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Morphological and yield performance of rice varieties grown in moderately and strongly saline soils of Khulna, Bangladesh

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Abstract: Coastal areas of Bangladesh is affected by various degrees of salinity where agricultural land use and cropping intensity is very much poor. In this regard, a pot experiment was conducted in moderately (EC- 5.70 dS/m) and strongly saline (EC- 8.24 dS/m) soils of the coastal areas for growing different local and high yielding rice varieties to investigate their yield performances in these soils. Different morphological (Plant height, leaf area, number of leaves, number of tillers, number of panicles , dry weight) and yield contributing parameters (filled grain , unfilled grain, harvest index, grain weight, yield of grain and straw yield) were observed. Pots were arranged in a completely randomized design. A total of five different rice varieties were tested namely: BRRI *dhan* 28, BRRI *dhan* 81, BRRI *dhan* 74, BRRI *dhan* 58 and the local variety *Balia*. Among the five rice varieties, BRRI *dhan 58* rice was completely failed to grow in both the soils. With the remaining rice varieties, BRRI *dhan* 28 showed better yield in strongly saline soil with respect to all the morphological and yield parameters studied. On the other hand, in moderately saline soil, BRRI *dhan* 74 rice variety showed better performance than that of the other rice varieties studied.

Keywords: salinity rice; variety; yield; salt tolerance; morphology

Rice (*Oryza sativa* L.) is the principal food for more than one third of the world's population and more than 90% rice is grown in Asia. Though rice is considered as one of the major food crops in the world, it is also considered as extremely salt-sensitive. Salinity is one of the most serious problems for limiting rice production all over the world especially in the coastal areas (Reddy et al, 2017).

In Bangladesh salt affected land was recorded 105.6 million hactersduring 2009, out of which about 2.5 million hectors of lands are coastal low laying land bearing salinity levels of 0.9 to 2.1dS/m(SRDI , 2010; Haque, 2006). In the last 35 years it showed that salinity has increased about 26% (Mahmuduzzaman et al, 2014).

According to the salinity level, four categories of saline soils are; non saline soil (<2 dS/m), slightly saline soil (2-4 dS/m), moderately saline soil (4-8 dS/m), strongly saline soil (8-16 dS/m) and very strongly saline soil (>16 dS/m). Moderately and strongly saline soil covers an area of 274.22 and 351.69 million hectares respectively in coastal areas of Bangladesh (SRDI, 2010). Among these categories, non-saline to strongly saline soils is used for crop production in wet season (Haque, 2006). The expected consumption of rice in the country per person per year will

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be 147.2 and 133.2 kg in 2020 and 2040 respectively (FAO, 2011).

Population of Bangladesh was 160 million in 2015 which will reach to 186, 215.4 and 243 million in 2030, 2050 and 2071 respectively and the end of this century, population of Bangladesh is predicted to reach 249 million (Kabir et al, 2015).

As a result, sufficient production of rice is the first and foremost thing to ensure food security in Bangladesh which influences social and political stability. The agricultural land of the country is decreasing day by day and horizontal expansion of land is not possible. To ensure the food production of the country large amount of food production is only the solution. For this reason, we need to use the marginal soils like salt affected soil for the production purpose.

In saline soil, crop is affected by different degrees of soil salinity which account about 50% yield reduction of the major crops in coastal areas of Bangladesh (Rahman et al, 2016). pH value (ranges from 6.0-8.4) with lower organic matter content (1.0-1.5%) of saline soil causes deficiency of macro (N and P) and micro (Cu and Zn) nutrients (Haque, 2006). Therefore, agricultural land use in these areas is very poor, which results lower cropping intensity. Various strategies (application of organic matter, organic manure, chemical amendments, conditioner or fertilizer, improving drainage system and adaptation of salt tolerant rice varieties) have been adopted to increase the cropping intensities in the coastal areas of Bangladesh.

To meet the demand of food in the country, various types of salt tolerant rice varieties currently cultivated in the south west coastal areas of Bangladesh. IRRI has developed a number of salt tolerant rice varieties that include BRRI dhan 47, BRRI dhan 53, BRRI dhan 54, Binadhan-8, BRRI dhan 55, Binadhan-10, BRRI dhan 61, BRRI dhan 67, BRRI dhan 73, and BRRI dhan 78 (Hassan and Islam, 2019). SABRAO (2013) also used BRRI dhan 28 as a salt tolerant rice variety in Satkhira district. All the above varieties are not suited to cultivate in a particular saline soil. With this end in view, it is necessary to test the yield performance of different salt tolerant rice varieties for growing in saline soils of the coastal areas of Bangladesh. Therefore, the present research is focused on the following objectives.

