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STUDY OF GENETIC VARIABILITY AND RESPONSE TO SELECTION IN SEGREGATING GENERATIONS OF RICE (*Oryza sativa* L.) CROSS

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ABSTRACT

For the trait PPP, exhibited moderate GCV in Istdate of TS, 2nd date of DS and TS. Moderate to high variability were observed in respect to PCV and GCV for GYP plant (g), GYP plot (g) in both the methods of sowing as well as two date of sowing in F_3 generation. High h^2 coupled with low genetic advance as per cent of mean had recorded for traits DFF in MTL as well as RPS group, which indicated the involvement of non-additive gene action. For trait GPP recorded high h^2 coupled with high GA as per cent of mean in Ist and 2nd date of DS as well as TP respectively under HY group whereas high GA along with moderate h^2 was obtained in both date of sowing under same selection method indicating the preponderance of additive gene action. Average selection response for all the studied traits had exhibited maximum in LY followed by HY and RPS selection method. In early generation of selection based on the LY criteria as well as high realized h^2 would be most effective.

INTRODUCTION

The early generation testing is one of the best option to reduce the amount of material to be handled in the segregating generations and at the same time retain the good recombinant lines for the traits under improvement. It is also enhanced by selection response which maximises either by selecting the best genotype available in the population or by increasing the rigour of selection. A very rigorous selection may not be desirable as it can eliminate some promising genotypes. Whan *et al.* (1982) suggested that selection for grain yield in early generation need to be done at many sites simultaneously at an early growth stage. Grain yield is a complex character and is the result of interaction of many variables due to different gene association that might exist in different population and might result in quite different relationships. It is also largely influenced by environment. Further genotype and environmental interaction reduces the effectiveness of early generation selection Whan *et al.* (1981). Large environmental differences may lead to failure of parental yield to be indicative of the yield of progeny. In the present investigation, the genetic variability and response to selection in segregating generations of rice (*Oryza sativa* L.) cross has been studied.

MATERIALS AND METHODS

The experimental material comprised F-$_2$ population of cross between BG102/BPT5204 which was obtained from Rice Project, Department of Plant Breeding and Genetics, Birsa Agricultural University, Ranchi, Jharkhand. The F_2 materials were grown in nursery on 6th June, 2013. Thirty (30) days old seedlings were transplanted in the puddled field. Out of total 5000 F_2 established population, 1000 F_2 were tagged randomly, data recording and harvesting of each plants were done separately after flowering, so that these F_2 plants be categorized and selected. On the basis of these data 50 plants were selected in each groups viz., high yielder (HY), low yielder (LY), multi trait limit (MTL) and random plant selection (RPS). Each group comprising 50 plants but in MTL having only 48plants. High and low yielder plants were selected on the basis of their high and low yield potential, however, in MTL group optimum plants were selected by fixing certain traits range *viz*, PH (70-110 cm), PPP (5-25), PL (18-35 cm), GPP (80-250) and test wt. (100 seed, 1.9-3.0 g) but in RPS group plant was selected on random basis. These F_2 selected plants were grown during *kharif*, 2014 in RBD with two replication and two methods of sowing, such as, direct seeded and transplanted at twenty days interval, each plot measuring 2.7 x 0.4 meter size. The row to row distance was kept at 20cm while plant to plant distance was maintained at 15cm. A fertilizer dose of 80 : 40 : 30 N:P:K Kg/ ha was applied in two parts 40 kg of N, all phosphate and potash were applied as a basal and the remaining 40 kg N was applied as top dressing in two split doses. The analysis of variance was carried out separately for each trait as per formula suggested by Panse and Sukhatme (1967), phenotypic and genotypic coefficient of variation by Burton (1952), heritability (Broad sense) and genetic advance as per cent of mean were estimated by the formula as suggested by Johanson *et al.* (1955). Standardized selection differential, response to selection and realized heritability were estimated as per Falconer (1989)

RESULTS AND DISCUSSION

The results obtained with respect to genetic variability of different traits of F_3 generations are given in the Table 1. Knowledge on nature and magnitude of genotypic and phenotypic variability present in any crop species plays an important role in formulating successful breeding programmes (Allard, 1960). Sivasubramanian and Menon (1973) also highlighted the importance of variability in early segregating generations and suggested that magnitude of genotypic coefficient of variability and phenotypic coefficient of variability should be given importance. Jennings *et al.* (1979) suggested that crosses which will realise early homozygosity are ideally suited for further breeding work.

