



## Estimates of Genetic Variability, Heritability and Genetic Advance in Rice (*Oryza sativa* L.) Under Sodic Soil

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### Abstract

The experiment was carried out to evaluate the genetic variability, heritability and genetic advance in rice under the sodic soil condition. Results revealed highly significant variations within parents and hybrids. The five characters *viz.*, number of spikelet's per panicle, grain per panicle, amylose content, flag leaf area and 1000-grain weight showed high estimates of heritability coupled with high estimates of genetic advance as well as less than one average degree of dominance and predictability ratio nearly one in  $F_1$ 's. This indicated that the inheritance of these five characters was governed by additive gene action and the direct selection for these characters would be rewarding.

**Keywords:** Rice (*Oryza sativa* L.), genetic variability, heritability, genetic advance and sodic soil

### Introduction

Rice (*Oryza sativa* L.) is the most important staple food crop of the world. Asia is the leader in rice production accounting for about 90% of the world's production. India has the world's largest rice-growing area (45million hectares), and ranks second in overall production (130.29 million tonnes) after China, with an average yield of 2895 kg/hectare (Anonymous 2021-22). The success of any breeding programme mainly depends on the quantum of genetic variability and the extent to which the desirable characters are heritable (Tiwari *et al.*, 2011). Heritability and genetic advance are the direct selection parameters, so correct knowledge of heritability and genetic advance is much more essential in formulation of selection strategy. Although the information on above aspects in rice is available, but most of these studies are based on irrigated and normal soil conditions and literature based on salinity conditions are quite meager. Therefore, further studies aimed at generating

and comparing information on above aspects in rice, are warranted to facilitate the development of high yielding rice cultivars for above ecosystem.

### Materials and Methods

This experiment was carried out at the Main Experimental Station of A.N.D. University of Agriculture and Technology, Narendra Nagar, Ayodhya, India. The experimental material was based on a line x tester set of 63 hybrids ( $F_1$ 's) developed by crossing 21 lines (females) with 3 testers (males). An attempt was made to make a sixty three cross combinations during *kharif* season 2017 to generate  $F_1$ 's. The 63  $F_1$ 's along with parents and two checks, Jaya and CSR 43 were evaluated to find out the genetic variability, heritability and genetic advance effects of their various attributes on grain yield under the sodic soil in Randomized Complete Block Design with three replications during *kharif* 2018. Phenotypic

(PCV), genotypic (GCV) and environmental (ECV) coefficients of variation for different characters were estimated by formulae suggested by Burton and de Vane (1953). The estimates of heritability in narrow sense ( $h^2_{(ns)}$ ) have been classified by Robinson (1966) into three categories *viz.*, high (> 30%), medium (10-30%) and low (<10%).

## Results and Discussion

### Analysis of variance

The analysis of variance for different characters of line × tester set 24 parents and their  $F_1$ s under sodic soil are presented in **Table 1**. Highly significant variability was found for all the characters in studied materials. Similar finding has also been reported by earlier researchers (Jayasudha *et al.*, 2009; Rahimi *et al.*, 2010; Sanghera and Hussain 2012; Latha *et al.*, 2013; Kargbo *et al.*, 2019; Sarker *et al.*, 2020 and Kulsum *et al.*, 2022). The analysis of variance revealed that mean squares due to parents *v/s* crosses were highly significant or significant for all the characters except flag leaf area in  $F_1$ 's. Similar result has also been supported by earlier researchers (Rahimi *et al.*, 2010; Sanghera *et al.*, 2012; Bassuony *et al.*, 2021 and Mazal *et al.*, 2021).

### Coefficients of variation

The phenotypic (PCV) and genotypic (GCV) coefficients of variation for the eighteen characters have been presented in **Table 2**. The magnitude of phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation for all the traits. The high estimates of phenotypic and genotypic coefficient of variation (> 20%) were estimated for amylose content, grain per panicle, spikelet's per panicle, flag leaf area, grain yield per plant in  $F_1$ 's. Similar results have also been reported by earlier researcher (Khedikar *et al.*, 2003; Saxena *et al.*, 2005; Singh and Singh, 2005; Dhanwani *et al.*, 2013; Gyawali *et al.*, 2018; Hasan *et al.*, 2020; Chavan *et al.*, 2022).

### Estimates of heritability and genetic advance

The estimates heritability in narrow sense and genetic advance in per cent of mean have been presented in **Table 3**. High estimates of heritability in narrow sense were recorded for flag leaf area (94.36), amylose content (89.86), protein content ( 84.15), 1000-grain weight (76.84), panicle bearing tillers per plant (75.92), spikelets per panicle (66.91), panicle length (56.17), grains per panicle (55.23) in  $F_1$  generation. Similar result has also been reported by earlier research (Sanghera and Hussain. 2012).