(i) To monitor the morphological and yield contributing characteristics of different rice varieties grown in moderately and strongly saline soil conditions.

(ii) To evaluate the performance of different rice varieties grown in moderately and strongly saline soil conditions,

(iii) To identify the best rice variety copes with moderately and strongly saline soil condition.

MATERIALS AND METHODS

Pot experiment was carried out from 19 January 2019 to 29 April 2019 at the field lab of Soil, Water and Environment discipline located in campus of Khulna University, Khulna, Bangladesh. The detail of materials used and methods followed in the investigation are described in this chapter.

Location of the study area for sample collection

The locations for soil sample collection for this experiment were Pankhali village of Chalnaupozila in Khulna district and Kashipur village of Rampalupozila in Bagerhat district.

Collection of soil and preparation

Soils were collected from the depth of 0 – 15 cm. The soils were air dried and unwanted materials were cleared. After drying, the larger aggregates were broken down into smaller particles using wooden hammer. The soils were then passed through a 4 mm sieve. Five kg sieved soils were filled into each of the 30 pots. The dimension of the pot used in this experiment was 23 cm height and average radius was 20 cm. The pore of each crocks were filled by cement because stagnant water was needed for rice cultivation.

Test plant

Rice plant was selected for the study and the varieties used in this study are described in Table 1.

Table 1. Rice cultivars used for the experiment.

BRRI variety	Local name
BRRI *dhan* 28	-----
BRRI *dhan* 81	-----
BRRI *dhan* 74	-----
Balia	*Balia*
BRRI *dhan* 58	-----

Rice varieties were collected from the farmers of Chulkathi, Fultola and Batiaghata villages. Days of seedling for BRRI dhan 28 and BRRI dhan 81 varieties were 27 and 32 days respectively. Days of seedling for BRRI dhan 74, BRRI dhan 58 and Balia variety were 35 days.

Soils used for the experiment

Properties of the soils used in the experiment are described in Table 2.

Table 2. Properties of the saline soils.

Properties	Moderately saline soil	Strongly saline soil
Location	Chalna	Bagerhat
GPS reading	N-22°63.127’	N-22°36.083’
	E-89°50.842’	E-89°41.798’
pH	7.26	8.07
EC (dS/m)	5.70	8.24
Bulk density (D_b) (g/cc)	1.31	1.20
Available Na^+ (mg/kg)	1224.9	1837.35
Available K^+ (mg/kg)	856.24	934.08

Experimental design

A Complete Randomize Design (CRD) was used for the experiment with three replications.

Laboratory analyses

Bulk density was determined by core sampling method described by Black (1965). Soil pH (soil: water = 1: 2.5) was measured electro chemically with the help of glass electrode pH meter as suggested by Jackson (1973). Electrical conductivity (EC) of soil (ratio of soil to water of 1: 5) was determined by EC meter (USDA, 2004). Exchangeable Na and K of the soil was determined by using 1N NH_4OAc (pH 7.0) solution as described by Benton (2001).

Statistical analysis

One way analysis of variance (ANOVA) was carried out to show significant differences using 0.05 levels of confidence interval. The common statistical software SPSS 16.0 was used for all the statistical analysis. The means and standard deviation were calculated and graphs were designed by using MS Excel (Microsoft office 2013).

RESULTS AND DISCUSSION

The experiment was conducted to investigate the growth performance of various rice varieties in strongly and moderately saline soils.

Morphological characteristics of different rice varieties in strongly saline soil

Fig. 1. showed the morphological characteristics (plant height, leaf area, and shoot dry weight, number of leaves, tillers, and panicles per hill) of different rice varieties in strongly saline soil.

Height: The highest height was found with BRRI dhan 28 variety which was 102 cm and the lowest height was found with local variety Balia which was 78 cm. BRRI dhan 81 and BRRI dhan 74 rice varieties showed a height of 84 and 90 cm respectively. Height of BRRI dhan 28 was significantly ($*p \leq 0.05$) higher as compared to other rice varieties studied. BRRI dhan 74 showed significantly ($*p \leq 0.05$) higher height as compared to local variety Balia but did not produce any significant difference in height with BRRI dhan 81. The reduction in height of studied rice varieties except BRRI dhan 28 may be due to lower susceptibility against salinity which reduced cell division and elongation due to the toxicity of excess sodium ion present in saline condition. Rahman et al (2016) found reduced height of aromatic rice under salt stress. On the other hand, Murtaza et al (2005) observed that plant height of diffident crops decreased due to the presence of high amount of salts.

