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Variability Analysis in F_2 Population of Rice (*Oryza sativa* L.) for Yield and Related Traits

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ABSTRACT

This study was conducted to evaluate genetic variation among eight parents and their six F_2 populations for various fourteen morphological traits at the Regional Rice Research Station, N.A.U., Vyara during Kharif – 2015. The segregating populations manifested increased mean values over the parental means for most of the traits. All the population exhibited high GCV and PCV value for productive tillers per plant and grain yield per plant. Among six crosses NVSR-2031 X GAR-13 exhibited the higher values of GCV and PCV for leaf area and straw yield per plant, Jaya x Lalkada for panicle length and straw yield per plant and GR-7 X GAR-13 for panicle length. While, the IR-28 x Lalkada exhibited the highest value of PCV for panicle length and straw yield per plant and GR-7 X GAR-13 for straw yield per plant indicating greater scope for improvement of these traits through selection. The heritability estimates of grain yield per plant, straw yield per plant, productive tillers per plant, plant height and panicle length were high with high genetic advance as per cent mean compared to other traits in all the six F_2 populations.

Key word: *GVC, PCV, Heritability, Genetic advance, Genetic advance as percent mean.*

INTRODUCTION

Rice (*Oryza sativa* L., 2n = 2x = 24) is second most widely grown cereal crop and the staple food for more than half of world's population, providing two thirds of calorie intake for more than three billion people in Asia and one - third of calorie intake of nearly 1.5 billion people in Africa and Lat in America. In India, rice is cultivated in 44.13 million hectares during 2015 with production of 106.19 million tones and productivity of 2416 kg per hectare. In Gujarat, rice is cultivated in 7.88 lakh hectares with production of 16.36 lakh tones and productivity of 2076 kg per hectare.

The progress of any breeding programme depends on the information regarding genetic variability present in a population. Therefore, the assessment of variability for yield and its component characters is importance before planning for an appropriate breeding strategy for genetic improvement.

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Genetic parameters such as genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) are helpful tools in detecting the amount of variability present in the germplasm. Heritability influences the selection programme to a larger extent. Heritability value indicates the relative effectiveness of selection based on phenotypic expression of a trait, the genetic advance is more useful in predicting the actual value of selection as shown by Johnson *et al*[8].

MATERIAL AND METHOD

Experiment was conducted in non-replicated trial as it was segregating material. Each row consisted of 20 plants with spacing of 20 cm x 15 cm inter and intra row spacing. Each F2 was raised with minimum of 500 plant population and individual plant observations were recorded from 100 randomly selected plants. While, each parent and F1 consisted of 50 plants and observations were recorded from 20 randomly selected plants. The experiment was planted in the month of July, 2015 at Regional Rice Research Stat ion, N.A.U., Vyara. Data were recorded on DF-Days to flowering, DM-Days to maturity, PH-Plant height (cm), PL-Panicle length (cm), PT/PL-Productive tillers per plant, NG/PA-No. of grains per panicle, 100 GW-100 grain weight (g), KL-Kernel length (mm), KB-Kernel breadth (mm), KL/B ratio-Kernel L/B ratio, GY/PL-Grain yield per plant (g), SY/PL-Straw yield per plant (g), HI-Harvest index (%) and LA-Leaf area (cm^2)

Statistical analysis

The mean and variances were analyzed based on the formula given by Singh and Chaudhary (30).

$$\textbf{Mean} = \frac{1}{n}\left(\sum_{i=1}^{n} y_i\right)$$

$$\textbf{Variance} = \frac{1}{n-1}\left\{\sum_{i=1}^{n}(y_i - \bar{y})^2\right\}$$

Where, y_i = individual value

$\bar{y}$ = Population value

The genotypic and phenotypic coefficient of variation was computed according to Burton and Devane[4].

Genotypic coefficient of variance (GCV)

$$\textbf{GCV} = \frac{\sqrt{\sigma^2 g}}{\bar{X}} \times 100$$

Phenotypic coefficient of variance (PCV)

$$\textbf{PCV} = \frac{\sqrt{\sigma^2 p}}{\bar{X}} \times 100$$

Where, $\sigma^2 g$ = Genotypic variance

$\sigma^2 p$ = Phenotypic variance

$\bar{X}$ = General mean of the character PCV and GCV was classified as suggested by Johnson *et al.* (8) that 0-10 % : Low,

11-20% : Moderate, > 20% : High

Heritability in broad sense was estimated as the ratio of genotypic to phenotypic variance and expressed in percentage (Hanson *et al.* (7).

$$\textbf{Heritability}\left[\mathbf{h^2}\ (\mathbf{bs})\right] = \frac{\sigma^2 g}{\sigma^2 p} \times 100$$

Where, $\sigma^2 g$ = Genotypic variance

$\sigma^2 p$ = Phenotypic variance

The heritability was classified as suggested by Robinson *et al.* (23) that 0-30% : Low,

31-60% : Moderate, > 60% : High

Genetic advance (GA) Genetic advance was computed according to the formula proposed by Johnson *et al*. (8).

