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Genetic Variability, Heritability and Genetic Advance studies in Quantitataive Traits in Rice (*Oryza sativa* L.)

Sirigadi Rajesh*, K. Chaithanya, J. Sajeev, B. Jalandhar Ram and B. G. Suresh

Department of Genetic and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj-(211007), Uttar Pradesh, India

**Corresponding author*

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A B S T R A C T

The present investigation carried out on 25 rice genotypes during Kharif-2018 at field experimentation centre of Genetics and Plant Breeding, Naini Agricultural Institute, SHUATS, Prayagaraj to assess genetic variability, heritability and genetic advance. Analysis of variance showed highly significant genetic variability for all the 25 rice genotypes for 13 quantitative characters studied indicating that significant at 1% and 5% genetic variability present in the material. High to moderate estimates of GCV and PCV were recorded for number of panicles per hill, number of spikelets per panicle, test weight, flag leaf length, days to 50% flowering, plant height, and grain yield per hill. High estimates of heritability coupled with high values of genetic advance as perecent mean was observe for characyers number of spikelets per panicle, days to 50% flowering, number of panicles per hill and test weight respectively suggesting there was preponderance of additive gene action for the experession of these characters. Hence selection of these traits were useful for further improvement in breeding programme.

Introduction

Rice (*Oryza sativa* L.) is a cultivated crop belonging to family Graminae, sub-family Bamboosoideae and tribe Oryzeae (sarla and Swamy, 2005). It is diploid with 12 chromosomes (2n=24) (Garriset *et al.*, 2005). Rice is cultivated as low as 3m below sea level in Bhutan and Nepal khush and Virk, 2000). It is one of the major food crops all over the world and is the most widely consumed staple food for large part of the world's human population, especially in Asian region. It is the agricultural commodity which in production ranks third (741.5 million tons in 2014) worldwide after sugarcane and maize. However, in aspect of calories intake and nutrition, it is the most important grain which provides more than one fifth of the calories to human, worldwide (Smith, Bruce D, 1998). Rice contains starch (75-80%), water (12% and protein (7%) (Hossain *et al.*, 2015). Also, in many countries of the world, rice is the source of animal feed (Muhammad

et al., 2015). According to Economic survey 2017-2018 total production of rice in India is 110.2 million tons with gross area of 43.2 million hectares, whereas yield per hectare is 2550 kg. Indian states like West Bengal contributes (15.1 million tons), U. P (12.9 million tons) and Punjab (11.0 million tons) in production of rice in India.

Materials and Methods

The experimental material comprised of 25 germplasm of rice (*oryza sativa* L.) grown in RBD at field experimentation centre of Genetics and Plant Breeding, Naini Agricultural Institute, SHUATS, Prayagraj, U. P, India, during *Rabi* 2018. The recommended agronomic and plant protection measures were followed in order to raise a normal crop. Observations on 13 different quantitative characters *viz*., days to 50% flowering, days to maturity, plant height, flag leaf length, flag leaf width, number of tillers per hill, number of panicles per hill, panicle length, number of spikelets per panicle, biological yield, test weight, harvest index and grain yield per hill were recorded on 5 randomly selected plants for each replication of each genotype except for days to 50% flowering and days to maturity where data is recorded based on plot basis during various phenophase of the crop.

Mean values of 5 randomly selected plants of 3 replications for each genotype were averaged and expressed as the mean of the respective character and considered by RBD for each of the character separately as per standard statistical procedure given by (Panse and Sukhtame, 1978).

Heritability (h2) in the broad sense was calculated according to the formula given by (Allard, 1960) for all the characters. Phenotypic and genotypic coefficient of variation (PCV and GCV) were computed according to (Burton, 1952).

Results and Discussion

Analysis of variance shown that highly significant differences among the genotypes for all the traits as shown in Table 1. This indicates that there was an ample scope for selection of promising lines from the present gene pool for yield and its components. The presence of large amount of variability might due to diverse source of materials taken as well as environmental influence affecting the phenotypes.

On the basis of mean performance as shown in Table 2, the highest grain yield per hill was observed for the rice genotypes like MTU-1075 (43.00g) followed by MTU-1121 (42.40g), MTU-1001 (40.50g) and IR-11N-187 (40.20g) was found to be superior in grain yield.

In the present investigation as shown in Table 3. The studies on GCV and PCV indicated that the presence of high amount of variation and role of the environment on the expression of these traits. The magnitude of PCV was higher than GCV for all the characters which may due to higher degree of interaction of genotype with the environment (Senapathi and Kumar, 2015).