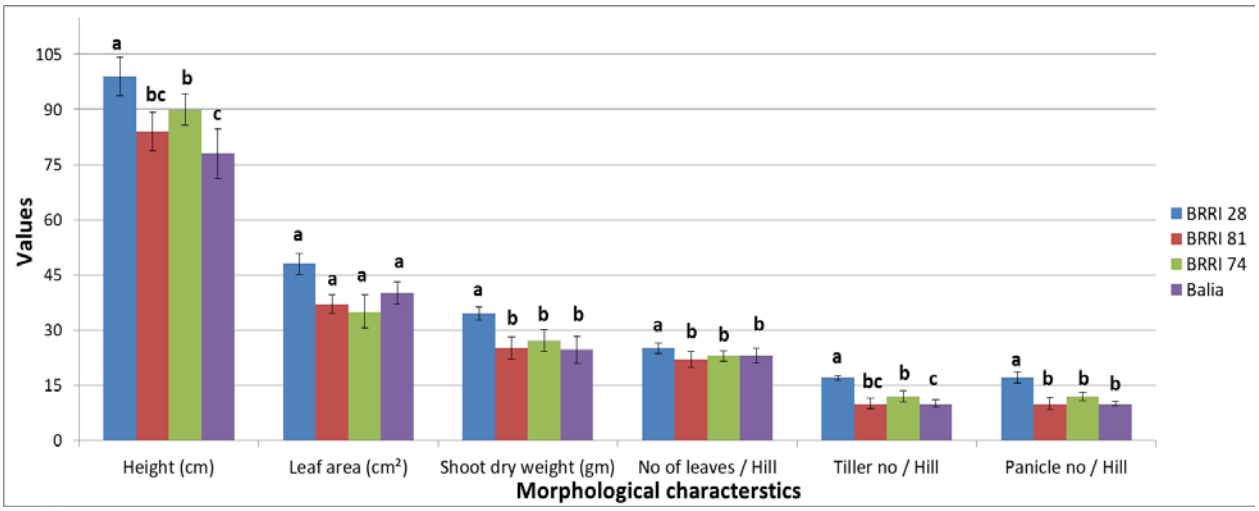

Fig. 1. Morphological characteristics of different rice varieties in strongly saline soil.

Leaf area: The highest leaf area was found in BRRI dhan 28 variety which was 48 cm^2 whereas the lowest leaf area was found for BRRI dhan 74 variety which was 35 cm^2. Leaf area of BRRI dhan 81 and Balia were 37 and 40 cm^2 respectively. Leaf area did not differ significantly for all the rice varieties studied. The decrease in leaf area was due to the negative effect of salinity which decreases whole plant photosynthesis by restricting leaf area expansion.Netondo et al (2004) found the reduction of leaf area for sorghum under salt stress.

Shoot dry weight: BRRI dhan 28 variety showed the highest shoot dry weight which was 11.17 gm / pot and BRRI dhan 81 showed the lowest shoot dry weight which was 8.68 gm. /pot. Shoot dry weight for BRRI dhan 74 and local variety Balia were 10.71 and 10.88 gm /pot respectively. BRRI dhan 28 rice variety showed significantly (*$p \leq 0.05$) higher shoot dry weight than that of the other rice varieties studied. The increase in shoot dry weight of BRRI dhan 28 may be due to higher accumulation of carbohydrate which may be a result of genetic difference as compared to the other rice varieties. Nahar et al (2018) observed difference in dry matter production for millet under salinity.Hasamuzzaman et al (2009) reported that, dry matter production in rice depends greatly on genetic potentiality of the varieties under salinity stress.

Number of leaves per hill: The highest number of leaves for rice plant was found in BRRI dhan 28 rice variety which was 25 and the lowest number of leaves was found for BRRI dhan 81 variety which number was 22. BRRI dhan 74 and Balia rice varieties produced 23 and 24 leaves per hill respectably. Number of leaves of BRRI dhan 28 was significantly (*$p \leq 0.05$) higher as compared to other rice varieties studied. Significant reduction of no of leaves was because of low leaf water potential resulted in large reductions in photosynthesis, the reduction are caused both by decreases in the photosynthetic activity of a unit of leaf and in the production in the new leaf surface. Zubaer et al (2007) also found same result regarding the number of leaves per hill.

Tiller no per hill: The highest number of tiller produced in BRRI dhan 28 rice variety which was 17 and the lowest number of tiller was 10 found both in BRRI dhan 81 and Balia variety where BRRI dhan 74 showed a tiller number of 12. Number of tiller of BRRI dhan 28 was

significantly (*p≤0.05) higher as compared to other rice varieties studied. The fewer tiller recorded could be as a result of salinity stress imposed at tillering because of non-availability of water at tillering state resulted in reduction in photosynthesis. Akram et al (2013) found the reduction of tiller number in water stress condition for basmati rice cultivar.

