, which occupied >23% of the cultivable lands [2]. Khan also added that these soils displayed high agricultural potentials if they were to be reclaimed by appropriate methods. Because of the highly saline (2% salts) sea or river water and groundwater, application of salt free water is quite impossible. It has been evidenced that the coastal salinity is increasing in the coastal zone due to sea level rise, reduction of fresh water flow in the southern rivers and also due to entrainment of sea water with recurrent storm surges caused by the increasing frequency of tropical cyclones of higher intensity [3].

Salinity has serious negative impacts on agriculture [4]. During 1973 to 2009, the salinity affected area has increased from 8,330 km^2 in 1973 to 10,560 km^2 in 2009 [5]. Tidal flooding occurs during wet season (June-October), direct inundation by saline water and upward on lateral movement of saline ground water during the dry season (November-May). In addition, cyclone and tidal surge is accelerating this problem. In the coastal areas of Bangladesh, saline water is used for irrigation which reduces the growth of most agricultural crops [6]. Soil salinity (electrical conductivity: EC > 4 dS m^{-1}) is a major abiotic stress which limits plant growth and development, causing yield loss in crop species [3]. Salt-affected soils are identified by excessive levels of water-soluble salts, especially sodium chloride [7]. Salinity is causing decline in soil productivity and crop yield which results in severe degradation of bio-environment and ecology as well as responsible for low cropping intensity in coastal area [8].

Bangladesh has a long history of rice cultivation. Rice is grown throughout the country, except for the southeastern hilly areas. The agro-climatic conditions of the country are year-round suitable for growing rice. However, the national average rice yield is much lower (2.94 t ha^{-1}) than that of other rice-growing countries [9]. It also reported that rice is the staple food for about 156 million people of the country. The population increases at 2 million per year, and if the population increases at this rate, the total population will reach 238 million by 2050. An increase in total rice production is required to feed this ever-increasing population. Rice has been reported as salt susceptible in both seedling and reproductive stages leading to a reduction of more than 50% in yield when exposed to 6.65 dS m^{-1} ECe [10]. So rice production is drastically reduced due to salinity and low fertility of coastal soils. Against this background, the implementation of different management strategies, such as improved soil moisture level, application of organic amendments and adaptation and screen out of salt tolerant rice cultivar grown in saline soil were considered for the increment of rice production and reclamation of coastal saline soil.

II. MATERIALS AND METHODS

The study was conducted in the field with 6 varieties of rice (BRRI-28, BRRI-47, BRRI-60, BRRI-61, BRRI-64, BR-3, Guti Swarna) grown on saline soil at Kuakata in Patuakhali during January to May (Boro Season), 2016. This study was conducted to evaluate the efficiency of rice hull, rice straw, saw dust applied at rates 0, 2, 4 t ha^{-1} in two different moisture conditions (moist and standing water condition: Table 1). The physico-chemical characteristics of initial soils were determined by the following standard methods (Table 2). Indigenous organic amendments, viz., Rice Hull (RH), Rice Straw (RS) and Saw Dust (SD) were used as the treatments/amendments for the experiment. The experiment was conducted following 3 factorial design with Rice Hull (RH: 3 levels) × Rice Straw (RS: 3 levels) × Saw Dust (SD: 3 levels) having 3 replications under 2 moisture levels. Basal doses of N, P_2O_5 and K_2O were applied at the rate of 120, 60 and 80 kg ha^{-1} from Urea, TSP and MP fertilizers, respectively. The whole TSP, MP and half of the Urea were applied during soil preparation by thorough mixing of the fertilizers with soils. The remaining Urea was top dressed in two splits, one at active tillering and another at panicle initiation stage. Seedlings were collected from the local experienced farmers. Thirty-days-old seedlings of BRRI 64 were transplanted at the rate of 3 seedlings per hill. The hill to hill and row to row distances were 18 and 22 cm, respectively. For proper establishment of the rice seedlings, all plots in the field were irrigated with pond water for two weeks after transplantation and then the moisture levels were controlled.

TABLE I. TREATMENT COMBINATIONS.

