Progressive Agriculture 28 (1): 1-6, 2017 ISSN: 1017 - 8139

Progressive Agriculture
Journal homepage:http://www.banglajol.info/index.php/PA

Phenotypic performance of rice landraces under salinity stress in reproductive stage

MM Rashid[1], L Hassan[1*], SN Begum[2]

[1]Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh; [2]Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh 2202, Bangladesh

Abstract

An experiment was conducted using a randomized complete block design to explore the performance of rice landraces under salinity stress condition at Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. The experiment was consisted of five replication and three different salt treatments *viz.,* EC-6 dSm^{-1}, EC-8 dSm^{-1}, EC-12 dSm^{-1} with one control condition. Analysis of variance for yield and yield contributing traits showed significant (p<0.01) variation among the genotypes. The performance of all the landraces with respect to yield and yield contributing traits differed from each other under saline condition. Hogla, TalMugur, Nona Bokhra were identified as tolerant to salinity compared to check Binadhan-8, Binadhan-10 and BRRI dhan47 at 12 dSm^{-1} salinity treatment. All the traits under this study reduced in the salt stress except days to 50% flowering. In higher salt stress landrace Tal Mugur showed maximum yield followed by Ghunshi and Hogla. The findings of this study can be used for further study and also for developing salt tolerant rice varieties.

Key words: Landraces, salinity stress, reproductive stage, phenotypic study

***Corresponding Author:** lutfulhassan@yahoo.co.uk

Introduction

Rice (*Oryza sativa* L.) belongs to the family Gramineae. It is the staple food of more than 50% of the world's population (Aggarwal *et al.,* 2002). Bangladesh stands fourth with 52.2 million tons as China occupies the first place with 206.5 million tons in the world's production table of 479.3 million tons (FAOSTAT, 2014). By the year 2025, 21% increase in rice production will be needed over that of year 2000 (Bhuiyan *et al.,* 2002). In Bangladesh, rice provides nearly 48% of rural employment, about two- third of total calorie supply and about one-half of the total protein intakes of an average person in the country and rice sector contributes one-half of the agricultural GDP and one-sixth of the national income (Chakravarthi and Naravaneni, 2006).

Landraces of rice played a very important role in the local food security and sustainable development of agriculture, in addition to their significance as genetic resource for rice genetic improvement (Tang *et al.,* 2002). Landraces provided "adaptability genes" for specific environmental conditions. Incorporation of adaptability genes from landraces could ensure optimum grain yield for the region. Salinity is one of the major obstacles in increasing production in rice growing areas worldwide, which is an ever-present threat to crop yield. The response of rice to salinity varies with growth stage. Several studies indicated that

rice is tolerant during germination, becomes very sensitive during early seedling stage and reproductive stage (IRRI, 1967). The conventional methods of plant selection for salt tolerance are not easy because of the large effects of the environment and low narrow sense heritability of salt tolerance (Gregorio *et al.,* 1997).

Therefore, development of salt tolerant varieties has been considered as one of the strategies to increase rice production in saline prone coastal areas. So the objective of this study is to explore the performance of rice landraces under salinity stress condition.

Materials and Methods

The present experiment was carried out in the net house of the Plant Breeding Division at Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during the period from June to December 2015. Ten rice genotypes including seven landraces (Hogla, DakhShail, KutePatnai, Ghunshi, Mondeshor, Tal Mugur, Nona Bokhra) and three released varieties (Binadhan-8, Binadhan-10 and BRRI dhan47) were used as plant material. The experiment was carried out in a Randomized Complete Block Design (RCBD) with five replication and three different salt treatments *viz.,* EC-6 dSm^{-1}, EC-8 dSm^{-1}, EC-12 dSm^{-1} with one control condition. Management practices such as irrigation and fertilization were performed by following the standard procedures (IRRI, 2002). Other intercultural operations were done whenever necessary.