Panicle no per hill: BRRI dhan 28 rice variety showed highest number of panicle (17) whereas both BRRI dhan 81 and Balia produced the lowest (10) panicle per plant. In case of BRRI dhan 74 rice variety, panicle per plant was found 12 in this study. Number of panicles of BRRI dhan 28 was significantly (*p≤0.05) higher as compared to other rice varieties studied. The lower panicle initiation other than BRRI dhan 28 may be due to disturbed bio chemical, physiological and enzymatic activities in these plants. Basu et al (2010) also observed reduction of panicle for rice plant in draught condition.

Morphological comparison among different rice varieties for moderately saline soil

Fig.2. showed the morphological characteristics (plant height, leaf area, and shoot dry weight, number of leaves, tillers, and panicles per hill) of different rice varieties in moderately saline soil.

Height: The highest height of rice plant was found in BRRI dhan 74 variety which was 97 cm and the lowest height was found for BRRI 28 variety which was 85 cm. BRRI dhan 81 and Balia rice varieties showed a height of 93 and 88 cm respectively. Height of BRRI dhan 74 was significantly (*p≤0.05) higher as compared to other rice varieties studied. On the other hand, height of BRRI dhan 81, Balia and BRRI dhan 28 was significantly (*p≤0.05) varied among the varieties respectively. Except BRRI dhan 74 rice variety, the reduction of the height for other rice varieties may be due to the lower susceptibility against the toxicity of excess sodium ion which reduced the elongation and cell division. Rahman et al (2016) observed that, height of aromatic rice plant reduced under salt stress. Moreover, Murtaza et al (2005) found that high level of salt concentration decreased the height of the rice and wheat plant. Mazher et al (2007) reported reduction in height of ornamental and woody tress due to the reduction in enzyme activity, photosynthesis, the level of carbohydrates and growth hormone under saline condition.

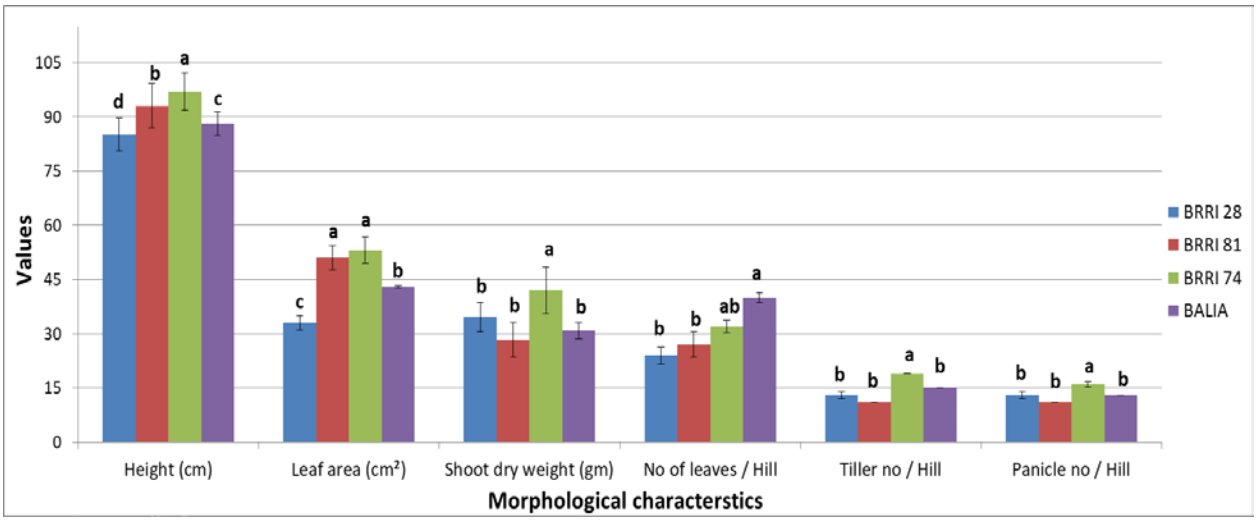

Fig. 2. Morphological comparisons among different rice varieties for moderately saline soil.

