RESEARCH ARTICLE https://doi.org/10.58297/CVTL7441

Assessment of Genetic Variability, Heritability and Genetic Advance for Grain Yield and Other Yield Attributing Traits in Elite Lines of Rice (*Oryza sativa* L.)

Sindhura NRH[1]*, Ravi Kumar BNVSR[2], Dayal Prasad Babu J[3] and Raju MRB[4]

[1]Department of Genetics and Plant Breeding, Agricultural College
Bapatla-522101, Andhra Pradesh, India
[2]Department of Genetics and Plant Breeding, RARS, Maruteru, 534122
West Godavari District, India
[3]Department of Genetics and Plant Breeding, ANGRAU, Lam, Guntur - 522034, India
[4]Department of Plant Pathology, RARS, Maruteru- 534122, West Godavari District, India
*Corresponding author's Email: ruthhepsisindhura@gmail.com

Received: 30th July 2022; Accepted: 20th August 2022

Abstract

The present investigation was carried out during *Kharif*, 2021 at Regional Agricultural Research Station (RARS), Maruteru, with an objective to study the genetic parameters and magnitude of variability for yield enhancement. The experimental material comprised of 88 elite lines including checks namely, Maruteru Samba (MTU 1224), Sravani (MTU 1239), Maruteru Mahsuri (MTU 1262), Improved Samba Mahsuri, Swarna, TN1 and Krishnaveni which were evaluated in alpha lattice design with two replications. Observations on days to 50 % flowering, plant height (cm), ear bearing tillers per m^2, panicle length (cm), number of grains per panicle, test weight (g), spikelet fertility (%) and grain yield per plant (g) were recorded. The analysis of variance among 88 elite lines revealed the presence of significant differences for all 8 characters indicating the existence of variability in the material. The mean performance of the elite lines studied for yield and yield components revealed that the lines AM885, AM891 and AM913 significantly outperformed the superior yield check Sravani for panicle length, ear-bearing tillers per m^2, number of grains per panicle, test weight, and grain yield per plant. The genetic parameters revealed that high heritability coupled with high genetic advance as per cent of mean for the traits days to 50% flowering, plant height, panicle length, test weight, spikelet fertility and grain yield per plant.

Keywords: Genetic variability, Heritability, Genetic advance, Elite lines, Grain yield

Introduction

Rice (*Oryza sativa* L. 2n=2x=24) is the most important food crop that provides a significant portion of carbohydrates to the world's population. The world's population growth has exceeded the growth rate in food-grain production. The demand for rice is still increasing in Asia as the consumption rate is at least 90% and it is globally projected that the demand for rice will rise to 650 million tonnes by 2050 (Chukwu *et al*., 2019).

The availability of sufficient variability and its proper use through breeding techniques are crucial for any successful crop improvement programme. Important factors in the genetic improvement of plant populations are the amount of genetic variability and the degree to which traits are heritable. The amount of variability present in the germplasm can be determined using genetic parameters like the genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV). Heritability estimates give accurate information about the consistency with which a specific genetic trait will be transmitted to succeeding generations. High heritability values suggest that the studied traits are less influenced by the environment.

Heritability coupled with genetic advance is a more reliable and useful genetic parameter in predicting genetic gain under selection than heritability values alone (Bhargavi *et al.,* 2021).

Material and Methods

The experimental material comprised 88 elite lines including checks namely, Maruteru Samba (MTU 1224), Sravani (MTU 1239), Maruteru Mahsuri (MTU 1262), Improved Samba Mahsuri, Swarna, TN1 and Krishnaveni were evaluated at Regional Agricultural Research Station (RARS), Maruteru, West Godavari district of Andhra Pradesh. It is located at 81.44^0 E longitude, 26.38^0 N latitude and 5 m above mean sea level, in Godavari Zone of Acharya N. G. Ranga Agricultural University. The present experiment was laid out in Alpha lattice design with two replications. All the 88 elite lines including checks were randomized in 11 blocks with a block size of eight *i.e.,* each block consists of eight genotypes. Observations were recorded on five randomly selected plants in each genotypewithout border effect as per the methodology given in SES, IRRI, (2014). The average values obtained for each character were subjected to statistical analysis.