Morphological data were collected at appropriate growth stage of rice plant following the standard evaluation system indicated by IRRI (IRRI, 2002). The characters that were evaluated included days to 50% flowering, days to maturity, plant height (cm), panicle length (cm), number of effective tillers $plant^{-1}$, number of filled grains $panicle^{-1}$, number of unfilled grains $panicle^{-1}$, fertility (%), 1000 Seed weight (g) and yield $panicle^{-1}$ (g). The recorded data for different parameters were assembled and organized properly for statistical analysis using MSTAT-C following RCBD design.

Results and Discussion

***Analysis of variance*:** The analyses of variance of different rice genotypes for quantitative traits are shown in Table 1. Analysis of variance indicated that the difference among genotypes for all the traits under study *viz.,* days to 50% flowering, days to maturity, plant height, panicle length, no. of effective tillers $plant^{-1}$, no. of filled grains $panicle^{-1}$, no. of unfilled grains $panicle^{-1}$, fertility (%), 1000 seed weight and yield $panicle^{-1}$were highly significant for genotype, treatment and genotype-treatment interaction.

Performance of the genotypes at reproductive stage: The mean effects of genotypes and treatments on different morphological traits related to yield of rice are shown in Table 2 and Table 3, respectively.

Days to 50% flowering: Being an important character to assess early maturity, days to flowering was taken to an account for the genotypes. Days to 50% flowering among the genotypes ranged from 89.85 to 119.00 days with a mean value of 105.61 days. Binadhan-10 took the lowest days to 50% flowering (89.85 days) and Ghunshi took the highest days to 50% flowering (119.00 days). In case of effect of treatment, it is desired that control treatment will give the maximum days to 50% flowering. Days to 50% flowering were highest in the control treatment (106.9 days) followed by treatments T_1 (103.5 days), T_2 (105.9 days) and T_3 (106.1 days).

Days to maturity: Early maturity is the most desirable character of rice variety in present situation. Days to maturity among the genotypes ranged from 119.10 to 153.70 days with a mean value of 137.54 days. Binadhan-8 took the lowest days to maturity (119.10 days) and Ghunshi took the highest days to maturity (153.70 days). In case of effect of treatment days to maturity were highest in the control treatment (143.1 days) followed by treatments T_1 (137.1 days), T_2 (135.1 days) and T_3 (134.8 days).

Table 1. Analysis of variance for different morphological plant characters of ten rice genotypes

Characters	df	Days to 50% flowering	Days to maturity	Plant height (cm)	Panicle length (cm)	No of effective tillers plant^{-1}	No of filled grains panicle^{-1}	No of unfilled grains panicle^{-1}	Fertility (%)	1000 seed weight (g)	Yield panicle^{-1} (g)
Replication	4	28.93	15.72	60.18	0.27	0.338	26.60	2.134	18.28	4.07	0.032
Genotypes (A)	9	2070.09**	2896.07**	15050.54**	96.72**	7.789**	11531.17**	1261.581**	1435.60**	251.71**	3.334**
Treatment (B)	3	105.17**	734.05**	3139.77**	250.04**	90.413**	30740.87**	7858.686**	14941.98**	725.27**	42.503**
Ax B	27	28.27*	53.58**	220.75**	85.23**	2.202**	703.28**	599.999**	750.24**	84.79**	0.706**
Error	156	16.55	23.07	25.97	2.28	0.435	11.28	0.924	5.26	5.59	0.015

** Indicates significant at 0.01 probability level and * indicates significant at 0.05 probability level

Table 2. Mean effect of genotypes on different morphological traits related to yield of rice