Leaf area: The highest leaf area was found in BRRI dhan 74 variety which was 53 cm^2 whereas the lowest leaf area was found for BRRI dhan 28 variety which was 33 cm^2. On the other hand, BRRI dhan 81 and Balia variety showed 51 and 43 cm^2respectively. Leaf area of BRRI dhan 74 was significantly (*p≤0.05) higher as compared to BRRI dhan 28 and Balia rice varieties studied but insignificant for BRRI dhan 81 rice variety. BRRI dhan 28 and Balia rice varieties also possess significant differences. The decrease in leaf area may be due to the loss of potential efficiency of chlorophyll cause by salinity which ultimately affects the assimilation of carbon dioxide in leaves. Wankhade et al (2013) observed the reduction of bulliform cells and their dimension under salinity stress for rice plant is the main cause of reduced leaf area.

Shoot dry weight: The highest dry weight of shoot was found in BRRI dhan 74 rice variety which 14.88 gm. was whereas BRRI dhan 81 showed lowest weight which was 11.57 gm. BRRI dhan 28 and Balia rice variety showed 13.15 and 13.9 gm. respectively. Shoot dry weight of BRRI dhan 74 was significantly (*p≤0.05) higher as compared to BRRI dhan 81 rice variety but it was insignificant for BRRI dhan 28 and Balia rice varieties. On the other hand, there was no significant difference between BRRI dhan 28 and Balia variety. BRRI dhan 74 produced the highest dry weight because of the higher accumulation of carbohydrate. This may be due to the genetic difference compared with the other rice varieties studied. Hasamuzzaman et al (2009) observed influence of genetic potentiality on dry matter production of rice under different saline condition. On the other hand Nahar et al (2018) showed variation in dry matter production for millet crop under saline condition.

No of leaves per hill: The highest number of leaves for rice plant was found in Balia rice variety which was 40 and the lowest number of leaves was found for BRRI dhan 28 variety which number was 24. BRRI dhan 74 and BRRI dhan 81 rice varieties produced 32 and 27 leaves per hill respectably. Number of leaves of Balia variety was significantly (*p≤0.05) varied with BRRI dhan 28 and BRRI dhan 81 but it was insignificant for the BRRI dhan 74 rice variety. Reduction of leaf number was due to the low water potential in the leaf surface which effects on photosynthetic activity of individual leaf and the production of new leaf. Khanam et al (2018) reported that, leaf number decreases due to the accumulation of sodium chloride in the cell walls and cytoplasm of the older leaves. Alamgir and Ali (2006) found that, reduction of the formation of leaf primordia under salinity could be the probable reason for low leaf number. Zubaer et al (2007) observed the reduction of leaves for aman rice in saline stress condition.

Tillers no per plant: The highest number of tillers produced in BRRI dhan 74 rice variety which was 19 and the lowest number of tillers were found both in BR 81 variety which was 11. On the other hand, BRRI dhan 28 and Balia showed a tiller number of 13 and 15 respectively. Number of tillers of BRRI dhan 74 was significantly (*p≤0.05) higher as compared to other rice varieties studied. Reduced stomatal conductance, photosynthetic rate, transpiration rate and relative water content may be the cause for the reduction of tiller number in rice plant studied except BRRI

dhan 74 variety. Basu et al (2010) also investigated the same result in case of diminishing of tiller number in water stress condition.

Panicle no per plant: BRRI dhan 74 rice variety showed height number of panicle (16) whereas BRRI dhan 81 produced the lowest (11) panicle per plant. BRRI dhan and Balia produced (12) and (13) panicle per plant respectively. Number of panicle of BR 74 was significantly (*p≤0.05) higher as compared to other rice varieties studied. Lowering of panicle number was recorded due to the salinity stress because of the unavailability of water at the stage of panicle initiation. Reduction of panicle number for rice in drought condition was found by Akram et al (2013).

Yield comparison among different rice varieties for strongly saline soil

Fig.3. showed the yield contributing characteristics (Harvest index, 1000 grain weight, straw yield and grain yield) of different rice varieties in strongly saline soil.

1000 Grain weight: The highest 1000 grain weight was found in BRRI dhan 74 rice variety which was 16.33 gm. and the lowest weight was found 12 gm. for local variety Balia. BRRI dhan BR 81 and BRRI dhan 28 showed 10.97 and 14 gm. grain weight respectively. BRRI dhan 74 rice variety showed significantly (*p≤0.05) higher 1000 grain weight as compared to other varieties except BRRI dhan 28. Salt stress decreases the translocation of the food materials to the grain results in lowering of grain weight. Zubaer et al (2007) observed the degree of reduction in 1000 grain weight was different in different genotypes. The study finds that the grain of BR 74 was course in nature. As a result 1000 grain weight was found highest in this variety.