Statistical analysis

Analysis of variance is a technique by which total variation present in data is divided into two components: variation due to assignable factors and variation due to non-assignable factors. The ANOVA of 88 elite lines including checks showed the presence of highly significant differences among the lines for all the characters studied *viz.*, days to 50% flowering, plant height (cm), ear bearing tillers per m^2, panicle length (cm), number of grains per panicle, test weight (g), spikelet fertility (%) and grain yield per plant (g) at 1% level denotes considerable variation in the material being studied (**Table 1**).

Table 1. Analysis of variance for yield and yield component traits

Source of variation	d.f	Mean sum of squares							
		Days to 50% flowering	Plant height (cm)	Ear bearing tillers per m^2	Panicle length (cm)	Number of grains per panicle	Test weight (g)	Spikelet fertility (%)	Grain yield per plant (g)
Replications	1	0.57	0.90	261.67	0.14	3.01	0.36	0.38	6.19
Treatments	87	193.69**	383.41**	2295.21**	18.73**	279.50**	7.63**	149.83**	21.86**
Blocks (b)	20	1.52	11.86	262.10	0.53	6.57	0.28	0.94	1.54
Experimental error	67	1.63	10.54	411.35	0.68	5.30	0.29	0.70	1.82
Total	175	197.40	406.71	3230.33	20.08	294.38	8.57	151.85	31.41

* Significance at 5% level, ** Significance at 1% level

Results and Discussion

Days to 50% flowering ranged from 81 days for AM855 to 114 days for AM902 with a mean value of 99 days. A total of 23 elite lines showed significantly fewer days to 50% flowering than the yield check Sravani. The plant height ranged from 94 cm (Improved Samba Mahsuri) to 156 cm (Sravani) with a mean of 132 cm. Ear-bearing tillers per m^2 ranged from 182 (AM924) to 360 (AM904), with a mean value of 274. Panicle length in the present study ranged from 21 cm (Nellore Mahsuri) to 35 cm (AM884) with a mean of 28 cm. The range for the number of grains per panicle was observed between 114 (AM865) to 162 (AM845) with a mean of 134.2. Test weight of the elite lines ranged from 15.0 g (AM853) to 23.5 g (AM924, AM896) with an overall mean value of 18.0 g (**Table 2**). The trait value ranged from 62.1% (BM549) to 94.5% (TN1) with a mean value of 83.0%. In the

Table 2. Mean performance of elite lines for yield and yield components

S. No.	Entry	DFF (days)	PH (cm)	EBT/m²	PL (cm)	GP	TW (g)	SF (%)	YP (g)
1	AM 844	105	145	218	28	161	16.4	86.5	19.70
2	AM 845	104	146	195	32	162	17.0	68.0	22.00
3	AM 846	106	149	227	32	136	18.4	91.3	17.30
4	AM 847	96	133	206	28	159	17.1	79.9	19.59
5	AM 848	108	154	254	31	153	16.9	86.3	18.52
6	AM 849	98	141	244	29	154	17.0	86.2	18.55
7	AM 850	105	147	244	29	157	15.8	83.8	18.10
8	AM 852	92	133	261	29	146	15.3	66.0	15.15
9	AM 853	82	122	267	23	142	15.0	70.4	11.25
10	AM 854	82	130	274	24	142	15.3	68.9	16.15
11	AM 855	81	106	281	24	129	17.0	90.7	16.55
12	AM 856	81	118	248	26	130	16.7	85.0	13.42
13	AM 857	81	108	271	24	158	17.0	91.0	23.09
14	AM 858	82	118	273	23	146	16.3	81.2	15.82
15	AM 859	81	117	267	25	140	17.8	81.9	17.86
16	AM 860	92	122	267	26	143	15.3	71.0	17.36
17	AM 861	82	102	284	24	131	18.8	87.9	21.13
18	AM 863	84	112	274	25	122	17.2	89.2	12.17
19	AM 864	83	123	314	24	129	17.8	76.5	19.31
20	AM 865	82	107	228	26	114	19.0	86.1	12.04
21	AM 866	83	125	264	24	147	17.2	90.7	18.30
22	AM 867	84	118	267	27	144	17.1	93.8	19.66
23	AM 868	82	113	271	22	122	16.2	79.8	14.68
24	AM 869	89	115	231	28	132	16.9	83.3	13.87
25	AM 870	89	119	264	25	146	16.9	71.5	17.69
26	AM 871	88	115	281	27	145	17.5	63.7	22.68
27	AM 873	103	141	271	29	159	16.5	84.2	22.89
28	AM 874	100	143	261	32	149	16.2	64.0	15.24
29	AM 875	98	145	199	30	141	17.0	92.4	14.65
30	AM 876	102	136	310	26	147	16.6	91.3	23.84
31	AM 877	101	135	330	29	137	17.3	91.7	19.01
32	AM 879	104	148	254	27	155	16.5	85.8	17.81
33	AM 880	101	151	257	29	150	18.4	81.8	22.21
34	AM 881	98	149	251	28	152	17.3	90.3	20.03
35	AM 882	112	146	290	26	150	16.0	87.9	21.23
36	AM 883	84	131	274	30	134	19.4	75.8	26.47