$GA = k.\ \sigma_p\ .\ H.$

Where, k = Intensity of selection (2.06)

σ_p = Phenotypic standard deviation

H = Heritability in broad sense

Genetic advance expressed as percentage over mean (GAM)

$$\textbf{GAM} = \frac{GA}{\bar{x}} \times 100$$

Where, $\bar{x}$ = General mean of the character

The GAM was categorized, as suggested by Johnson *et al.* (8) that 0-10 % : Low, 11-20 % : Moderate; > 20 % : High

RESULTS AND DISCUSSION

All the population exhibited high GCV and PCV value for productive tillers per plant and grain yield per plant. Among six crosses NVSR-2031 X GAR-13 exhibited the higher values of GCV and PCV for leaf area and straw yield per plant, Jaya x Lalkada for panicle length and straw yield per plant and GR-7 X GAR-13 for panicle length. While, the IR-28 x Lalkada exhibited the highest value of PCV for panicle length and straw yield per plant and GR-7 X GAR-13 for straw yield per plant.

In general, the F_2 populations exhibited higher PCV and GCV values for productive tillers plant, grain yield per plant and straw yield per plant. Similar finding was also observed by Ratnakar *et al*.[22] for productive tillers per plant, grain yield per plant and straw yield per plant, Kiran *et al*.[10] for productive tillers per plant and grain yield per plant, Pathak and Patel (19) for grain yield per plant and straw yield per plant, Bhuvaneswari *et al*.[3] and Subbaiah *et al*.[33] for productive tillers per plant, Mokate *et al*.[15] for straw yield per plant, Agrawal[1], Kumar *et al*.[13], Nandeshwar *et al*.[16], Fukrei *et al*.[5], Sravan *et al*.[32], Lingaiah *et al*.[14] and Krishna *et al*.[11] for grain yield per plant.

In general, the estimation of heritability in broad sense for different traits (Table 1 to 6) revealed that the high values were observed for kernel length, L/B ratio, days to maturity, days to flowering, plant height, panicle length, kernel breadth, no. grains per panicle, 100 grain weight and leaf area. These results are in accordance with the report of Savitha and Usha[27] and Vanisree *et al*.[34] for kernel length, kernel breadth and L/B ratio; Sanghera and Kashyap[26] for days to maturity; Kahani and Hittalmani[9] for days to flowering; Gangashetty *et al*.[6] and Kumar and Senapati[12] for plant height; Singh *et al*.[30] and Shet *et al*.[29] for panicle length; Sedeek *et al*.[28] and Sadimantara *et al*.[24] for no. grains per panicle; Rahman *et al*.[21] and Kumar *et al*.[13] for 100 grain weight; Rahman *et al*.[20] for leaf area; Panvar and Mathur[18] for days to flowering, plant height and panicle length and Nayak[17] for plant height, panicle length and 100 grain weight.

Table 1: Estimation of genetic variability parameters for fourteen quantitative characters in F_2 generation of IR-28 x Lalkada in rice

Character	Mean	σ^2_p	σ^2_e	σ^2_g	GCV	PCV	h^2 (b)	GA	GAM
DF	89.55	71.26	5.06	66.20	9.09	9.43	92.90	16.15	18.04
DM	119.44	69.82	3.93	65.90	6.80	7.00	94.37	16.24	13.60
PH (cm)	104.86	254.94	5.60	249.35	15.06	15.23	97.80	32.17	30.68
PL (cm)	21.11	19.25	1.49	17.77	19.97	20.79	92.27	8.34	39.52
PT/PA	5.85	3.40	0.98	2.42	26.61	31.53	71.25	2.71	46.28
NG/PA	100.92	36.32	6.51	29.80	5.41	5.97	82.06	10.19	10.09
100 GW (g)	2.42	0.014	0.002	0.012	4.55	4.83	88.70	0.21	8.83
KL (mm)	5.75	0.410	0.002	0.408	11.11	11.13	99.56	1.31	22.83
KB(mm)	2.26	0.015	0.001	0.014	5.32	5.49	94.03	0.24	10.63
KL/B ratio	2.55	0.085	0.001	0.083	11.33	11.43	98.40	0.59	23.16
GY/PL (g)	14.28	21.62	10.93	10.69	22.90	32.56	49.44	4.74	33.17
SY/PL (g)	16.92	21.96	11.33	10.63	19.27	27.70	48.39	4.67	27.62
HI (%)	45.42	2.13	0.99	1.14	2.35	3.21	53.41	1.61	3.54
LA (cm^2)	26.88	25.90	5.74	20.16	16.70	18.93	77.85	8.16	30.36