Harvest index: The highest harvest index (HI) was found in BRRI dhan 28 variety which was 48.31 and the lowest index value was found in BRRI dhan 74 variety which was 39.47. BRRI dhan 81 and Balia showed 46.01 and 44.81 respectively. Harvest index of BRRI dhan 28 rice variety was significantly (p≤0.05) higher as compared to other rice varieties studied. BRRI dhan 81 and Balia rice varieties showed greater significant difference with BRRI dhan 74 rice varieties. Different harvest index was due to the genotype and the salt stress in saline condition which affects the translocation of the carbohydrate in the cultivars. Zubaer et al (2007) also found same result in water stress condition.

Grain yield: Grain yield included production of spikelet, pollen viability and root properties of the different rice varieties. The highest grain yield was found in BRRI dhan 28 variety which was 3.77 t/ha whereas the lowest yield was found in BRRI dhan 81 variety which was 2.24 t/ha. Balia and BRRI dhan 74 showed 2.3 and 2.63 t/ha grain yield respectively. Grain yield of BRRI dhan 28 rice variety was significantly (*p≤0.05) higher as compared to other rice varieties studied. Nahar et al (2018) investigated lower yield for foxtail millet crop under saline condition. Murtaza et al (2005) observed that paddy yield depends on the salt tolerance capacity of the varieties.

Straw yield: The highest straw yield was found in BRRI dhan 28 variety which was 4.93 t/ha and the lowest yield was found in BRRI dhan 81 variety which was 3.34 t/ha. Balia and BRRI dhan 74 showed 3.48 and 3.39 t/ha straw respectively. BRRI dhan 28 rice variety was

significantly (*p≤0.05) higher as compared to other rice varieties studied. Hasan et al (2015) observed the genotypic difference is the main cause for the variation of yield for wheat.

Grain properties of different rice varieties in strongly saline soil

Table 3. showed the grain properties (Total grain, filled grain, unfilled grain and percent filled grain per panicle) of different rice varieties in strongly saline soil.

Total grain per panicle: The highest number of grain was found in BRRI dhan 28 variety which was 129 and the lowest grain number was found in BRRI dhan 81 variety which was 98. Balia and BRRI dhan 74 rice varieties produced 110 and 109 grain respectably. Total grain number of BRRI dhan 28 rice variety was significantly (*p≤0.05) higher as compared to BRRI dhan 81 and BRRI dhan 74 rice varieties and insignificant with the local variety Balia. This variation may be due to the different genetic makeup of the cultivars and the varying in assimilation of photosynthetic product. Chamely et al (2015) also observed same criteria for the grain production perpanicle.

Filled grain per panicle: The highest filled grain was found in BRRI dhan 28 variety which was 102 and the lowest number of filled grain was found in BRRI dhan 81 variety which was 87. Balia and BRRI dhan 74 rice varieties showed 95 and 88 grain respectably. There is no significant difference among the rice varieties studied.

Unfilled grain per panicle: The highest unfilled grain was found in BRRI dhan 28 variety which was 27 and the lowest number of unfilled grain was found in Balia rice variety which was 15. BRRI dhan 81 and BRRI dhan 74 rice varieties showed 17 and 21 respectably. Unfilled Grain of BR 28 rice variety was significantly (*p≤0.05) higher as compared to other rice varieties studied. Due to the salinity stress, the water unavailability could not provide much of the assimilate to the grain.