In general PCV was bit higher than GCV which indicates additive effect of environment on the expression of the trait. Similar finding have been reported earlier by Mohan and Chauhan (2011), Praveen *et al.* (2010), Chakraborty and Chakraborty (2010) and Gala *et al.* (2016).

In 50F_3 progenies of two date of sowing and different methods of selection followed by two methods of sowing of same cross, DFF, PH and Tw recorded very small differences between GCV and PCV indicating the very small degree of environmental influence on manifestation of these characters governed by additive genes, similar finding have been reported earlier by Praveen *et al.* (2010),Seyoum *et al.* (2012). High GCV and PCV had been observed in MTL and RPS for PPP, GYP plant and GYP plot indicated that existence of wide spectrum of variability for this trait and offer greater opportunities for desired trait through phenotypic selection by Devi (2006), Raut *et al* (2009), Nandeshwar, *et al.* (2010),Devi *et al.* (2016),Gala *et al.* (2016). In the present investigation,high h^2 coupledwith moderate genetic advance as per cent of mean has been recorded for Tw in all selection methods as well as different methods and date of sowing except in HY group of Istdate TP, LY group of Ist date DS, and MTL group of 2nd date TP, in 50F_3 progenies, indicating the preponderance of additive gene action as well as non-additive gene action. For trait GPP recorded high h^2 coupled with high GA as per cent of mean in Ist and 2nd date of DS as well as TP respectively under HY group whereas high GA along with moderate h^2 was obtained in both date of sowing under same selection method indicating the preponderance of additive gene action. Similar finding earlier have been reported by Kumar *et al.* (2013), Dhurai *et al.* (2014), Singh *et al.* (2013), Dutta *et al.* (2013), Rajendra *et al.* (2013), Tuhina *et al.* (2015) and Lingaiah (2015), whereas for most of characters have been recorded high h^2 coupled with low to moderate genetic advance as per cent of mean in HY and LY group which is might be due to preponderance of additive and non- additive gene action Similar finding earlier have been reported by Chakraborty and Chakraborty (2010) and Sanghera *et al.* (2013). The high heritable characters indicated that selection for these characters should be fairly easy and could be used as a selection criterion for future hybridisation programme. This is because there would be close correspondence between the genotype and phenotype due to a relatively smaller contribution of the environment to the phenotype.

Table 1: Genetic Parameters of 50 F_3 progenies selected from F_2 population (BG102/BPT5204) based on different selection indices and grown under different crop ecology