Treatments			
No.	Denotations	No.	Denotations
T_1	Control ($RH_0SD_0RS_0$)	T_{15}	RH_4RS_4
T_2	RH_2	T_{16}	SD_2RS_2
T_3	RH_4	T_{17}	SD_2RS_4
T_4	SD_2	T_{18}	SD_4RS_2
T_5	SD_4	T_{19}	SD_4RS_4
T_6	RS_2	T_{20}	$RH_2SD_2RS_2$
T_7	RS_4	T_{21}	$RH_2SD_4RS_2$
T_8	RH_2SD_2	T_{22}	$RH_2SD_2RS_4$
T_9	RH_2RS_2	T_{23}	$RH_2SD_4RS_4$
T_{10}	RH_2SD_4	T_{24}	$RH_4SD_2RS_2$
T_{11}	RH_2RS_4	T_{25}	$RH_4SD_2RS_4$
T_{12}	RH_4SD_2	T_{26}	$RH_4SD_4RS_2$
T_{13}	RH_4RS_2	T_{27}	$RH_4SD_4RS_4$
T_{14}	RH_4SD_4		

RH_0, RH_2, RH_4 Indicate Rice Hull dose @ rates 0, 2, 4 t ha^{-1} SD_0, SD_2, SD_4 Indicate Saw Dust dose @ rates 0, 2, 4 t ha^{-1} and RS_0, RS_2, RS_4 Indicate Rice straw dose @ rates 0, 2, 4 t ha^{-1}

TABLE II. PHYSICO-CHEMICAL CHARACTERISTICS OF INITIAL SOIL (1-15 CM) ON OVEN DRY BASIS

Properties	Values
Textural Class	Silty Clay Loam
Soil pH (Soil: Water = 1: 2.5)	6.3
EC (Soil : Water = 1:5, dS m^{-1})	4.17
Organic Carbon (g kg^{-1},)	14.3
Total N (g kg^{-1})	1.4
C/N ratio	10.20
Cation Exchange Capacity (C mol kg^{-1})	21.23
Available N (mg kg^{-1})	42
Available S (mg kg^{-1})	192
Available P (mg kg^{-1})	14
Available K (mg kg^{-1})	24.16
Base Saturation Percentage	53.32
Exchangeable Cations :	
Na^+ (C mol kg^{-1})	4.02
K^+ (C mol kg^{-1})	1.90
Ca^{2+} (C mol kg^{-1})	2.90
Mg^{2+} (C mol kg^{-1})	2.50
Water Soluble Ions :	
Cl^- (C mol L^{-1})	2.63
SO_4^{-2} (C mol L^{-1})	1.75
Carbonate (C mol L^{-1})	Nil
Bicarbonate (C mol L^{-1})	0.98
Sodium adsorption Ratio	2.45
Exchangeable Sodium percentage	18.9

After treatment with 1 M CH_3COONH_4 (pH 5.0) and with 30% H_2O_2 to remove free salts and organic matter respectively, particle size distribution of the initial soils was determined by the Hydrometer method [11]. Soil pH was measured in the field by the soil-water ratio of 1:2.5 [12] using a Corning pH meter Model-7. The electrical conductivity of soil solution was determined at the ratio of 1:5 [13]. Organic matter content was determined [14] by wet combustion with $K_2Cr_2O_7$. Available N (1.3 M KCl extraction, [12]), available P (0.5 M $NaHCO_3$, pH 8.5 extraction, [15]) and available S ($BaCl_2$ turbidity, [16]) were determined. Cation exchange capacity was determined by saturation with 1 M CH_3COONH_4 (pH 7.0), ethanol washing, NH_4^+ displacement with acidified 10 % NaCl, and subsequent analysis by steam (Kjeldhal method) distillation [17]. Exchangeable Na^+, K^+, Ca^{2+} and Mg^{2+} were extracted with 1 M CH_3COONH_4 (pH 7.0) and determined by flame photometry (Na^+, K^+) and atomic absorption spectrometry.

Plant samples were collected after harvesting the crop at maturity. Growth and yield parameters were recorded at maturity stage. The plants per plot were cut at the (1 cm above) ground level and total N, P and K in rice straw [12] were determined. Analysis for variance (ANOVA), Tukey's Multiple Range Tests were done for the interpretation of the results.

III. RESULTS AND DISCUSSION

A. *Plant height*

The effects of rice straw, rice hull, saw dust as organic amendments on rice plant heights in coastal saline soil were observed under the field moist (70% moisture, FM) and 2-5 cm standing water (SW) conditions (Fig.1). Plant heights of BRRI-60 rice variety increased significantly ($p < 0.05$) with the increased rates regardless of types and kinds of treatments under both FM and SW conditions. The highest plant heights (83 cm in FM and 94 cm in SW) were recorded during maturity stage of rice in the T_{27} ($RH_4SD_4RS_4$) treatment, which received the highest rates of combination of these amendments. The lowest plant heights (67 cm in FM and 71 cm in SW) were recorded at maturity in control condition ($RH_0SD_0RS_0$) where no treatment was applied. Almost similar and significant ($p < 0.05$) positive effects on plant heights were studied for all other rice varieties (BRRI-28, BRRI-47, BRRI-61, BR-3, Guti Swarna). The plant height was increased most in BRRI-60 variety followed by the sequence of BR-3> BRRI-61> BRRI-47> BRRI-28> Guti Swarna under FM and SW conditions. Quite similar study was conducted by scienctists and they revealed that rice plants grown on soils treated with rice straw were significantly ($p < 0.05$) taller than those grown on soils without treatment [18]. Incorporation of rice straw into the soil combined with application of cattle manure gave the maximum plant height [19].