High estimates of genetic advance per cent of mean were reported for spikelets/panicle, grain per panicle, amylose content, plant height, flag leaf area and 1000-grain weight in  $F_1$  generation. Similar result has also been reported by earlier researchers (Kargbo *et al.*, 2019, Prasad *et al.*, 2017 and Jaiswal *et al.*, 2020).

Some of the characters *i.e.*, flag leaf area, panicle bearing tiller per plant, panicle length, spikelets per panicle, grain per panicle, 1000-grain weight, amylose content and protein content showed less than unity of average degree of dominance in  $F_1$ s, revealing lack of dominance. The predictability ratio was lesser than one for all the characters studied in  $F_1$ s and above mention traits *i.e.*, flag leaf area, panicle bearing tiller per plant, panicle length, 1000-grain weight, amylose content and protein content showed close to one predictability ratio, this finding state that these characters was governed by additive gene. The same finding have also been reported by earlier reporters (Awad-Allah *et al.*, 2016; Bassuony and Zsembeli 2021; Abo-Yousef *et al.*, 2022).

### Conclusion

From the study, it could be concluded that most of the characters were governed by dominant gene action. The five characters, spikelets/panicle, grain per panicle, amylose content, flag leaf area and 1000-grain weight showed high estimates of narrow sense heritability

Table 1: Analysis of variance for 18 characters of line × tester set of crosses (F<sub>1</sub>S) and their parents in rice under sodic soil

Characters	Sources of variation													Error
	Replica-tions	Treatments	Parents	Parents (Line)	Parents (testers)	Line vs testers	Parents vs Crosses	Crosses	Lines Effect	Testers Effect	Lines × testers Effect			
d.f.	2	86	23	20	2	1	1	62	20	2	40	172		
Days to 50% flowering	4.533	23.844**	19.196**	19.411**	3.111	47.056**	55.643**	25.055**	64.550**	1.466	6.488**	3.591		
Chlorophyll content	0.124	13.149**	9.791**	8.740**	14.066**	22.281**	46.735**	13.853**	35.210**	11.142*	3.310**	0.244		
Leaf nitrogen	0.001	0.019**	0.016**	0.013**	0.001	0.107**	0.023**	0.019**	0.046**	0.005	0.007**	0.001		
Leaf temperature	0.128	12.051**	11.205**	3.043**	0.032	196.801**	360.198**	6.749**	12.214**	0.077	4.350**	0.123		
Flag leaf area (cm <sup>2</sup> )	0.596*	147.160**	134.078**	149.315**	47.452**	2.612**	0.334	154.381**	477.493**	0.715	0.508**	0.158		
Plant height (cm)	0.794	415.83**	520.247**	477.477**	583.108**	1249.920**	373.497**	377.788**	1114.465**	84.964*	24.091**	1.9523		
Panicle bearing fillers/plant	0.002	13.517**	13.118**	13.428**	2.919**	27.314**	120.576**	11.938**	36.594**	0.021	0.206**	0.091		
Panicle length (cm)	0.031	20.710**	25.136**	19.019**	3.969**	189.815**	45.582**	18.667**	56.134**	1.920	0.771**	0.446		
Spikelets/panicle	5.107	4078.566**	1259.884**	1190.030**	2192.111**	792.508**	44748.580**	4468.238**	13596.620**	172.577	118.832**	5.561		
Grains/panicle	24.969*	3472.527**	1397.688*	1390.316**	2072.444**	195.627**	26821.710**	3865.625**	11463.930**	1881.370**	165.687**	6.810		
Spikelet fertility (%)	2.712	131.232**	116.838**	130.307**	19.6612**	41.815**	66.844**	137.610**	247.490**	435.496**	67.776**	3.992		
Biological yield/plant (g)	1.184	140.447**	137.447**	118.549**	387.111**	16.071**	3702.759**	84.104**	205.699**	135.894**	20.716**	2.180		
Harvest index (%)	1.191	45.352**	61.207**	64.483**	58.461**	1.172	281.575**	35.660**	55.080**	181.603**	18.653**	2.338		
L/B ratio	0.024	0.655**	0.781**	0.638**	2.491**	0.218**	0.106**	0.617**	1.581**	0.757**	0.128**	0.010		
1000-grain weight (g)	1.737*	24.200**	23.901**	26.424**	5.003**	11.241**	23.592**	24.321**	74.567**	0.302	0.398	0.369		
Amylose content	0.000	200.271**	186.176**	211.551**	8.976**	33.090**	10.504**	208.561**	646.506**	0.001	0.016	0.001		
Protein content (%)	0.001	0.512**	0.4523**	0.517**	0.025**	0.014**	0.315**	0.537**	1.655**	0.004	0.006**	0.001		
Grain yield/plant (g)	0.048	33.619**	19.249**	16.884**	51.051**	2.947**	949.83**	24.172**	47.133**	99.290**	8.936**	0.081		