Among the 13 quantitative characters GCV ranged from harvest index (4.31%) to number of panicles per hill (31.11%). The GCV estimates would show that the genotypic variability was low (below 10%) for harvest index (4.31%), biological yield (8.91%) and panicle length (9.94%). Moderate (10-20%) for flag leaf width (10.98%), grain yield per hill (11.19%), days to maturity (11.53%), plant height (11.92%), days to 50% flowering (13.77%), number of tillers per hill (14.32%), flag leaf length (17.94%) and test weight (18.59%). High for (above 20%) number of spikelets per panicle (23.67%) and number of panicles per hill (31.11%).

The PCV ranged from harvest index (5.29%) to number of panicles per hill (31.27%). The PCV estimates would show that the phenotypic variability was low for harvest index (5.29%), Moderate for panicle length (10.46%), flag leaf width (11.34%), grain yield per hill (11.53%), plant height (12.34%), days to 50% flowering (13.78%), biological yield (14.49%), days to maturity (15.54%), number of tillers per hill (17.52%), test weight (18.83%) and flag leaf length (18.92%). High for number of panicles per hill (31.27%).

In the present investigation, as expected, the PCV estimates were higher than the GCV estimates the variation due to environment as well as variation due to interactions. However, there was a close correspondence between the estimates of PCV and GCV for the characters *viz*., days to 50% flowering, days to maturity, plant height, panicle length, flag leaf width, biological yield, test weight and grain yield per hill under study indicating the fact that these characters were less influenced by the environmental factors as evidenced from the less differences in magnitude of PCV and GCV.

In contrast, others characters, *viz.*,biological yield, days to maturity, number of tillers per hill and harvest index were highly influenced by environment as evidenced from high magnitudinal differences between the estimates of PCV and GCV. Hence selection for these characters sometimes may be misleading. These environmental factors could be due to heterogeneity in soil fertility status and other unpredictable factors (Reddy *et al.*, 2012). The findings of (Falconer, 1960) are not only helpful in determining the heritable portion of variation. For this estimates of heritability of these traits are necessary. Similar pattern of PCV and GCV was reported by several workers for all of most of these characters (Dhurai *et al.*, 2014, Rashmi *et al.*, 2017, and Harsha *et al.*, 2017). According to Burton and Devane (1953) heritability in broad sense is ratio bêtween genotypic variance to total variance.

Table.1 Analysis of variance for 13 characters of 25 rice genotypes during *kharif*-2018

Characters	Mean Sum of Squares		
	Replication	Treatments	Error
	(df= 2)	(df= 24)	(df=48)
Days to 50% flowering	0.013	579.564**	0.305
Plant height	2.271	577.556**	13.729
Flag leaf length	1.64	122.00**	4.42
Flag leaf width	0.005	0.086*	0.002
No of Tillers/hill	1.281	12.245**	1.742
No of Panicles/ hill	0.410	12.249**	0.126
Panicle length	1.638	22.497**	0.772
No of Spikelets/panicle	1.960	7445.784**	0.960
Days to maturity	122.080	855.119**	182.511
Biological yield	98.314	206.566**	73.190
Test weight	1.960	51.708**	0.460
Harvest Index	4.029	15.152**	2.192
Grain Yield/ Plant	5.760	49.465**	1.010

** Significant at 1% level of significance, * Significant at 5% level of significance

Table.2 Mean performance for 13 quantitative characters of 25 rice genotypes during *kharif*-2018