Table 2: Estimation of genetic variability parameters for fourteen quantitative characters in F_2 generation of NVSR-2031 x GAR-13 in rice

Character	Mean	σ^2_p	σ^2_e	σ^2_g	GCV	PCV	h^2 (b)	GA	GAM
DF	96.22	14.92	2.71	12.21	3.63	4.01	81.81	6.51	6.77
DM	126.12	14.96	4.90	10.06	2.51	3.07	67.26	5.36	4.25
PH (cm)	103.26	63.57	6.57	57.00	7.31	7.72	88.66	14.73	14.26
PL (cm)	21.16	9.57	2.48	7.09	12.58	14.62	74.07	4.72	22.31
PT/PA	5.78	3.10	0.69	2.41	26.86	30.47	77.68	2.82	48.76
NG/PA	115.54	43.42	3.69	39.73	5.46	5.70	91.50	12.42	10.75
100 GW (g)	2.11	0.014	0.001	0.013	5.46	5.67	92.61	0.23	10.83
KL (mm)	6.17	0.190	0.002	0.188	7..03	7.06	99.14	0.89	14.42
KB(mm)	2.21	0.045	0.002	0.043	9.39	9.63	94.96	0.42	18.85
KL/B ratio	2.82	0.114	0.007	0.107	11.64	12..01	93.95	0.65	23.24
GY/PL (g)	14.13	19.65	4.46	15.18	27.57	31.37	77.28	7.06	49.93
SY/PL (g)	18.44	20.75	6.02	14.73	20.82	24.71	70.97	6.66	36.13
HI (%)	42.95	6.17	0.95	5.22	5.32	5.78	84.66	4.33	10.08
LA (cm^2)	32.98	51.90	5.66	46.24	20.62	21.84	89.09	13.22	40.08

Table 3: Estimation of genetic variability parameters for fourteen quantitative characters in F_2 generation of IR-28 x GAR-13 in rice

Character	Mean	σ_p^2	σ_e^2	σ_g^2	GCV	PCV	h^2 (b)	GA	GAM
DF	94.99	58.90	2.87	56.03	7.88	8.08	95.13	15.04	15.83
DM	124.86	58.73	2.40	56.32	6.01	6.14	95.91	15.14	12.13
PH (cm)	87.93	77.18	4.76	72.41	9.68	9.99	93.83	16.98	19.31
PL (cm)	20.10	10.97	1.81	9.16	15.06	16.48	83.49	5.70	28.34
PT/PA	4.15	2.82	1.07	1.74	31.80	40.43	61.85	2.14	51.52
NG/PA	102.73	28.36	3.90	24.46	4.81	5.18	86.25	9.46	9.21
100 GW (g)	2.19	0.005	0.001	0.004	2.93	3.31	77.99	0.12	5.32
KL (mm)	6.24	0.218	0.002	0.217	7.46	7.49	99.16	0.95	15.30
KB(mm)	2.02	0.016	0.002	0.014	5.94	6.26	90.09	0.23	11.61
KL/B ratio	3.11	0.084	0.005	0.079	9.06	9.34	94.09	0.56	18.11
GY/PL (g)	9.34	14.54	6.30	8.24	30.73	40.82	56.66	4.45	47.64
SY/PL (g)	14.32	15.31	5.89	9.42	21.44	27.33	61.52	4.96	34.64
HI (%)	38.50	12.35	1.38	10.97	8.60	9.13	88.84	6.43	16.71
LA (cm^2)	36.94	17.14	7.19	9.94	8.54	11.21	58.02	4.95	13.40

Table 4: Estimation of genetic variability parameters for fourteen quantitative characters in F_2 generation of Gurjari x Varalu in rice

Character	Mean	σ_p^2	σ_e^2	σ_g^2	GCV	PCV	h^2 (b)	GA	GAM
DF	84.02	68.69	1.41	67.28	9.76	9.86	97.95	16.72	19.90
DM	113.91	68.55	1.83	66.72	7.17	7.77	97.34	16.60	14.57
PH (cm)	85.94	123.41	9.50	113.91	12.42	12.93	92.31	21.12	24.58
PL (cm)	21.37	21.25	1.54	19.71	20.77	21.57	92.76	8.81	41.22
PT/PA	4.63	2.36	0.96	1.40	25.53	33.16	59.30	1.88	40.50
NG/PA	108.98	57.09	3.31	53.78	6.73	6.93	94.20	14.66	13.45
100 GW (g)	2.48	0.011	0.002	0.009	3.89	4.20	85.78	0.18	7.42
KL (mm)	6.64	0.109	0.003	0.106	4.90	4.98	97.15	0.66	9.96
KB(mm)	2.12	0.009	0.001	0.007	4.04	4.43	83.35	0.16	7.60
KL/B ratio	3.14	0.043	0.004	0.039	6.30	6.59	91.43	0.39	12.41
GY/PL (g)	12.51	18.74	6.82	11.92	27.61	34.61	63.62	5.67	45.36
SY/PL (g)	13.76	18.60	6.85	11.76	24.92	31.34	63.20	5.62	40.81
HI (%)	47.35	1.31	1.02	0.29	1.14	2.42	22.09	0.52	1.10
LA (cm^2)	27.78	13.44	4.08	9.36	11.01	13.20	69.63	5.26	18.93