Genotypes	Days to 50% flowering	Days to maturity	Plant height (cm)	Panicle length (cm)	No of effective tillers plant^{-1}	No of filled grains panicle^{-1}	No of unfilled grains panicle^{-1}	Fertility (%)	1000 seed weight(g)	Yield panicle^{-1} (g)
Hogla	109.9c	151.4a	125.6d	22.96c	4.90d	111.4c	24.93c	81.44c	18.61e	2.011d
DakhShail	114.1b	140.8c	132.0c	19.62e	3.85e	64.44hi	11.34h	63.28i	20.73cd	1.780e
KutePatni	107.4cd	139.4c	138.8b	22.76c	5.80ab	99.10d	23.25d	80.13c	22.74b	2.230c
Ghunshi	119.0a	153.7a	147.0a	23.34c	5.15cd	118.8b	15.67f	86.99b	18.75e	2.469b
Mondeshor	115.7b	147.2b	144.6a	25.94b	4.85d	72.43f	28.91b	71.24f	29.29a	2.083d
Tal Mugur	107.7cd	139.6c	145.3a	27.01a	5.05d	123.5a	14.80g	88.66a	19.49de	2.632a
Nona Bokhra	105.8d	128.4e	96.73e	21.28d	5.95a	78.50e	38.05a	66.79h	15.99f	1.849e
Binadhan-8	93.45e	119.1f	85.73f	21.58d	5.10cd	63.64i	28.43b	69.70g	22.00bc	1.556f
Binadhan-10	89.85f	119.9f	82.04g	22.57c	5.85ab	68.60g	18.90e	78.14d	22.38b	1.558f
BRRI dhan47	93.10e	135.8d	86.26f	21.51d	5.50bc	66.43h	23.27d	73.83e	21.84bc	1.385g
$LSD_{0.05}$	2.54	3.00	3.18	0.943	0.412	2.09	0.600	1.43	1.47	0.076
Mean	105.61	137.54	118.40	22.86	5.20	86.69	22.76	76.02	21.18	1.96
Standard Error	3.22	3.81	8.67	0.70	0.20	7.59	2.51	2.68	1.12	0.13
Standard Deviation	10.17	12.03	27.43	2.20	0.62	24.01	7.94	8.47	3.55	0.41
Level of sign.	**	**	**	**	**	**	**	**	**	**
CV%	3.85	3.49	4.30	6.61	12.68	3.87	4.22	3.02	11.17	6.23

** indicates significant at 0.01 probability level

Plant height: Lower plant height is desirable in rice breeding. The average range of plant height among the genotypes was 82.04 cm to 147.02 cm with a mean value of 147.02 cm. Binadhan-10 parent had the lowest plant height (82.04 cm) and Ghunshi had the highest plant height (147.02 cm). Plant height was highest in the control treatment (128.6 cm) and lowest in T_3 treatments (109.7 cm).

Panicle length: Panicle length is also an important yield contributing character since higher panicle length could provide higher grains numbers. Panicle length among the genotypes ranged from 19.62 cm to 27.01 cm with a mean value of 22.86 cm. Tal Mugur had the longest panicle (27.01 cm) and DakhShail parent had the lowest panicle length (19.62 cm). It is desired that control treatment will give the maximum panicle length. Panicle length was highest in the control treatment (25.13 cm) followed by treatments T_1 (23.85 cm), T_2 (22.55 cm) and T_3 (19.90 cm).

Number of effective tillers plant^{-1}: The number of effective tillers per plant is directly related to grains yield. In this study the number of effective tillers per plant ranged from 3.85 to 5.95 with a mean value of 5.20. Nona Bokhra had maximum number of effective tillers per plant (5.95) and DakhShail had minimum number of effective tillers per plant (3.85). In case of effect of treatment (Table 4.4) the number of effective tillers per plant was highest in control treatment (6.70) and the lowest number of effective tillers per plant was present in T_3treatment (3.52).

Table 3. Mean effect of treatments on different morphological traits related to yield of rice

Treatments	Days to 50% flowering	Days to maturity	Plant height (cm)	Panicle length (cm)	No of effective tillers plant^{-1}	No of filled grains panicle^{-1}	No of unfilled grains panicle^{-1}	Fertility (%)	1000 seed weight (g)	Yield panicle^{-1} (g)
T_0	106.9a	143.1a	128.6a	25.13a	6.70a	112.70a	11.13d	90.58a	25.53a	3.04a
T_1	103.5b	137.1b	119.6b	23.85b	5.70b	97.33b	16.17c	85.09b	22.14b	2.22b
T_2	105.9a	135.1c	115.7c	22.55c	4.88c	82.31c	23.88b	76.92c	20.73c	1.71c
T_3	106.1a	134.8c	109.7d	19.90d	3.52d	54.47d	39.84a	51.49d	16.33d	0.84d
$LSD_{0.05}$	1.60	1.89	2.01	0.596	0.26	1.32	0.379	0.906	0.934	0.04
Level of sign.	**	**	**	**	**	**	**	**	**	**
CV%	3.85	3.49	4.30	6.61	12.68	3.87	4.22	3.02	11.17	6.23