Genotypes	Days to 50% flowering	Plant height (cm)	Flag leaf length (cm)	Flag leaf width (cm)	No of Tillers/ hill	No of Panicles/ hill	Panicle length (cm)	No of Spikelets/ panicle	Days to maturity	Biological yield (g)	Test weight(g)	Harvest Index (%)	Grain Yield/ hill (g)
MTU - 1001	111.33	111.87	35.65	1.59	14.33	13.20	25.40	197.67	138.67	85.13	16.98	47.81	40.50
MTU - 1061	126.00	99.83	27.30	1.33	16.47	14.27	24.40	196.67	153.67	74.67	19.44	42.57	31.60
MTU - 1064	122.67	105.21	30.67	1.49	14.53	12.47	24.70	241.67	149.67	80.20	22.80	48.02	38.50
MTU - 1075	121.33	111.06	29.78	1.56	12.33	9.00	25.80	256.33	149.33	83.87	17.38	51.48	43.00
MTU - 1121	119.67	104.48	30.49	1.61	12.93	10.80	26.50	259.00	147.67	86.80	18.58	48.98	42.40
MTU - 7029	119.00	83.85	20.20	1.32	15.27	14.73	23.90	231.67	148.00	71.53	18.38	49.94	35.60
BPT - 3291	114.67	94.28	35.54	1.75	11.40	10.27	22.30	262.33	142.67	76.27	15.34	49.45	36.70
BPT - 5204	121.00	89.25	24.31	1.23	15.80	13.13	23.00	249.00	150.00	72.87	16.64	47.55	34.80
MTU - 1010	88.33	106.73	26.41	1.31	15.07	14.47	25.60	202.00	116.00	58.87	24.82	50.43	30.20
HHZ3 - SAL6 - Y1 - Y2	88.00	120.04	41.64	1.55	11.27	9.13	26.00	316.33	118.00	69.00	22.56	48.19	33.30
IR - 11A 257	95.33	129.13	40.04	1.41	13.40	10.33	34.10	187.00	124.33	79.80	26.50	49.73	38.70
IR - 10N 276	87.00	140.20	41.76	1.58	9.27	9.13	25.90	244.00	115.00	51.20	23.56	51.93	26.90
HHZ4 - SAL 12 - LI1 - LI2	86.00	125.87	37.90	1.51	11.67	10.60	29.30	171.67	116.00	67.27	22.76	46.31	30.70
PR - 133	94.67	110.10	37.87	1.79	9.67	7.67	24.80	200.67	122.67	70.47	30.86	49.27	34.80
IR - 11N - 187	98.33	127.50	48.03	1.39	12.20	10.07	29.50	239.00	127.33	82.47	26.55	48.56	40.20
IR - 118 - 304	94.67	126.30	33.57	1.54	12.47	11.40	31.60	217.33	123.67	71.93	25.22	50.38	35.90
SHIATS DHAN - 1	98.00	130.11	41.59	1.87	16.60	14.40	26.80	274.33	127.00	79.67	17.40	47.80	38.00
SHIATS DHAN - 2	93.67	126.81	40.45	1.50	13.40	10.33	27.90	147.33	121.67	80.47	26.23	47.72	38.40
SHIATS DHAN - 3	91.67	119.84	32.67	1.24	14.00	12.00	30.20	216.33	120.67	77.33	23.50	48.94	37.50
SHIATS DHAN - 4	105.00	128.70	38.55	1.68	12.40	10.27	26.50	212.33	134.00	77.53	16.60	46.77	36.00
SHIATS DHAN - 5	95.67	120.77	37.97	1.38	15.40	13.27	28.70	213.67	124.67	75.13	21.62	46.47	34.90
TP – 30596	86.33	109.11	32.69	1.55	13.07	10.73	29.40	124.33	115.50	75.47	25.44	43.80	33.10
TP – 30601	88.33	121.57	36.95	1.51	10.80	9.60	28.10	152.00	118.33	85.07	24.80	47.27	40.10
TP – 30603	87.33	112.21	39.11	1.61	10.73	8.53	27.90	132.67	116.67	72.27	25.80	50.72	36.60
TP – 30606	89.33	121.56	31.41	1.72	12.27	10.93	28.40	117.00	119.33	65.87	26.20	45.10	29.60
Mean	100.93	115.06	34.90	1.52	13.07	11.23	27.07	210.49	129.62	74.85	22.24	48.21	35.92
CD5%	**0.91**	**6.08**	**3.45**	**0.07**	**2.17**	**0.58335**	**1.44**	**1.61**	**22.18**	**14.04**	1.11	2.43	1.65
Max	126.00	140.20	48.03	1.87	16.60	14.73	34.10	316.33	153.67	86.80	30.86	51.93	43.00
Min	86.00	83.85	20.20	1.23	9.27	7.67	22.30	117.00	115.00	51.20	15.34	42.57	26.90

Table.3 Estimation of genetic parameters for grain yield and other components in rice