S. No.	Entry	DFF (days)	PH (cm)	EBT/m^2	PL (cm)	GP	TW (g)	SF (%)	YP (g)
37	AM 884	98	119	248	35	125	19.5	88.2	15.65
38	AM 885	109	133	307	35	143	18.2	75.1	23.51
39	AM 886	100	127	248	30	120	19.7	85.7	13.09
40	AM 887	100	143	294	32	132	19.1	75.2	21.91
41	AM 888	109	145	272	34	135	18.5	84.5	20.57
42	AM 890	113	147	248	31	127	20.1	89.8	16.18
43	AM 891	102	134	317	31	138	18.5	91.1	24.38
44	AM 892	109	132	310	30	123	20.5	81.7	21.70
45	AM 893	113	142	248	26	121	20.8	92.6	15.91
46	AM 894	109	140	327	32	125	20.1	94.0	23.06
47	AM 895	100	132	287	31	129	19.9	88.1	19.42
48	AM 896	111	143	314	26	121	23.5	88.7	16.94
49	AM 897	109	146	310	30	132	18.9	90.6	18.20
50	AM 898	101	135	248	27	124	22.2	90.9	20.83
51	AM 900	109	141	271	30	126	21.4	85.8	19.26
52	AM 901	110	127	300	29	120	19.2	78.0	18.30
53	AM 902	114	140	287	30	138	17.5	65.0	19.09
54	AM 903	113	133	333	31	128	18.8	67.2	18.85
55	AM 904	110	142	360	31	126	18.0	75.9	21.85
56	AM 905	99	144	310	27	125	20.3	92.7	20.11
57	AM 906	108	137	248	30	128	18.8	71.0	15.51
58	AM 907	108	132	317	29	123	22.5	84.8	23.10
59	AM 908	110	110	231	25	122	20.6	81.5	16.73
60	AM 910	105	151	281	29	142	18.5	89.0	21.95
61	AM 911	108	127	248	28	123	20.5	83.7	18.95
62	AM 912	104	139	297	28	131	18.6	81.0	23.12
63	AM 913	104	144	310	34	138	18.3	91.7	23.45
64	AM 914	106	143	310	32	132	18.0	90.5	24.12
65	AM 915	99	136	317	31	124	18.0	94.1	17.23
66	AM 916	106	123	318	28	131	17.7	74.5	18.86
67	AM 918	105	148	294	29	130	18.1	78.2	19.44
68	AM 919	104	123	248	29	119	18.6	70.6	12.41
69	AM 920	99	143	304	32	122	20.5	80.6	22.56
70	AM 921	97	138	310	28	125	21.3	92.2	21.51
71	AM 922	98	135	292	30	126	20.5	89.8	21.79
72	AM 923	96	134	241	31	118	22.5	75.7	15.86
73	AM 924	92	139	182	33	114	23.5	74.7	11.00