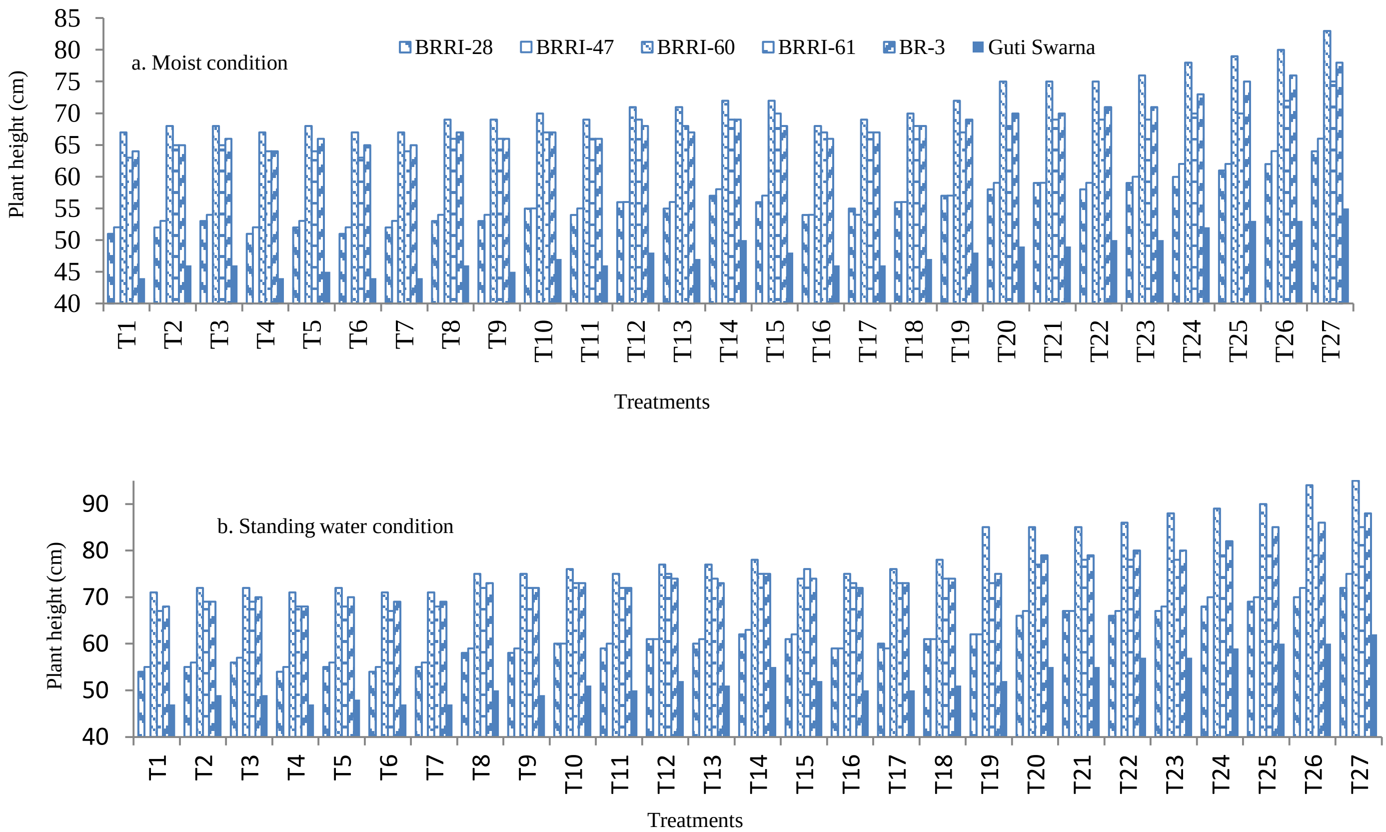

Figure 1. Effects of Rice hull (RH), Saw dust (SD) and Rice straw (RS) on plant heights of rice varieties grown under a) moist and b) 2-5 cm standing water condition