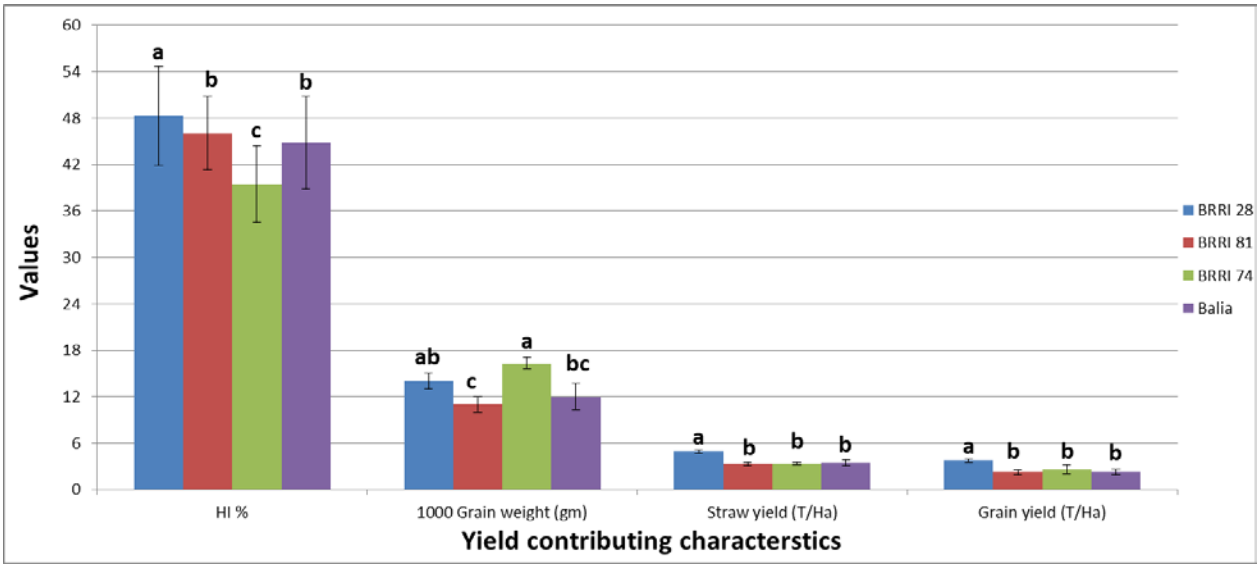

Fig. 3. Yield comparisons among different rice varieties for strongly saline soil.

Percent filled grain: Highest percentage of filled grain was found in Balia variety which was 86.36% and the lowest percentage was found in BRRI dhan 28 rice variety which was 79.06%. BRRI dhan 81 and BRRI dhan 74 rice varieties showed 82.85% and 80.73% of filled grain respectably. No significant difference was found for percent filled grain.

Table 3. Grain properties of the cultivars in strongly saline soil.

Variety	*Total grain/Panicle*	*Filled grain/Panicle*	*Unfilled grain/Panicle*	*%Filled grain/Panicle*
BRRI 28	129±2.12 a	102±0.71 a	27±5.29 a	79.06±4.10 a
BRRI 81	98±3.54 b	87±1.41 a	17±4.58 b	82.85±2.55 a
BRRI 74	109±5.03 b	88±3.54 a	21±3.21 b	80.73±3.58 a
Balia	110±4.24 ab	95±4.35 a	15±3.51 b	86.36±3.92 a

Yield comparison among different rice varieties for moderately saline soil

Fig.4. showed the yield contributing characteristics (Harvest index, 1000 grain weight, straw yield and grain yield) of different rice varieties in moderately saline soil.

Harvest index: The highest harvest index value was found in BRRI dhan 74 variety which was42.12 and the lowest index value was found in Balia variety which was 37.18. BRRI dhan 28 and BRRI dhan 81 showed 39.8 and 38.03 respectively. Harvest index of BRRI dhan R 74 rice variety was significantly (*$p \leq 0.05$) higher as compared to other rice varieties studied. On the other hand, the other rice varieties did not show any significant difference.

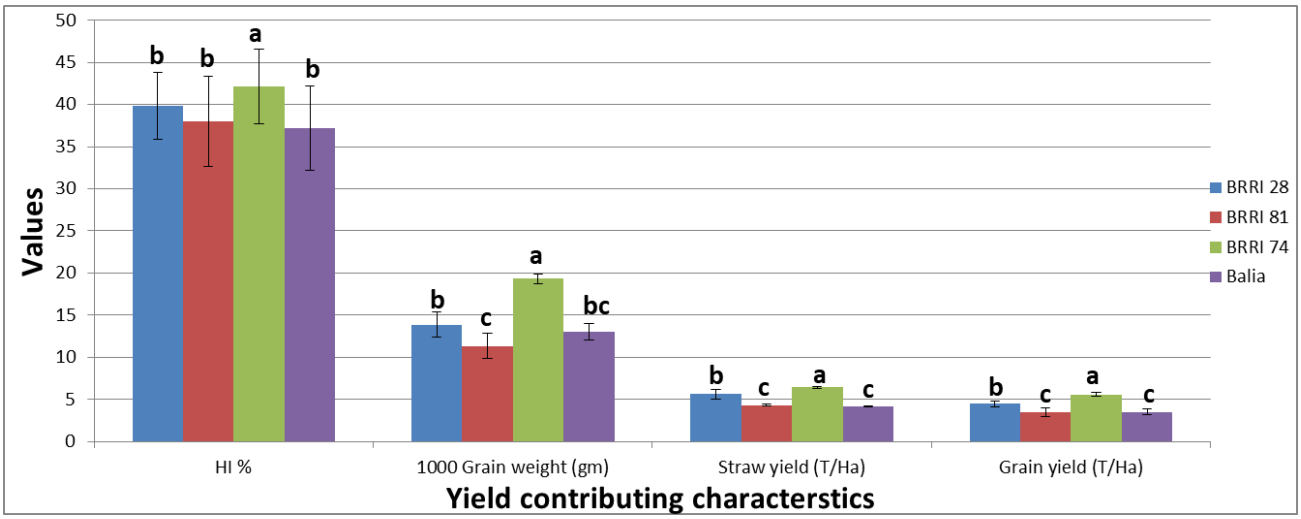

Fig. 4. Yield comparisons among different rice varieties for moderately saline soil.

