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Original Research Article

Studies on Genetic Variability, Heritability and Genetic Advance in Rice (*Oryza sativa* L.) for Yield and Its Components under Salt Affected Soil

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A B S T R A C T

The present investigation was under taken with the objectives to estimate genetic variability for yield and yield contributing components. The experiment was conducted at the Research Farm of Genetics & Plant Breeding, Narendra Deva University of Agriculture & Technology, Narendra Nagar, Kumarganj, Faizabad (U. P.) during *kharif*, 2015. The experimental materials of rice for this investigation comprised of 20 genotypes as lines (female) and three testers (male) *viz.*, NDR 359, Narendra Usar 2009 and Narendra Usar 3. Each of three testers was crossed with 20 lines during *kharif*, 2014. The experiment was based on evaluation of a line × tester set of 60 hybrids (F_1s) along with their 20 parents and check varieties *viz.*, CSR 43 and IR 28, for thirteen characters *viz.*, days to 50 % flowering, plant height (cm), flag leaf area, (cm^2), panicle bearing tillers per plant, panicle length (cm), spikelets per panicle, grains per panicle, spikelet fertility (%), biological yield per plant (g), harvest index (%), L:B ratio, 1000-grains wt. (g) and grain yield per plant (g) under salt affected soil in randomized block design with three replications. The analysis of variance revealed that all the treatments, parents, parent *vs* crosses, crosses, lines and lines x testers were highly significant for majority of the yield and its contributing traits indicated sufficient variation among the treatment/materials under study. In general, PCV were higher than the GCV for all characters under salt affected indicates influence of environment. High heritability coupled with high genetic advance were observed for flag leaf area, panicle bearing tillers per plant, spikelets per panicle, grains per panicle, biological yield per plant, L:B ratio and grain yield per plant, it indicates that that presence of additive gene action. Hence, emphasis should be given to select these quantitative traits to enhance the yield potential of rice (*Oryza sativa* L.) under salt affected soil.

Introduction

Rice, *Oryza sativa* L. (2n=24) is a cereal foodstuff which forms an important part of the diet of more than three billion people around the world. It is the principal staple food for more than half of the world's population. It is grown under diverse agro-climatic conditions and over wide geographical range (Cheng *et al.*, 2005). Drought and salinity are major constraints on crop production and food security and adversely impact the socioeconomic fabric of many developing countries. Water scarcity, declining water quality for irrigation and soil salinity are problems which are becoming more acute. It is estimated that 20% of all cultivated land and nearly half of irrigated land is affected by salt, greatly reducing the yield of crops to well below their genetic potential. There is limited evidence at present that remediation of saline soils enhance crop yield stability (Tester and Devenport, 2003). Salinity-stress effects on crop grown are manifested by impairment of photosynthetic capacity. High amounts of sodium in the soil solution impair cell metabolism and photosynthesis by imposing an osmotic stress on cell water relations and by increasing the toxicity of sodium in the cytosol. Heritability is the proportion of observed differences on a trait among individuals of a population that are due to genetic differences. Factors including genetics, environment and random chance can all contribute to the variation between individuals in their observable characteristics. Genetic variability is a measure of the tendency of individual genotypes in a population to vary from one another. Variability is different from genetic diversity, which is the amount of variation seen in a particular population. The variability of a trait describes how much that trait tends to vary in response to environmental and genetic influences. Therefore, present investigation was under taken with the view of to find out genetic variability in the study materials.