B. Tiller Production

The number of productive tillers of rice variety BRRI-47 was observed to be increased significantly ($p < 0.05$) by the individual application of rice straw, rice hull and saw dust, while the combination of these treatments and their increased doses were more effective than those of their individual treatments in increasing tiller production of rice. The maximum number of productive tillers (24 in FM and 27 in SW) were recorded at maturity stage of rice in the T_{27} treatment ($RH_4SD_4RS_4$) which received highest doses of these treatments followed by the T_{26} ($RH_4SD_4RS_2$) treatment (Fig. 2). The lowest number of productive tillers (10 in FM and 11 in SW) were recorded at maturity in controlled condition ($RH_0SD_0RS_0$) where no treatment was applied. Almost similar and significant ($p < 0.05$) positive effects on productive tillers were also observed for all other varieties (BRRI-28, BRRI-60, BRRI-61, BR-3, Guti Swarna) studied. The producitve tillers were increased most in BRRI-47 variety followed by the sequence of BR-28> Guti Swarna> BRRI-61> BRRI-3> BRRI-60 both in FM and SW conditions.

C. Straw yield

Straw dry matter production of rice variety BRRI-47 was found to be increased significantly ($p < 0.05$) by the individual application of rice straw, rice hull and saw dust, while the combination of these treatments and their increased doses were found to be more effective than those of their individual treatments in increase of the straw yields (Figures 4.5 and 4.6). The highest straw yields (6.5 t ha^{-1} in FM and 7.4 t ha^{-1} in SW) were recorded at maturity stage of rice in the T_{27} ($RH_4SD_4RS_4$) treatment, which received highest doses of these treatments followed by the T_{26} ($RH_4SD_4RS_2$) treatment. The lowest straw yields (4.3 t ha^{-1} in FM and 4.6 t ha^{-1} in SW) was recorded at maturity in control condition ($RH_0SD_0RS_0$) where no treatment was applied. Tukey pairwise treatment comparison tests were done at 5% ($p < 0.05$) level (Table 3).

The effects of these treatments alone or in combination showed almost similar and significant ($p < 0.05$) positive effects on straw yields for all other varieties (BRRI-28, BRRI-60, BRRI-61, BR-3, Guti Swarna).