Characters	Genetic parameters	Ist method of selection (HY)				2nd method of selection (LY)				3rd method of selection (MTL)				4th method of selection (RPS)			
		Ist Date		2nd Date		Ist Date		2nd Date		Ist Date		2nd Date		Ist Date		2nd Date	
Characters		DS	TP	DS	TP	DS	TP	DS	TP	DS	TP	DS	TP	DS	TP	DS	TP
DFF	h^2 (%)	74.59	76.75	42.53	67.64	73.21	22.03	9.60	64.28	65.43	84.12	65.98	84.26	91.13	71.48	78.87	86.18
	GA (%)	12.93	7.31	5.08	5.95	6.72	2.19	1.14	4.94	5.34	6.51	5.38	6.52	8.66	7.18	7.75	8.30
	GCV (%)	4.40	4.05	3.78	3.51	3.83	2.26	1.78	2.99	3.82	3.75	3.94	3.37	5.31	4.52	5.24	4.28
	PCV (%)	5.10	4.62	5.79	4.26	4.48	4.82	5.75	3.72	4.73	4.08	4.85	3.67	5.56	5.35	5.90	4.61
PH (cm)	h^2 (%)	5.35	16.38	10.45	3.73	11.07	18.69	34.66	37.65	15.98	11.21	12.78	27.98	11.34	10.35	70.42	13.12
	GA (%)	0.84	2.20	1.67	0.71	1.52	3.47	5.68	6.09	2.61	1.68	2.23	5.18	2.25	2.07	14.00	2.91
	GCV (%)	1.75	2.63	2.50	1.78	2.22	3.89	4.68	4.82	3.11	2.39	2.97	4.66	3.23	3.11	8.09	3.90
	PCV (%)	7.59	6.50	7.73	9.22	6.69	9.01	7.95	7.85	7.78	7.12	8.32	8.81	9.61	9.69	9.65	10.76
PPP	h^2 (%)	9.93	23.53	25.41	27.26	21.85	41.82	15.61	38.68	27.16	50.69	19.75	27.22	43.97	11.91	53.95	14.88
	GA (%)	3.78	9.56	8.69	12.00	5.64	16.73	5.42	15.24	10.09	35.25	14.98	11.59	20.28	5.84	26.70	7.15
	GCV (%)	5.81	10.87	8.08	9.98	7.38	12.29	6.45	12.54	10.40	24.04	15.57	11.01	13.18	8.97	16.76	8.91
	PCV (%)	18.45	22.41	16.03	19.12	15.79	19.00	16.33	20.17	19.97	33.77	35.06	21.12	19.88	26.01	22.82	23.10
GPP	h^2 (%)	73.41	58.96	69.99	52.46	57.28	41.79	47.27	40.82	50.47	12.35	37.14	49.09	40.39	56.02	47.36	37.68
	GA (%)	39.07	25.91	30.92	21.59	24.72	17.22	20.21	15.90	24.26	6.24	15.43	20.71	18.54	22.30	23.37	16.06
	GCV (%)	22.13	16.38	17.94	14.46	15.85	12.92	14.26	12.27	16.28	8.47	12.08	14.10	14.16	14.46	14.60	12.70
	PCV (%)	25.83	21.33	21.44	19.97	20.94	19.99	20.75	19.20	22.91	24.12	19.82	20.12	22.28	19.32	21.22	20.68
TW(g)	h^2 (%)	76.00	84.77	82.59	96.42	95.35	92.00	93.39	89.07	86.38	92.10	88.87	95.94	62.27	86.06	79.19	86.47
	GA (%)	12.20	14.56	13.13	26.33	20.97	19.94	21.24	21.17	15.98	16.76	16.17	27.90	10.01	14.42	12.86	13.07
	GCV (%)	6.79	7.67	7.01	13.01	10.42	10.09	10.66	10.83	8.17	8.30	8.15	13.55	6.15	7.54	7.01	6.82
	PCV (%)	7.79	8.33	7.71	13.25	10.67	10.51	11.04	11.48	8.80	8.65	8.65	13.83	7.79	8.13	7.88	7.33
GYP Plant (g)	h^2 (%)	46.14	28.47	35.74	50.26	50.32	59.74	32.16	25.01	49.89	53.38	31.42	17.23	31.57	29.84	41.84	16.05
	GA (%)	18.45	11.58	14.92	25.29	28.25	25.77	10.73	6.38	45.55	43.06	22.30	6.26	14.67	10.76	28.40	4.60
	GCV (%)	13.18	10.53	12.10	17.31	19.32	16.18	9.18	6.44	30.80	28.14	19.02	7.19	12.67	9.55	21.30	5.56
	PCV (%)	19.40	19.75	20.25	24.42	27.24	20.93	16.18	12.87	43.61	38.51	33.94	17.31	22.55	17.48	32.94	13.89
GYP Plot (g)	h^2 (%)	44.28	35.19	57.01	34.98	19.01	18.99	49.76	19.01	14.13	13.36	16.44	33.57	4.09	12.41	21.24	14.97
	GA (%)	17.23	15.01	29.53	16.42	6.59	7.01	25.07	6.59	4.12	4.17	6.61	12.64	1.37	4.01	12.50	5.65
	GCV (%)	12.57	12.27	18.98	13.47	7.33	7.80	17.25	8.65	5.32	5.53	7.91	10.58	3.29	5.52	13.15	7.09
	PCV (%)	18.89	20.69	25.14	22.77	16.81	17.91	24.45	19.84	14.16	15.13	19.52	18.27	16.28	15.66	28.54	18.32

Table 2: Estimates of Standardized selection differential, standardized selection response and realized heritability for different traits from two methods as well as two date of sowing based on different methods of selection of BG102/BPT5204