Table 5: Estimation of genetic variability parameters for fourteen quantitative characters in F_2 generation of GR-7 x GAR-13 in rice

Character	Mean	σ_p^2	σ_e^2	σ_g^2	GCV	PCV	h^2 (b)	GA	GAM
DF	91.90	68.84	1.40	67.44	8.94	9.03	97.97	16.74	18.22
DM	121.79	68.57	1.32	67.25	6.73	6.80	98.07	16.73	13.74
PH (cm)	94.64	304.29	6.39	297.90	18.24	18.43	97.90	35.18	37.17
PL (cm)	20.92	21.76	1.75	20.00	21.38	22.30	91.94	8.83	42.23
PT/PA	5.24	2.49	1.04	1.44	22.92	30.01	58.01	1.88	35.97
NG/PA	101.34	32.19	4.00	28.18	5.24	5.60	87.56	10.23	10.10
100 GW (g)	2.10	0.005	0.002	0.003	2.52	3.21	61.73	0.09	4.08
KL (mm)	6.27	0.117	0.002	0.115	5.41	5.45	98.54	0.69	11.06
KB(mm)	2.13	0.006	0.002	0.004	2.97	3.51	71.56	0.11	5.18
KL/B ratio	2.95	0.039	0.004	0.035	6.33	6.70	89.22	0.36	12.31
GY/PL (g)	11.14	11.69	6.61	5.08	20.25	30.71	43.47	3.06	27.50
SY/PL (g)	14.75	12.36	6.67	5.69	16.17	23.83	46.01	3.33	22.59
HI (%)	42.60	9.10	0.21	8.89	7.00	7.08	97.65	6.07	14.25
LA (cm^2)	38.96	9.10	2.93	6.17	6.38	7.74	67.83	4.21	10.82

Table 6: Estimation of genetic variability parameters for fourteen quantitative characters in F_2 generation of Jaya x Lalkada in rice

Character	Mean	σ_p^2	σ_e^2	σ_g^2	GCV	PCV	h^2 (b)	GA	GAM
DF	89.65	33.70	1.57	32.13	6.32	6.48	95.33	11.40	12.72
DM	119.66	33.22	1.87	31.34	4.68	4.82	94.36	11.20	9.36
PH (cm)	107.35	313.30	31.31	281.99	15.64	16.49	90.01	32.82	30.57
PL (cm)	21.65	19.97	0.80	19.16	20.22	20.64	95.97	8.83	40.80
PT/PA	5.17	3.92	1.14	2.78	32.27	38.30	71.00	2.90	56.01
NG/PA	138.95	53.79	4.39	49.40	5.06	5.28	91.84	13.87	9.99
100 GW (g)	2.61	0.002	0.001	0.001	1.14	1.80	39.82	0.04	1.48
KL (mm)	6.33	0.255	0.002	0.253	7.95	7.98	99.32	1.03	16.32
KB(mm)	2.28	0.014	0.002	0.013	4.93	5.24	88.21	0.22	9.53
KL/B ratio	2.78	0.075	0.002	0.073	9.71	9.82	97.74	0.55	19.77
GY/PL (g)	18.72	50.14	10.73	39.41	33.54	37.83	78.60	11.46	61.25
SY/PL (g)	20.14	48.64	13.87	34.78	29.28	34.63	71.49	10.27	51.00
HI (%)	47.89	1.61	0.69	0.92	2.00	2.65	57.26	1.50	3.13
LA (cm^2)	38.20	20.41	4.51	15.90	10.44	11.83	77.88	7.25	18.97

CONCLUSION

High GCV and PCV value indicating greater scope for improvement of these traits through selection on these character in desirable direction. Low to moderate GCV and PCV values of the limited scope for improvement of this character by selection. Most of the characters exhibited high heritability in almost all the six segregating populations. The traits *viz*., kernel length followed L/B ratio, days to maturity, days to flowering, plant height, panicle length, kernel breadth, no. grains per panicle, 100 grain weight and leaf area were observed high heritability suggested that these traits are governed by additive gene actions and simple selection would be effective for genetic improvement. Comparison of genetic advance as per cent mean value of all the segregating populations revealed higher genetic advance for grain yield per plant followed by straw yield per plant, productive tillers per plant, plant height and panicle length.

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