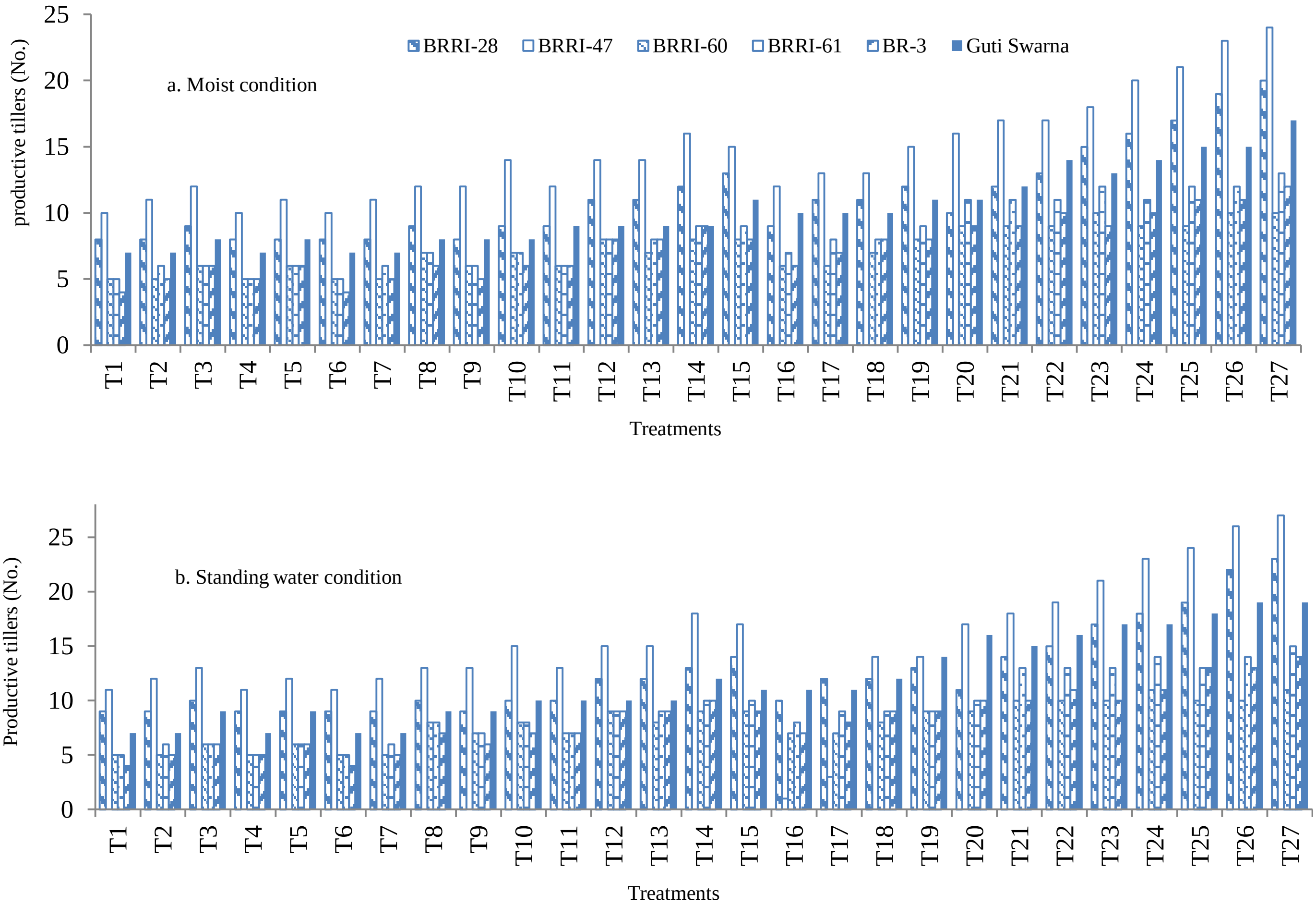

Figure 2. Effects of Rice hull (RH), Saw dust (SD) and Rice straw (RS) on the production of productive tillers of rice varieties

These effects of amendments were increased most in BRRI-47 variety followed by the sequence of BR-28>Guti Swarna>BRRI-61>BRRI-60>BRRI-3 under both FM and SW conditions. The straw yields of BRRI-47 rice variety under Tukey pairwise treatments comparison showed that T_{27} ($RH_4SD_4RS_4$) ranked first followed by T_{26} ($RH_4SD_4RS_2$) under both FM and SW conditions. The higher straw yields were attained from the treatments T_{21} to T_{27}. The treatment T_{16} (SD_2RS_2) ranked 6th from the lowest dose both in FM and 7th in SW conditions (Tables 3).

Tukey pairwise treatment comparison of straw yields of other rice varieties (BRRI-28, BRRI-60, BRRI-61, BR-3, Guti Swarna) also exhibited similar patterns of increase in straw yields with the application of treatments (Table 3). Almost similar observation was noticed from the study conducted in different coastal areas of Bangladesh [20]. They found that application of rice hull increased growth and yield contributing characters of BRRI Dhan 47. Though they have practiced for the higher rates and suggested to practice for lower rates of the treatments. They also concluded that the application of rice hull is effective in improving the adverse effect of salinity.

TABLE III. EFFECTS OF SELECTED AMENDMENTS ON MEAN STRAW YIELDS (T HA^{-1}) OF RICE VARIETIES GROWN ON SALINE SOIL.