Materials and Methods

The experiment was conducted during *kharif*, 2015 at the Research Farm of Genetics & Plant Breeding, N.D. University of Agriculture and Technology, Kumarganj, Faizabad. The experimental materials of rice for this investigation comprised of 20 genotypes as lines (female) and three testers (male) NDR 359, Narendra Usar 2009 and Narendra Usar 3. Each of three testers was crossed with 20 lines during *kharif* 2014. Thus, total number of 60 hybrids (F_1) were obtained. The total set of eighty five genotypes were grown during *kharif*, 2015 and evaluated along with their parents and two check varieties (CSR 43 and IR28) in Randomized complete block design with three replications, with the spacing of 20 cm row to row and 15 cm plant to plant. Observations were recorded on randomly selected five plants from each entry in each replication. The data were recorded on days to 50 % flowering, plant height (cm), flag leaf area, (cm^2), panicle bearing tillers per plant, panicle length (cm), spikelets per panicle, grains per panicle, spikelet fertility (%), biological yield per plant (g), harvest index (%), L:B ratio, 1000-grains wt. (g) and grain yield per plant (g). Recommended cultural practices were adopted to raise good crop. The mean data of different traits were subjected to analyze by standard statistical and biometrical method for Line x Tester analysis.

Results and Discussion

Mean sum of square due to treatments were significant for all the characters showed presence of variability in the study materials (Table 1and 2).

The success of selection in improving plant characters depends mainly on presence of substantial genetic variability and nature of heritability and gene action. The genetic variability is the raw material of plant breeding programme on which selection acts to evolve superior genotypes. The phenotypic and genotypic coefficients of variation can be used for assessing and comparing the nature and magnitude of variability existing for different characters in the breeding materials. Heritability in broad sense quantifies the proportion of heritable genetic variance to total phenotypic variance. Estimates of heritability help in estimating expected progress through selection. The genetic advance in per cent of mean provides indication of expected selection response by taking into account the existing genetic variability and heritability of the character.

The analysis of variance for eighty three genotypes of line × tester set comprising of sixty crosses and twenty three parents is presented in table-2 under salt affected soil soil . The analysis variance revealed that all the treatments, parents, parent *vs* crosses, crosses, lines and testers were highly significant for majority of the yield and its contributing traits indicating wide genetic variability among the materials under study.

The high estimates of phenotypic and genotypic coefficient of variation (> 20%) were estimated for panicle bearing tillers per plant (23.11, 21.02), biological yield per plant (20.40, 20.06) and grain yield per plant (23.36, 22.47) indicating high opportunity of selection for these characters under salt affected soil but high PCV and moderate GCV was recorded only for L:B ratio (20.28, 18.33).

The moderate estimates (10-20%) of PCV and GCV were recorded for flag leaf area (12.04, 11.13), spikelets per panicle (16.56, 16.10) and grains per panicle (18.95, 18.49) and it was low for days to 50 % flowering (5.62, 5.53), plant height (7.05, 6.76), panicle length (9.31, 8.43), spikelet fertility (4.20, 3.77), harvest index (5.46, 4.33) and 1000- grains weight (6.75, 6.08) indicating little opportunity of selection for these characters under salt affected soil (Table 3). High coefficient of variability indicated that there is a scope of selection and improvement of these traits. Low values indicated the need for creation of variability either by hybridization or mutation followed by selection. Similar findings were also reported by Pandey *et al.* (2010) and Tiwari *et al.* (2011). The proportion of genetic variability which is transmitted from parents to offspring is reflected by heritability. Robinson *et al*. (1949) viewed that the knowledge of heritability of a character is important to the breeder, as it indicates the possibility and extent to which improvement is possible through selection. In the present study, high estimates of broad sense heritability (>75%) was recorded for all the characters except harvest index, which exhibited moderate estimate of heritability (50-75%). The genetic advance in per cent of mean in salt affected soil was found to be high (>20%) for flag leaf area, panicle bearing tillers per plant, spikelets per panicle, grains per panicle, biological yield per plant, L:B ratio and grain yield per plant. On the other hand, moderate genetic advance in per cent of mean (10-20%) were noted for days to 50 % flowering, plant height, panicle length and 1000-grain while low (<10%) for spikelet fertility and harvest index (Table 3).

The broad sense heritability of these characters are in accordance with those of Bhattacharya (1978) for grain yield per plant; Kumar and Verma (2016) for days to 50% flowering, Plant hight, spikelets per panicle, 1000 grain weight and grain yield per plant.