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



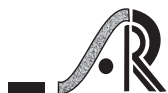
coupled with high genetic advance as well as less than one average degree of dominance and predictability ratio in  $F_1$  generations. This indicated very clearly that the inheritance of these five characters was governed by additive gene action and the direct selection for these two characters would be rewarding.

**Table 2: Estimates of general mean, phenotypic (PCV) and genotypic (GCV) coefficient of variation for 18 characters in rice under sodic soil**

S. No.	Characters	General mean $\pm$ SE	Coefficient of variation (%)	
			PCV	GCV
1	Days to 50% flowering	84.4944 $\pm$ SE1.0789	3.7800	3.0563
2	Chlorophyll content	13.0219 $\pm$ SE0.2813	16.5523	16.1190
3	Leaf nitrogen	0.5931 $\pm$ SE0.0143	13.7167	13.0572
4	Leaf temperature	35.0979 $\pm$ SE0.2004	5.8070	5.7211
5	Flag leaf area (cm <sup>2</sup> )	32.7261 $\pm$ SE0.2258	21.3384	21.3045
6	Plant height (cm)	114.3304 $\pm$ SE0.7990	10.5977	10.5276
7	Panicle bearing tillers/plant	10.9906 $\pm$ SE0.1714	19.2656	19.0731
8	Panicle length (cm)	24.5035 $\pm$ SE0.3789	11.0447	10.7112
9	Spikelets/panicle	157.4007 $\pm$ SE1.3502	23.2804	23.2324
10	Grains/panicle	132.7453 $\pm$ SE1.6431	25.5728	25.4818
11	Spikelet fertility (%)	84.1179 $\pm$ SE1.2496	8.1508	7.7292
12	Biological yield/plant (g)	40.4981 $\pm$ SE0.8486	17.0131	16.6170
13	Harvest index (%)	39.1072 $\pm$ SE0.8772	10.3499	9.5840
14	L/B ratio	2.9280 $\pm$ SE0.0558	16.0935	15.7477
15	1000-grain weight (g)	24.4255 $\pm$ SE0.3451	11.7572	11.4968
16	Amylose content	18.8346 $\pm$ SE0.0155	43.0035	43.0033
17	Protein content (%)	6.2306 $\pm$ SE0.0199	6.5868	6.5632
18	Grain yield/plant (g)	15.8858 $\pm$ SE0.1621	20.9624	20.8868

**Table 3: Heritability in narrow sense and genetic advance in per cent of mean for 18 characters in rice under sodic soil**

Characters	Heritability (h <sup>2</sup> <sub>ns</sub> ) (%)	Genetic advance in per cent of mean	Average degree of dominance $\sqrt{\frac{\sigma^2_s}{2\sigma^2_g}}$	Predictability ratio $\frac{2\sigma^2_g}{2\sigma^2_g + \sigma^2_d}$
Days to 50% flowering	13.6550	0.4452	1.6804	0.2615
Chlorophyll content	14.9678	0.3512	2.2939	0.1597
Leaf nitrogen	9.4691	0.0097	2.9593	0.1025
Leaf temperature	2.9568	0.0745	5.6473	0.0304
Flag leaf area (cm <sup>2</sup> )	94.3605	3.3689	0.2031	0.9604
Plant height (cm)	44.7904	3.5190	1.0643	0.4689
Panicle bearing tillers/plant	75.9264	0.8344	0.4202	0.8499
Panicle length (cm)	56.1769	0.8865	0.5741	0.7521
Spikelets/panicle	66.9151	15.0828	0.6865	0.6797
Grains/panicle	55.2367	12.6391	0.8815	0.5627
Spikelet fertility (%)	5.3870	0.5423	4.0656	0.0570
Biological yield/plant (g)	14.4625	0.8465	2.3004	0.1589
Harvest index (%)	4.7966	0.2525	4.1666	0.0545
L/B ratio	17.3950	0.0815	2.0960	0.1854
1000-grain weight (g)	76.8403	1.1987	0.1496	0.9781
Amylose content	89.8609	4.0346	0.0365	0.9987
Protein content (%)	84.1591	0.1871	0.3903	0.8678
Grain yield/plant (g)	8.6103	0.3202	3.2431	0.0868



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