Treatment		Mean Straw Yield (t ha^{-1})											
No.	Denotation	BRRI-28		BRRI-47		BRRI-60		BRRI-61		BR-3		Guti Swarna	
		FM	SW	FM	SW	FM	SW	FM	SW	FM	SW	FM	SW
T_1	Control ($RH_0SD_0RS_0$)	3.8 s	4.1s	4.3 q	4.6 s	3.2 q	3.5 q	3.5 p	3.8 r	3.2 l	3.5 m	3.7 q	4.0 r
T_2	RH_2	4.1 p	4.4 p	4.7 m	5.1 o	3.5 q	3.8 o	3.5 p	3.8 r	3.4 j	3.7 k	4.0 p	4.3 q
T_3	RH_4	4.3 o	4.6 o	4.8 l	5.2 n	3.7 l	4.0 m	3.7 n	4.0 p	3.6 h	3.9 j	4.3 m	4.6 n
T_4	SD_2	3.9 r	4.2 r	4.5 o	4.9 q	3.5 q	3.8 o	3.5 p	3.8 r	3.3 k	3.6 l	4.1 o	4.4 p
T_5	SD_4	4.0 q	4.3 q	4.6 n	5.0 p	3.6 n	3.9 n	3.7 n	4.0 p	3.4 j	3.7 k	4.2 n	4.5 o
T_6	RS_2	3.9 r	4.2 r	4.4 p	4.8 r	3.4 p	3.7 p	3.6 o	3.9 q	3.2 l	3.5 m	4.1 o	4.4 p
T_7	RS_4	4.0 q	4.3 q	4.6 n	5.0 p	3.6 n	3.9 n	3.8 m	4.1 o	3.3 k	3.6 l	4.2 n	4.5 o
T_8	RH_2SD_2	4.4 n	4.8 n	4.8 l	5.3 m	3.9 k	4.3 k	3.8 m	4.2 n	3.6 h	4.0 i	4.6 j	5.1 k
T_9	RH_2RS_2	4.4 n	4.8 n	4.8 l	5.3 m	3.9 k	4.3 k	3.9 l	4.3 m	3.5 i	3.9 j	4.5 k	5.0 l
T_{10}	RH_2SD_4	4.6 m	5.1 m	4.9 k	5.4 l	4.0 j	4.4 j	4.0 k	4.4 l	3.6 h	4.0 i	4.5 k	5.0 l
T_{11}	RH_2RS_4	4.7 l	5.2 l	5.0 j	5.5 k	4.1 i	4.5 i	4.1 j	4.5 k	3.5 i	3.9 j	4.6 j	5.1 k
T_{12}	RH_4SD_2	5.0 i	5.5 i	5.1 i	5.6 j	4.2 h	4.6 h	4.2 i	4.6 j	3.8 g	4.2 h	4.7 i	5.2 j
T_{13}	RH_4RS_2	4.9 j	5.4 j	5.0 j	5.5 k	4.1 i	4.5 i	4.0 k	4.4 l	3.9 f	4.3 g	4.8 h	5.3 i
T_{14}	RH_4SD_4	5.2 g	5.7 g	5.3 g	5.8 h	4.2 h	4.6 h	4.4 g	4.8 i	4.1 d	4.5 e	5.0 f	5.5 g
T_{15}	RH_4RS_4	5.1 h	5.6 h	5.2 h	5.7 i	4.4 f	4.8 f	4.2 i	4.6 j	4.1 d	4.5 k	4.9 g	5.4 h
T_{16}	SD_2RS_2	4.6 m	5.1 m	4.7 m	5.2 n	3.8 l	4.2 l	3.9 l	4.3 m	3.4 j	3.7 j	4.4 l	4.8 m
T_{17}	SD_2RS_4	4.7 l	5.2 l	4.9 k	5.4 l	3.9 k	4.3 k	4.0 k	4.4 l	3.5 i	3.9 i	4.6 j	5.1k
T_{18}	SD_4RS_2	4.8 k	5.3 k	4.8 l	5.3 m	4.1 i	4.5 i	4.1 j	4.5 k	3.6 h	4.0 h	4.7 i	5. j
T_{19}	SD_4RS_4	4.9 j	5.4 j	4.9 j	5.4 l	4.3 g	4.7 g	4.2 i	4.6 j	3.8 g	4.2 f	4.8 h	53 i
T_{20}	$RH_2SD_2RS_2$	5.3 f	6.0 f	5.1 i	5.8 h	4.5 e	5.1 e	4.3 h	4.9 h	3.9 f	4.4 e	5.0 f	0.7 f
T_{21}	$RH_2SD_4RS_2$	5.5 e	6.2 e	5.3 g	6.0 g	4.6 d	5.2 d	4.4 g	5.0 g	4.0 e	4.5 f	5.0 f	5.7 f
T_{22}	$RH_2SD_2RS_4$	5.5 e	6.2 e	5.5 f	6.2 f	4.7 c	5.3 c	4.5 f	5.1 f	3.9 f	4.4 d	5.1 e	5.8 e
T_{23}	$RH_2SD_4RS_4$	5.7 c	6.4 c	5.7 e	6.4 e	4.7 c	5.3 c	4.7 e	5.3 e	4.1 d	4.6 e	5.2 d	5.9 d
T_{24}	$RH_4SD_2RS_2$	5.6 d	6.3 d	5.8 d	6.6 d	4.6 d	5.2 d	4.8 d	5.4 d	4.0 e	4.5 c	5.4 c	6.1 c
T_{25}	$RH_4SD_2RS_4$	5.7 c	6.4 c	6.0 c	6.8 c	4.8 b	5.4 b	5.0 c	5.7 c	4.2 c	4.8 b	5.4 c	6.1 c
T_{26}	$RH_4SD_4RS_2$	5.9 b	6.7 b	6.2 b	7.0 b	4.7 c	5.3 c	5.1 b	5.8 b	4.3 b	4.9 b	5.6 b	6.3 b
T_{27}	$RH_4SD_4RS_4$	6.2 a	7.0 a	6.5 a	7.4 a	5.0 a	5.7 a	5.3 a	6.0 a	4.5 a	5.1 a	5.8 a	6.6 a