Further, results revealed that high heritability coupled with high genetic advance in per cent of mean were observed for the characters *viz*., flag leaf area, panicle bearing tillers per plant, spikelets per panicle, grains per panicle, biological yield per plant, L:B ratio and grain yield per plant indicated the involvement of additive gene action. High heritability in broad sense coupled with moderate genetic advance in per cent of mean were observed for the characters *viz*., days to 50 % flowering, plant height, panicle length, 1000- grain weight salt affected soil.

Table.1 Analysis of variance for randomized block design for 13 characters in rice under salt affected soil

Characters	Sources of variation		
	Replications	**Treatments**	**Error**
d.f.	2	82	164
Days to 50% flowering	0.01	92.67**	1.00
Plant height (cm)	0.82	136.27**	3.83
Flag leaf area (cm^2)	0.83	20.29**	1.10
Panicle bearing tillers per plant	0.10	11.01**	0.74
Panicle length (cm)	0.77	11.08**	0.75
Spikelets per panicle	44.97	1380.94**	26.11
Grains per panicle	8.30	1177.00**	19.81
Spikelet fertility (%)	5.74	28.29**	2.21
Biological yield per plant (g)	0.21	167.42**	2.00
Harvest-index (%)	0.09	10.80**	1.76
L:B ratio	0.04	1.22**	0.08
1000- grains weight (g)	0.37	6.19**	0.44
Grains yield per plant (g)	0.09	34.71**	0.95

*,** Significant at 5% and 1% probability levels,, respectively.

Table.2 Analysis of variance for 13 characters of line × tester set of crosses and their parents in rice under salt affected soil

Characters	Sources of variation								
	Replications	Treatments	Parents	Parents *vs* Crosses	Crosses	Parent(Lines)	Parent(Testers)	Parent(Lines × testers)	Error
d.f.	2	82	22	1	59	19	2	38	164
Days to 50% flowering	0.02	92.68**	182.42**	2.60	60.74**	210.44**	7.44**	5.83**	1.01
Plant height (cm)	0.83	136.28**	258.51**	172.74**	90.08**	276.98**	64.01**	13.23**	3.83
Flag leaf area (cm^2)	0.84	20.30**	23.21**	128.24**	17.38**	18.58**	35.61**	4.49**	1.11
Panicle bearing tillers per plant	0.11	11.01**	2.99**	265.88**	9.68**	2.32**	3.52**	4.79**	0.74
Panicle length (cm)	0.77	11.08**	8.03**	28.79**	11.92**	8.95**	2.07	2.55**	0.76
Spikelets per panicle	44.98	1380.94**	565.01**	18465.64**	1395.62**	536.34**	59.72	658.12**	26.12
Grains per panicle	8.31	11.77.01**	461.53**	17249.92**	1171.38**	423.22**	16.07	490.75**	19.82
Spikelet fertility (%)	5.75	28.30**	37.35**	178.67**	22.38**	40.57**	7.76*	8.83**	2.22
Biological yield per plant (g)	0.21	167.43**	80.87**	1962.58**	169.28**	73.26**	10.03**	73.87**	2.00
Harvest-index (%)	0.10	10.81**	1.29	321.13**	9.10**	1.21	2.40	5.54**	1.77
L:B ratio	0.05	1.22**	1.38**	0.37*	1.18**	1.52**	0.50**	0.42**	0.09
1000- grains weight (g)	0.38	6.19**	5.43**	31.50**	6.05**	5.65**	0.75	2.71**	0.44
Grains yield per plant (g)	0.09	34.72**	11.53**	593.01**	33.90**	10.46**	2.96*	13.20**	0.96

*,** Significant at 5% and 1% probability levels, respectively

Table.3 Estimates of general mean, phenotypic (PCV) and genotypic (GCV) coefficient of variation, heritability in broad sense (h^2b) and genetic advance in per cent of mean for 13 characters in rice under salt affected soil