Characters	Vg	Vp	GCV	PCV	Heritability (%) Bs	GA	GA AS % Mean
Days to 50% flowering	193.09	193.39	13.77	13.78	99.84	28.60	28.34
Plant height	187.94	201.67	11.92	12.34	93.19	27.26	23.70
Flag leaf length	39.19	43.61	17.94	18.92	89.86	12.22	35.03
Flag leaf width	0.03	0.03	10.98	11.34	93.66	0.33	21.88
No of Tillers/hill	3.50	5.24	14.32	17.52	66.78	3.15	24.10
No of Panicles/ hill	12.21	12.33	31.11	31.28	98.98	7.16	63.77
Panicle length	7.24	8.01	9.94	10.46	90.37	5.27	19.47
No of Spikelets/panicle	2481.61	2482.57	23.67	23.67	99.96	102.60	48.74
Days to maturity	224.20	406.71	11.53	15.54	55.13	22.90	17.64
Biological yield	44.46	117.65	8.91	14.49	37.79	8.44	11.28
Test weight	17.08	17.54	18.59	18.83	97.38	8.40	37.78
Harvest Index	4.32	6.51	4.31	5.29	66.34	3.49	7.23
Grain Yield/ hill	16.15	17.16	11.19	11.53	94.11	8.03	22.36

Vg = genotypic variance, Vp = phenotypic variance, GCV = Genotypic coefficient of variation, PCV = Phenotypic coefficient of variation, GA = Genetic advance

The estimates of genotypic coefficient of variation (GCV) reflect the total amount of genotypic variability present in the material. However, the proportion of this genotypic variability which is transmitted from parents to offspring is reflected by heritability. Broad sense heritability determines the efficiency with which we can utilize the genotypic variability in breeding programme. The genotypic variance and its components are influenced by the gene frequencies of genes differ from one population to another, estimates of heritability also vary from one population to another for a given character. The range of heritability was considered as low (<30%), medium (30-60%) and high (>60%) as proposed by Johnson et al., (1955). The estimates of heritability from present investigation are presented in Table 3.

In the present study, the heritability in broad sense (h2) ranges from biological yield (37.79%) to number of spikelets per panicle (99.96%). High estimates of heritability (above 60%) recorded for harvest index (66.34%), number of tillers per hill (66.78%), flag leaf length (89.86%), panicle length (90.37%), plant height (93.19%), flag leaf width (93.66%), grain yield per hill (94.11%), test weight (97.38%), number of panicles per hill (98.97%), number of spikelets per panicle (99.96%) and days to 50% flowering (99.84%). While moderate estimate of heritability for (30-60%) biological yield (37.79%) and days to maturity (55.13%). None of the characters showed low estimates of heritability (below 10%). It showed that the phenotypic variability of none characters had greater share of environmental.

The estimates of heritability are more advantageous where expressed in terms of genetic advance. Johnson *et al.,* (1955) suggested that without genetic advance the estimates of heritability will not be of practical value and emphasized the concurrent use of genetic advance along with heritability. Genetic advance as percent mean was low

(below 10%) for harvest index (7.23%) and moderate (10-20%) for biological yield (11.28%), days to maturity (17.64%) and panicle length (19.47%). While high genetic advance as percent mean (above 20%) recorded for flag leaf width (21.88%), grain yield per hill (22.36%), plant height (23.70%), number of tillers per hill (24.10%), days to 50% flowering (28.34%), flag leaf length (35.03%), test weight (37.78%), number of spikelets per panicle (48.74%) and number of panicles per hill (63.76%).

Most of the characters showed high heritability coupled with high genetic advance as percent mean was observed for flag leaf width, grain yield per hill, plant height, number of tillers per hill, days to 50% flowering, flag leaf length, test weight, number of spikelets per panicle and number of panicles per hill. Whereas high heritability coupled with moderate genetic advance as percent mean was observed for biological yield, days to maturity and panicle length indicating that this charater seems to be heritable and can be improved by selection. These findings were in accordance with Deepa *et al.,* (2006), Prajapathi *et al.,* (2011) and Sandeep *et al.,* 2018.

Moderate heritability coupled with high genetic advance as percent mean was observed for biological yield, while high heritability coupled with low genetic advance as percent mean was observed for number of panicles per hill which indicated the moderate influence of environment and selection would be ineffective.

From the present investigation it is concluded that among 25 genotypes of rice on the bases of mean performance MTU-1010 (6.8 t/ha) was found to be superior in grain yield over the check followed by MTU-1121 (6.2 t/ha), SHIATS DHAN-1 (6.0 t/ha) and MTU-1075 (5.9 t/ha) showed 1-1.2 t/ha over the check and these genotypes showed high variability for all 13 quantitative parameters taken in the present study.

High to moderate estimates of GCV and PCV were recorded for number of panicles per hill, number of spikelets per panicle, test weight, flag leaf length, days to 50% flowering, plant height and grain yield per hill. High estimates of heritability coupled with high values of genetic advance as percent mean was observed for characters number of spikelets per panicle, days to 50% flowering, number of panicles per hill and test weight respectively suggesting that there was preponderance in gene action.

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