Straw yield: The highest straw yield was found in BRRI dhan 74 rice variety which was 6.43 ton/ha and the lowest straw yield was found by Balia variety which was 4.13 ton/ha straw respectively. BRRI dhan 28 and BRRI dhan 81 rice variety produced 5.62 and 4.31 ton/ha. BRRI dhan 74 rice variety showed significantly (*$p \leq 0.05$) higher straw yield as compared to other varieties. On the other hand, BRRI dhan 28 also showed significantly high compared with the other rice varieties studied. Different straw yield was found may be due to the dry matter production which is influenced by differential carbohydrate supply, vegetative growth and the genotypes. Hasamuzzaman et al (2009) also observed the influence of differential accumulation of carbohydrate supply results variation in straw yield.

Grain yield: The highest grain yield was found in BRRI dhan 74 rice variety which was 5.58 ton/ha and the lowest straw yield was found by BRRI dhan 81 variety which was 3.47 ton/ha. BRRI dhan 28 and Balia rice variety produced 4.45 and 3.51 ton/ha. BRRI dhan BR 74 rice variety showed significantly (*$p \leq 0.05$) higher and BRRI dhan 28 also showed significantly high variation in straw yield as compared to other rice varieties studied. The variation in grain yield is due to the nutritional imbalance, deterioration of lipid metabolism, decreased photosynthesis which results in the lowering of grain quality under salt stress. Abbas et al (2013) observed same phenomenon for wheat plant. Saqib et al (2012) reported that grain yield reduces for the negative impact of salinity on number of grain and spike for wheat plant.

Table 4. Grain properties of the cultivars in moderately saline soil.

Variety	***Total grain/Panicle***	***Filled grain/Panicle***	***Unfilled grain/Panicle***	***%Filled grain/Panicle***

BR 28	140±13.44 ab	125±14.85 a	15±1.41 a	88.43±2.56 a
BR 81	158±0.71 a	140±1.41 a	18±2.12 a	88.48±1.04 a
BR 74	142±3.54 ab	127±5.66 a	15±2.83 a	89.95±1.82 a
Balia	133±6.36 c	125±4.24 a	8±2.12 a	91.08±1.22 a

Grain properties of different rice varieties in moderately saline soil

Table 4.2 showed the grain properties (total grain, filled grain, unfilled grain and percent filled grain per panicle) of different rice varieties in moderately saline soil.

Total grain per panicle: The highest number of grain was found in BRRI dhan 81 rice variety which was 158 and the lowest grain number was found in Balia rice variety which was 133. BRRI dhan 28 and BRRI dhan 74 rice varieties produced 140 and 142 grain respectably. Total grain number of BRRI dhan 81 rice variety was significantly (*$p \leq 0.05$) higher as compared with Balia rice variety but insignificant with BRRI dhan 28 and BRRI dhan 74 rice varieties studied. Assimilation of photosynthetic product may be the cause of the variation in grain production. Chamely et al., (2015) also observed same criteria for the grain production per panicle.

Filled grain per panicle: The highest filled grain was found in BRRI dhan 81 variety which was 140 and the lowest number of filled grain was found in BRRI dhan 28 and Balia rice variety which was 125. BRRI dhan 74 rice variety showed 127 grain respectably. Significant variation was not found for filled grain.

Unfilled grain per panicle: The highest unfilled grain was found in BRRI dhan 81 variety which was 18 and the lowest number of unfilled grain was found in Balia rice variety which was 8. Both BRRI dhan 81 and BRRI dhan 74 rice varieties showed 15 unfilled grains. There was no significant variation among the rice varieties studied.

Percent filled grain: Highest percentage of filled grain was found in Balia variety which was 98.08% and the lowest percentage was found in BRRI dhan 28 rice variety which was 88.43%. BRRI dhan 81 and BRRI dhan 74 rice varieties showed 88.48% and 89.95% of filled grain respectably. No significant variation was found in present filled grain among the rice cultivars.

Conclusion

From the study it is concluded that BRRI dhan 74 and BRRI dhan 28 was suited to grow in moderately and strongly saline soil conditions respectively whereas BRRI dhan 58 was not suitable to grow in both the soils.

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