Characters	General mean ±SE	Coefficient of variation (%)		Heritability in broad sense (%)	Genetic advance in per cent of mean
		PCV	GCV		
Days to 50% flowering	99.55±0.57	5.62	5.53	97.00	11.20
Plant height (cm)	97.46±1.12	7.05	6.76	92.00	13.36
Flag leaf area (cm^2)	22.91±0.60	12.04	11.13	85.00	21.18
Panicle bearing tillers per plant	9.04±0.50	23.11	21.02	83.00	39.40
Panicle length (cm)	22.06±0.50	9.31	8.43	82.00	15.75
Spikelets per panicle	133.26±2.97	16.56	16.10	95.00	32.25
Grains per panicle	107.66±2.57	18.95	18.49	95.00	37.17
Spikelet fertility (%)	80.62±0.86	4.20	3.77	81.00	6.98
Biological yield per plant (g)	38.08±0.82	20.40	20.06	97.00	40.62
Harvest-index (%)	39.89±0.76	5.46	4.33	63.00	7.09
L:B ratio	3.34±0.16	20.28	18.33	82.00	34.13
1000- grains weight (g)	22.67±0.38	6.75	6.08	81.00	11.27
Grain yield per plant(g)	15.26±0.56	23.36	22.47	93.00	44.53

Table.4 Components of genetic variance, average degree of dominance, predictability ratio, heritability in narrow sense and genetic advance in percent of mean for 13 characters in rice under salt affected soil

Characters	*gca* variance (σ^2g)	*sca* variance (σ^2s)	Average degree of dominance $\sqrt{\sigma^2 s/2\sigma^2 g}$	Predictability ratio $2\sigma^2 g/2\sigma^2 g+\sigma^2 s)$	σ^2A	σ^2D	Heritability (h^2n %)	Genetic Advance (%)
Days to 50% flowering	0.53	1.61	1.74	0.40	2.12	6.43	35.31	1.26
Plant height (cm)	0.74	3.13	2.05	0.32	2.97	12.52	25.19	1.26
Flag leaf area (cm^2)	0.12	1.13	3.01	0.18	0.50	4.51	14.26	0.39
Panicle bearing tillers per plant	0.06	1.35	5.34	0.07	0.19	5.40	5.59	0.15
Panicle length (cm)	0.09	0.60	2.57	0.23	0.36	2.38	17.59	0.37
Spikelets per panicle	7.12	210.67	5.44	0.06	28.48	842.67	6.10	1.92
Grains per panicle	6.57	156.98	4.89	0.08	26.28	627.92	7.44	2.04
Spikelet fertility (%)	0.13	2.20	4.10	0.11	0.52	8.81	8.16	0.30
Biological yield per plant (g)	0.92	23.96	5.10	0.07	3.68	95.82	6.96	0.74
Harvest-index (%)	0.03	1.26	6.06	0.05	0.14	5.03	3.58	0.10
L:B ratio	0.01	0.11	3.89	0.12	0.03	0.44	9.53	0.08
1000- grains weight (g)	0.03	0.76	4.84	0.08	0.13	3.02	6.67	0.14
Grains yield per plant (g)	0.20	4.08	4.52	0.09	0.80	16.33	8.32	0.38

High heritability coupled with high genetic advance have additive gene action and may be directly utilized for rice improvement. On the other hand the character having low heritability and high genetic advance in percent of mean and high heritability and low genetic advance in percent of mean have non-additive gene action. The high to very high estimates of direct selection parameters for above mentioned characters indicated that these would be ideal traits for improvement through selection in context of materials evaluated due to existence of high genetic variability represented by high coefficients of variation and high transmissibility denoted by high heritability for them. (Mall *et al*., 2005; Panwar *et al*., 2007; Basavaraja *et al.* 2013 and Kumar and Verma, 2016).