** indicates significant at 0.01 probability level; T= Treatments, T_0= control, T_1= 6 dSm^{-1}, T_2= 8 dSm^{-1} and T_3= 12 dSm^{-1}

Number of filled grains panicle^{-1}: The yield of the plant is related to number of filled grains per panicle and it differed significantly among the lines. In this study the number of filled grains per panicle range from 63.64 to 123.53 with a mean value of 86.69. Tal Mugur had the highest number of filled grains per panicle (123.53) and Binadhan-8 had the lowest number filled grains per panicle (63.64). In case of effect of treatment, the number of filled grains per panicle was highest in the control treatment (112.7) followed by treatments T_1 (97.33), T_2 (82.31) and T_3 (54.47).

Number of unfilled grains panicle^{-1}: Less number of unfilled grains per panicle is a positive attribute towards higher yield. The number of unfilled grains per panicle range from 11.34 to 38.05 with a mean value of 22.76. Nona Bokhra had the highest number of unfilled grains per panicle (38.05) and DakhShail had the

lowest number of unfilled grains per panicle (11.34). In case of effect of treatment the number of unfilled grains per panicle was lowest in the control treatment (11.13) followed by treatments T_1 (16.17), T_2 (23.88) and T_3 (39.84).

Fertility: Fertility percentage is directly related to yield of genotypes. In this study the fertility percentage range from 63.28 to 88.66 with a mean value of 76.02. Tal Mugur had the highest fertility percentage (88.66) and DakhShail had the lowest fertility percentage (63.28).

1000-seed weight: There was a significant difference in 1000 seed weight among the genotypes depending on the size and shape of grains. 1000 seed weight ranged from 15.99 g to 29.29 g with a mean value of 21.18 g. The highest 1000 seed weight was recorded in Mondeshor (29.29 g) and Nona Bokhra had minimum 1000 seed weight (15.99 g). In case of effect of treatments the 1000 seed weight was highest in the control treatment (25.53 g) followed by treatments T_1 (22.14 g), T_2 (20.73 g) and T_3 (16.33 g).

Yield panicle^{-1}: There was significant difference in yield per panicle among the studied rice genotypes. The yield per panicle ranged from 1.39 g to 2.63 g with a mean value of 1.96 g. Tal Mugur had maximum yield per panicle (2.63 g) and BRRI dhan47 had minimum yield per panicle (1.39 g). In case of treatment effect yield per panicle were highest in the control treatment (3.04 g) followed by treatments T_1 (2.22 g), T_2 (1.71 g) and T_3 (0.84 g).

Analysis of variance indicated that the difference among genotypes for all the traits under study were highly significant. (Yaqoob *et al.,* 2012) observed significant variation among genotypes for days to maturity, tillers plant^{-1}, effective tillers plant^{-1}, plant height, panicle length, 100 grains weight and yield plant^{-1}. (Tiwari *et al.,* 2011) also observed significant variation among genotypes for days to 50% flowering, effective tillers plant^{-1}, panicle length and grains yield plant^{-1}. These results suggest that all the genotypes under study had significant variation with each other.

In the present study, ten rice genotypes were studied to assess their genetic potential. All the genotypes revealed considerable amount of differences in their mean performance with respect to all the traits studied. This had also been exemplified by highly significant mean sum of squares for these characters, which indicated that, the lines under study were genetically diverse. Statistical analysis regarding the combined effects of genotypes and treatments on different morphological traits was provides important information about the tolerance level of the genotypes. Mean performance of plant materials helps to determinate the diversity of the rice genotypes.