S. No.	Entry	DFF (days)	PH (cm)	EBT/m^2	PL (cm)	GP	TW (g)	SF (%)	YP (g)
74	BM 519	98	138	257	31	136	18.5	86.5	20.51
75	BM 529	100	138	281	27	131	20.3	86.9	22.09
76	BM 530	102	139	235	31	119	21.0	71.9	16.44
77	BM 542	100	147	254	29	132	18.8	88.8	21.73
78	BM 544	99	133	267	31	139	18.8	84.2	20.59
79	BM 546	100	144	238	29	120	21.2	86.4	14.50
80	BM 549	109	130	267	26	134	17.3	62.1	16.98
81	Maruteru Samba (YC)	98	115	314	25	137	15.9	67.0	18.94
82	Sravani (YC)	96	156	281	29	133	16.8	94.3	21.22
83	Maruteru Mahsuri (YC)	108	136	269	29	137	17.1	81.1	19.18
84	Nellore Mahsuri	88	112	314	21	135	15.1	91.7	20.10
85	TN 1 (BSC)	85	118	292	24	123	20.9	94.5	19.30
86	Improved Samba Mahsuri (BRC)	96	94	314	22	133	16.0	88.5	17.35
87	Swarna (BRC)	110	118	314	24	125	18.3	91.8	19.30
88	Krishnaveni (BSC)	109	98	281	27	131	17.3	85.8	17.85
Minimum		**81**	**94**	**182**	**21**	**114**	**15.0**	**62.1**	**11.00**
Maximum		**114**	**156**	**360**	**35**	**162**	**23.5**	**94.5**	**26.47**
Mean		**99**	**132**	**274**	**28**	**134.2**	**18.0**	**83.0**	**18.84**
CV%		**1.3%**	**2.50%**	**7.40%**	**2.9%**	**1.70%**	**2.90%**	**1%**	**7.20%**
C.D. (0.05)		**2.51**	**6.54**	**38.59**	**1.59**	**4.7**	**1.06**	**1.72**	**2.63**

DFF-days to 50% flowering, PH - plant height, EBT - ear bearing tillers per m^2, PL - panicle length, GP - number of grains per panicle, TW - test weight, SF - spikelet fertility, YP - yield per plant, YC - Yield Check; BSC - BLB Susceptible Check; BRC - BLB Resistant Check , C.V % = Coefficient of variation per cent , C.D. = Critical Difference.

present study, the grain yield per plant ranged from 11.00 g (AM924) to 26.47 g (AM883) with an overall mean value of 18.84 g.

Moderate genotypic and phenotypic coefficient of variation was observed for the traits like plant height (GCV = 10.34, PCV = 10.63), ear-bearing tillers per m^2 (GCV = 11.30, PCV = 13.33), panicle length (GCV = 10.62, PCV = 10.99), test weight (GCV = 10.46, PCV = 10.86), spikelet fertility (GCV = 10.40, PCV = 10.46) and grain yield per plant (GCV = 16.84, PCV = 18.24) indicating that these traits can be improved by vigorous selection. Less variation between the GCV and PCV values indicates the environment's insignificant influence. Similar results were observed by Sandeep *et al*. (2018), Divya *et al*. (2020), Gupta *et al*. (2022) and Lavanya *et al*. (2022).

As suggested by Johnson *et al.* (1955), heritability in the broad sense is categorized into Low (0-30%), Moderate (31-60%) and High (More than 60%). High heritability along with high genetic advance as per cent of mean was recorded for the traits like days to 50% flowering (h^2 (bs) = 98.36%, GAM= 20.25), plant height (h^2 (bs) = 94.50%, GAM= 20.70), panicle length (h^2 (bs) = 93.36%, GAM = 21.14), test weight (h^2 (bs) = 92.71%, GAM = 20.74), spikelet fertility (h^2 (bs) = 90.00%, GAM = 21.33) and grain yield per plant (h^2 (bs) = 85.16%, GAM = 32.00). This provides evidence that this trait was under the control

of additive gene effects and selection may be effective. Sandeep *et al*. (2018), Divya *et al*. (2020), Keerthiraj *et al*. (2020), and Lavanya *et al*. (2022) reported similar results. High heritability along with moderate genetic advance as per cent of mean was recorded for the traits like ear bearing tillers per m^2 (h^2 (bs) = 71.78%, GAM= 19.72) and number of grains per panicle (h^2 (bs) = 96.08%, GAM= 17.61) indicating the existence of additive and non-additive gene actions (**Table 3**). Simple phenotypic selection has no role in the genetic improvement of this character. Similar outcomes were reported by Islam *et al*. (2015) and Parimala and Devi (2019).