D. Grain Yield

Grain yields of rice variety BRRI-47 were found to be increased significantly ($p <0.05$) by the individual application of rice straw, rice hull and saw dust treatments, while their higher rates and their combinations were more effective than their individual application for the increase in the straw yields (Table 4). The highest grain yields (6.2 t ha^{-1} in FM and 7.4 t ha^{-1} in SW) were recorded at maturity stage of rice in the T_{27} ($RH_4SD_4RS_4$) which received the highest doses of these treatments followed by the T_{26} ($RH_4SD_4RS_2$). The lowest grian yields (3.7 t ha^{-1} in FM and 3.9 t ha^{-1} in SW) were recorded at maturity in control condition ($RH_0SD_0RS_0$) where no amendment was applied. Tukey pairwise treatment comparison tests were done at 5% ($p <0.05$) level (Table 4).

Almost similar and significant ($p <0.05$) positive effects were observed on grain yeild for all other varieties (BRRI-28, BRRI-60, BRRI-61, BR-3, Guti Swarna) studied. These were increased most in BRRI-47 variety followed by the sequence of Guti Swarna>BRRI-28>BRRI-61>BRRI-60>BRRI-3 under both FM and SW conditions. Grain yield of rice was significantly different among the incorporation of rice straw into the soil and rice straw combined with various organic fertilizers treatments [21]. The rice straw incorporated into the soil combined with the application of cattle manure produced maximum grain yield (3820 kg ha^{-1}) which did not make a significant difference from the treatment of rice straw incorporated into the soil combined with cattle manure and bio-extracted fertilizer (3797 kg ha^{-1}).