Plant height decreased with the increase of salinity stress. This result agrees with that of (Khan *et al.,* 2008 and Saha, 2013) who reported that plant height of rice decreased under salinity at EC-8 dSm^{-1}. Salinity stress might inhibit cell division or cell enlargement so that plant height was reduced. Effective tillers number was highest at non-saline condition and lowest at high salinity (12dsm^{-1}). It was reported that the number of tillers decreased progressively with increase in salinity levels (Desai *et al.,*1975; Saxena and Pandey, 1981). Tolerant genotypes showed lower reduction of filled grains number panicle^{-1} than the susceptible. This result was consistent with the result observed by (Islam,2004) who worked with 80 recombinant inbred lines of Pokkali X IR29. This is because of loss of biomass production was lower in tolerant genotypes which increased the assimilation and ultimately produced the higher number of grains.

Conclusion

Among those landraces Hogla, Talmugur, Nona Bokhra were identified as tolerant to salinity compared to check Binadhan-8, Binadhan-10 and BRRI dhan47 at higher salt concentration (12dSm^{-1}). The performance of all the genotypes with respect to yield and yield contributing traits differed from each other under saline condition. All the traits under study reduced in the salt stress while days to 50% flowering

increased. In normal condition DakhShail, Ghunshi, Mondeshor and Tal Mugur showed better performance for yield and other components. In higher salt stress Tal Mugur showed higher yield followed by Ghunshi and Hogla.

Acknowledgements

The authors are thankful to the Plant Breeding Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. Financial support from Ministry of Science and Technology, Bangladesh is dully acknowledged.

References

Aggarwal RK, Shenoy VV, Ramadevi J, Rajkumar R, Singh L (2002). Molecular characterization of some Indian Basmati and other elite rice genotypes using fluorescent – AFLP.Theor. Appl. Genet., 105: 680-690.

Bhuiyan NI, Paul DNR, Jabber MA (2002). Feeding the extra millions by 2025: challenges for rice research and extension in Bangladesh. *In*: Proceedings of the National Workshop on Rice Research and Extension, Bangladesh Rice Research Institute, Gazipur, January. 29-31.

Chakravarthi BK, Naravaneni R (2006). SSR marker based DNA fingerprinting and diversity study in rice (*Oryza Sativa* L). African Journal of Biotechnology,5(9): 684-688.

Desai AD, Rao TS, Hirekeru LR (1975). Effect of saline water on growth and yield of rice.Journal of Indian Society of Soil Science,5: 13-16.

FAOSTAT (2014). Statistical data base. Food and Agriculture Organizations of the United Nations. Rome, Italia.

Gregorio GB, Senadhira D, Mendoza RD (1997).Screening rice for salinity tolerance. IRRI Discussion Paper Series no.22. Manila (Philippines), International Rice Research Institute,1-30.

IRRI (1967). Annual Report for 1967. Los Baños, Laguna, Philippines. P. 308.

IRRI (2002).Standard evaluation system for rice. International Rice Research Institute, Manila.

Islam MM (2004). Mapping salinity tolerance genes in rice (*Oryzasatiya* L.) at reproductive stage. PhD. Dissertation. University of the Philippines Los Banos, College, Laguna, Philippines.pp.150.

Khan MA, Weber DJ (2008). Ecophysiology of high salinity tolerant plants (tasks for vegetation science), 1st edn. Springer, Amsterdam.

Saha MK (2013). DNA fingerprinting and morpho molecular screening of selected rice germplasms for salt tolerance using SSR and RAPD markers, MS thesis, Dept. of Biotechnology, BAU, Mymensingh.

Saxena MK, Pandey UK (1981). Physiological studies on salt tolerance of ten rice varieties growth and yield aspect. Indian Journal of Plant Physiology,24: 61-68.

Tang SX, Jiang YZ, Wei XH, Li ZC, Yu HY (2002).Genetic diversity of isozymes of cultivated rice in china.ActaAgron. Sin.28: 203-207.

Tiwari DK, Pandey P, Tripathi S, Giri SP, Dwivedi JL (2011). Studies on genetic variability for yield components in rice (*Oryzasativa* L.). AAB Bioflux, 3(1): 76-81.

Yaqoob M, Hussain N, Rashid A (2012). Assessment of genetic variability in rice (*Oryzasativa*L.) genotypes under rainfed conditions.Journal of Agricultural Research, 50(3): 311-319.