The high narrow sense heritability with moderate genetic advance in per cent on mean was observed for days to 50 % flowering. Moderate narrow sense heritability with low genetic advance in per cent of mean was noticed for plant height and panicle length indicated that these traits are unlikely to provide reasonable selection response. Majority of the characters showed low narrow sense heritability and variable range genetic advance in per cent of mean indicated the preponderance of non-additive gene action reflecting heterosis breeding may be rewarding (Table 4). Above findings were also confirmed from the estimates of variance due to additive and dominance genetic components in the present study. These findings were similar to those of Verma and Srivastava (2004); Singh *et al*. (1980). The estimates of dominance variance were higher than the corresponding estimates of additive variance for all the traits indicated the predominance of non-additive gene effects represented by dominance variances. The values of average degree of dominance were more than unity (>1) revealing over dominance for all the characters. The importance of additive as well as non-additive gene effects with predominance of non-additive gene effects in inheritance of grain yield and yield components of rice has also been reported earlier Saidaiah *et al.* 2010; Gopikannana and Ganesh 2013 and Prasad *et al.*, 2015. The predominance of non-additive gene effects representing non-fixable dominance and epistatic components of genetic variance indicated that maintenance of heterozygosity, would be highly fruitful for improving the yield under salt affected soil.

References

Basavaraja, T.; Asif, M.; Mallikarjun, S. K. and Gangaprasad, S. (2013). Variability, heritability and genetic advance for yield and yield attributing characters in different local rice (*Oryza sativa* L.) cultivars. *Asian J. of Bio. Sci.*, **8** (1):60-62.

Bhattacharya R. K.; (1978). Estimates of genetic parameters of some quantitative characters in rice under stress soil (saline condition). *Oryza* 15:146-150.

Cheng, S. H,; Cao, L. Y,; Zhan, X. D.; (2005). Techniques for hybrid rice seed production. *Jindun Publishing House,* Beijing.

Gopikannan, M. and Ganesh, S.K. (2013). Investigation on combining ability and heterosis for sodicity tolerance in rice (*Oryza sativa* L.). *African J. Agril. Res.*, **8** (32):4326-4333.

Johnson, H.W.; Robinson, H.F.; Comstock, R.E. (1955). Estimates of genetic and environmental variability in soybeans. *Agron*.**47** •: 314-318.

Kempthorne, O. (1957). An introduction to genetical statistics.*John Wiley and Sons Inc. New York,* pp. 468-471.

Kumar, A. and . Verma, O.P. (2016).

Genetic variability, heritability and genetic advance studies in rice (Oryza sativa L.) under sodic soil. *Res. Environ* and *Life Sci*. 9(2): 149-151.

Mall, A.K.; Babu, J.D.P. and Babu, G.S. (2005).Estimation of genetic variability in rice. *J. Maharashtra Agric. Univ.*, **30** (2): 166-168.

Panwar, A.; Dhaka, R.P.S. and Kumar, V. (2007). Genetic variability and heritability studies in rice. *Adv. in Plant Sci.*,**20** (1): 47-49.

Prasad, S.; Verma, O. P.; Tripathi, N.; Ashish and Yadav, P. K. (2015). Combining ability for yield and its contributing traits in rice (*Oryza sativa* L.) Under salt affected soil. *Int. J. Sci. and Res.*, 4(9): 1050-1054.

Robinson H. F.; Comstock R. E.; Harvey P . H. (1949) Estimates of heritability and degree of dominance in corn. *Agro. J.* 41:353-359.

Saidaiah, P.; Kumar, S. and Ramesha, M.S. (2010).Combining ability studies for development of new hybrids in rice over environments. *J. Agrci. Sci.*, **2** (2): 225-233.

Sindelar, S. and Singh, S.K. (2016). Gain report- global agricultural information network. Gain report no. IN6033, 13-23.

Singh, S.P.; Singh, R.R. and Singh, R.V.(1980) Combining ability in rice. Oryza, 17: 104-108 (1980).

Tester, M.; Davenport, R.; (2003 Na^+ tolerance and Na^+ transport in higher plants. *Ann Bot* **91** : 503-527.

Verma, O. P. and Srivastava, H. K. (2004). Genetic component and combining ability in relation to heterosis for yield and associated trait using three diverse rice growing ecosystems. Field Crops Res., 88: 91-102.