TABLE IV. EFFECTS OF SELECTED AMENDMENTS ON MEAN GRAIN YIELDS (T HA-1) OF RICE GROWN ON SALINE SOIL

Treatment		Mean Grain Yield (t ha^{-1})											
No.	Denotation	BRRI-28		BRRI-47		BRRI-60		BRRI-61		BR-3		Guti Swarna	
		FM	SW	FM	SW	FM	SW	FM	SW	FM	SW	FM	SW
T_1	Control ($RH_0SD_0RS_0$)	3.5 r	5.2 h	3.7 r	3.9 t	2.9 k	3.0 l	3.1 p	3.3 s	2.5 l	2.6 o	3.4 r	3.6 s
T_2	RH_2	3.6 q	3.8 r	3.9 r	4.1 s	2.9 k	3.0 l	3.3 n	3.5 q	2.8 j	2.9 m	3.8 q	4.0 r
T_3	RH_4	3.8 o	4.0 p	4.1 p	4.3 p	3.0 j	3.2 k	3.5 l	3.7 o	3.0 h	3.2 k	4.1 n	4.3 o
T_4	SD_2	3.5 r	3.7 s	3.9 r	4.1 s	2.9 k	3.0 l	3.2 o	3.4 r	2.7 k	2.8 n	3.8 q	4.0 r
T_5	SD_4	3.7 p	3.9 q	4.0 q	4.2 r	2.9 k	3.0 l	3.3 n	3.5 q	2.8 j	2.9 m	4.0 o	4.2 p
T_6	RS_2	3.5 r	3.7 s	3.9 q	4.1 s	2.9 j	3.0 l	3.2 o	3.4 r	2.7 k	2.8 n	3.8 q	4.0 r
T_7	RS_4	3.6 q	3.8 r	4.0 p	4.2 r	3.0 j	3.2 k	3.4 m	3.6 p	2.8 j	2.9 m	3.9 p	4.1 q
T_8	RH_2SD_2	3.9 n	4.2 o	4.1 p	4.4 p	3.0 j	3.2 k	3.5 l	3.8 n	3.2 f	3.5 i	4.2 m	4.5 m
T_9	RH_2RS_2	3.9 n	4.2 o	4.3 n	4.6 n	3.0 j	3.2 k	3.5 l	3.8 n	3.1 g	3.3 j	4.0 o	4.3 o
T_{10}	RH_2SD_4	4.0 m	4.3 n	4.2 o	4.5 o	3.0 i	3.2 k	3.6 k	3.9 m	3.2 f	3.5 i	4.1 n	4.4 n
T_{11}	RH_2RS_4	4.0 m	4.3 n	4.3 n	4.6 n	3.1 h	3.3 j	3.7 j	4.0 l	3.1 g	3.3 j	4.3 l	4.6 l
T_{12}	RH_4SD_2	4.2 k	4.5 l	4.5 l	4.9 l	3.2 g	3.5 i	3.8 i	4.1 k	3.4 e	3.7 h	4.3 l	4.6 l
T_{13}	RH_4RS_2	4.2 k	4.5 l	4.5 l	4.9 l	3.3 d	3.6 h	3.6 k	3.9 m	3.5 d	3.8 g	4.4 k	4.8 k
T_{14}	RH_4SD_4	4.4 i	4.8 j	4.7 j	5.1 j	3.4 f	3.7 g	4.0 g	4.3 i	3.7 b	4.0 f	4.6 i	5.0 i
T_{15}	RH_4RS_4	4.6 h	5.0 i	4.8 i	5.2 i	3.6 h	3.9 f	3.9 h	4.2 j	3.5 d	3.8 g	4.5 j	4.9 j
T_{16}	SD_2RS_2	4.1 l	4.4	4.5 l	4.9 l	3.2 g	3.5 i	3.6 k	3.9 m	2.9 i	3.1 k	4.0 o	4.3 o
T_{17}	SD_2RS_4	4.3 j	4.6 k	4.6	5.0 k	3.3 h	3.6 h	3.7 j	4.0 l	3.1 g	3.3 j	4.1 n	4.4 n
T_{18}	SD_4RS_2	4.2 k	4.5 l	4.4 l	4.8 m	3.2 g	3.5 i	3.7 j	4.0 k	3.0 h	3.2	4.5 j	4.9 j
T_{19}	SD_4RS_4	4.4 i	4.8 j	4.5 k	4.9 l	3.3 e	3.6 h	3.8 i	4.1 h	3.2 f	3.5 i	4.5 j	4.9 j
T_{20}	$RH_2SD_2RS_2$	4.7 g	5.6 g	4.9 h	5.8 h	3.5 d	4.2 e	3.9 h	4.7 g	3.4 e	4.1 e	4.7 h	5.6 h
T_{21}	$RH_2SD_4RS_2$	4.9 e	5.8 e	5.2 g	6.2 g	3.6 c	4.3 d	4.0 g	4.8 f	3.5 d	4.2 d	4.8 g	5.7 g
T_{22}	$RH_2SD_2RS_4$	4.7 g	5.6 g	5.4 f	6.4 f	3.7 c	4.4 c	4.1 f	4.9 e	3.4 e	4.1 e	4.9 f	5.8 f
T_{23}	$RH_2SD_4RS_4$	4.8 f	5.7 f	5.6 e	6.7 e	3.7 d	4.4 c	4.2 e	5.0 d	3.5 d	4.2 d	5.1 e	6.1e
T_{24}	$RH_4SD_2RS_2$	5.2 d	6.2 d	5.7 d	6.8 d	3.6 b	4.3 d	4.3 d	5.1 c	3.6 c	4.3 c	5.2 d	6.2 d
T_{25}	$RH_4SD_2RS_4$	5.4 c	6.4 c	5.8 c	6.9 c	3.8 c	4.5 b	4.4 c	5.2 b	3.6 b	4.3 c	5.4 c	6.4 c
T_{26}	$RH_4SD_4RS_2$	5.5 b	6.6 b	5.9 b	7.0 b	3.7 c	4.4 c	4.5 b	5.4 b	3.7 b	4.4 b	5.5 b	6.6 b
T_{27}	$RH_4SD_4RS_4$	5.8 a	6.9 a	6.2 a	7.4 a	4.0 a	4.8 a	4.7 a	5.6 a	3.8 a	4.5 a	5.6 a	6.7 a

[a]**FM=** Field moist condition, [b]**SW=** Standing water condition, [c]**RH=** Rice hull, [d]**SD=** Saw dust, [e]**RS=** Rice Straw applied at 0, 2, 4 t ha^{-1}

IV. CONCLUSION

The best growth and yield performances of rice varieties were exerted by BRRI-47 followed by BRRI-28 and BRRI-60 varieties and the response were found to be increased with the increased rates of organic amendments. It is noted that, the BRRI-28 is a saline sensitive variety, but growth responses of this variety was also increased significantly and the effects were more pronounced with the higher rates of organic amendments. A local variety, Guti Swarna also performed well and ranked 4^{th} among the 6 varieties under both in field moist and standing water conditions. The application of rice hull, rice straw, sawdust individually or in combinations in coastal saline soils were determined better in relation to plant growth and the improvement of saline soil. These effects of organic amendments were more pronounced with their higher rates and also striking on the growth and yield of rice grown under standing water condition than that of field moist condition. However, further experiments should be conducted for ensuring the capability of salt tolerance of rice varieties and adaptability of the amendment by the local farmers under variable conditions.

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