Table 3. Variability, heritability and genetic advance as per cent of mean for grain yield in rice

S. No.	Characters	Range		Mean	CV%	C.D. (0.05)	Coefficient of variation		Heritability	GAM
		Minimum	Maximum				GCV	PCV		
1	Days to 50% flowering	81	114	99	1.30%	2.51	9.91	9.99	98.36%	20.25
2	Plant height	94	156	132	2.50%	6.54	10.34	10.63	94.50%	20.7
3	Ear bearing tillers per m^2	182	360	274	7.40%	38.59	11.3	13.33	71.78%	19.72
4	Panicle length	21	35	28	2.90%	1.59	10.62	10.99	93.36%	21.14
5	No. of grains per panicle	114	162	134	1.70%	4.7	8.72	8.9	96.08%	17.61
6	Test weight	15	23.5	18	2.90%	1.06	10.46	10.86	92.71%	20.74
7	Spikelet fertility	62.1	94.5	83	1%	1.72	10.4	10.46	99.00%	21.33
8	Grain yield per plant	11	26.47	18.84	7.20%	2.63	16.84	18.24	85.16%	32.00

C.V % = Coefficient of variation per cent, C.D. = Critical Difference, PCV = Phenotypic coefficient of variation, GCV = Genotypic coefficient of variation, GAM = Genetic advance as per cent of mean.

Conclusion

The superior yield check Sravani with the highest spikelet fertility was outperformed by the lines AM 885, AM 891 and AM 913 for the traits panicle length, ear bearing tillers per m^2, number of grains per panicle, test weight and grain yield per plant. The traits such as days to 50% flowering, plant height, panicle length, test weight, spikelet fertility and grain yield per plant, which had high heritability and genetic advance, are controlled by additive gene action. Selection for these traits with high heritability and genetic advance will accumulate more additive genes, further enhancing their performance.

References

Bhargavi M, Shanthi P, Reddy VL, Reddy MD and Reddy RB. 2021. Estimates of genetic variability, heritability and genetic advance for grain yield and other yield attributing traits in rice (*Oryza sativa* L.). *The Pharma Innovation Journal*, 10: 507-11.

Chukwu SC, Rafii MY, Ramlee SI, Ismail SI, Oladosu Y, Okporie E, Onyishi G, Utobo E, Ekwu L, Swaray S and Jalloh M. 2019. Marker-assisted selection and gene pyramiding for resistance to bacterial leaf blight disease of rice (*Oryza sativa* L.). *Biotechnology & Biotechnological Equipment*, 33: 440-55.

Divya T and Pandey DP. 2020. Genetic variability for yield and quality traits in local germplasm of rice of Himachal Pradesh. *Journal of Cereal Research*, 12: 157-9.

Gupta H, Purushottam GY, Yadav SK and Singh S, Kumar S. 2022. Genetic variability, heritability and genetic advance for yield and its related traits in rainfed upland rice (*Oryza sativa* L.) genotypes. *The Pharma Innovation Journal*, 11: 2520-2524.

Islam MA, Raffi SA, Hossain MA and Hasan AK. 2015. Analysis of genetic variability, heritability and genetic advance for yield and yield-associated traits in some promising advanced rice lines. *Progressive Agriculture,* 26: 26-31.

Johnson HW, Robinson HF and Comstock RE. 1955. Estimation of genetic and environmental variability in soybean. *Agronomy Journal*, 47: 314-318.

Keerthiraj B and Biju S. 2020. Genetic variability, heritability and genetic advance of yield and lodging-related traits in rice (*Oryza sativa* L.). *Electronic Journal of Plant Breeding,* 11: 1093-8.

Parimala K and Devi KR. 2019. Estimation of variability and genetic parameters in indica and japonica genotypes of rice (*Oryza sativa* L.). *International Journal of Current Microbiology and Applied Sciences,* 8: 1138-42.

Sandeep S, Sujatha M, Subbarao LV and Neeraja CN. 2018. Genetic variability, heritability and genetic advance studies in rice (*Oryza sativa* L.). *International Journal of Current Microbiology and Applied Science,* 7: 3719-27.

Lavanya K, Suman K, Abdul Fiyaz R, Chiranjeevi MC, Ramamurthy S, Satya A, Sudhakar P and Subba Rao LV. 2022. Phenotypic assessment of rice landraces for genetic variability and diversity studies under heat stress. *Oryza,* 59: 31-38.

Standard Evaluation System for Rice (SES), International Rice Research Institute (IRRI), 2014.