Methods of selection and selection intensity (5%)	Population mean	No. of selected lines	Mean of selected parent	Standardized selection differential (R/ó p)	Progeny mean				Standardized selection response (S/óp)				Average standardized selection response	Realized heritability (R/S)				Average Realized heritability
					Ist Date		2nd Date		Ist Date		2nd Date			Ist Date		02nd Date		
					DS	TP	DS	TP	DS	TP	DS	TP		DS	TP	DS	TP	
Based on HY		50																
PH (cm)	116.15		122.12	0.46	122.01	121.06	121.79	121.70	0.45	0.38	0.43	0.43	0.42	0.98	0.82	0.94	0.93	0.92
PPP	8.08		12.32	1.41	12.07	10.63	11.00	12.29	1.33	0.85	0.97	1.40	1.14	0.94	0.60	0.69	0.99	0.81
GPP	78.48		109.48	1.14	80.95	103.34	99.22	88.37	0.09	0.92	0.76	0.36	0.53	0.08	0.80	0.67	0.32	0.47
GYP Plant (g)	10.12		25.38	2.68	24.90	24.52	20.25	17.49	2.60	2.53	1.78	1.30	2.05	0.97	0.94	0.66	0.48	0.76
Based on LY		50																
PH (cm)	116.15		122.34	0.48	122.30	121.43	122.09	122.20	0.47	0.41	0.46	0.46	0.45	0.99	0.85	0.96	0.98	0.95
PPP	8.07		10.06	0.66	9.74	9.94	10.00	9.74	0.55	0.62	0.64	0.55	0.59	0.84	0.94	0.97	0.84	0.90
GPP	78.48		89.76	0.42	88.06	89.30	89.59	89.00	0.35	0.40	0.41	0.39	0.39	0.85	0.96	0.98	0.93	0.93
GYP Plant (g)	10.12		16.43	1.11	15.90	15.50	15.72	15.90	1.02	0.95	0.98	1.02	0.99	0.92	0.85	0.89	0.92	0.90
Based on MTL		48																
PH (cm)	116.15		101.92	-1.09	114.72	115.37	115.62	115.33	-0.11	-0.06	-0.04	-0.06	-0.07	0.10	0.05	0.04	0.06	0.06
PPP	8.07		9.08	0.34	9.00	8.63	8.78	8.45	0.31	0.19	0.24	0.13	0.22	0.92	0.55	0.70	0.38	0.64
GPP	78.48		87.85	0.35	85.19	85.96	87.80	84.48	0.25	0.28	0.34	0.22	0.27	0.72	0.80	0.99	0.64	0.79
GYP Plant (g)	10.12		10.76	0.11	10.72	10.43	10.69	10.63	0.11	0.05	0.10	0.09	0.09	0.94	0.48	0.89	0.79	0.78
Based on RPS		50																
PH (cm)	116.15		124.72	0.66	120.66	122.90	123.96	123.88	0.35	0.52	0.60	0.59	0.52	0.53	0.79	0.91	0.90	0.78
PPP	8.07		9.72	0.55	9.65	8.83	9.28	9.36	0.52	0.25	0.40	0.43	0.40	0.96	0.46	0.74	0.78	0.74
GPP	78.48		90.28	0.43	88.74	82.61	88.56	89.03	0.38	0.15	0.37	0.39	0.32	0.87	0.35	0.85	0.89	0.74
GYP Plant (g)	10.12		16.08	1.05	15.88	15.58	14.82	14.82	1.01	0.96	0.83	0.83	0.91	0.97	0.92	0.79	0.79	0.87

DFF = Days to 50 % Flowering, PH = Plant Height, PPP = Panicle per Plant, PL = Panicle Length, GPP = Grains per Panicle, GYP plant = Grain yield per plant, GYP plot = Grain yield per plot, HY = High Yielder, LY = Low yielder, MTL = Multi trait limit, RPS = Random plant selection, DS = Direct seeding, TP = Transplanting, GCV = Genotypic coefficient of variation, PCV = Phenotypic coefficient of variation and GA = Genetic Advance.

Average selection response for all the studied traits had exhibited maximum in LY followed by HY and RPS selection method (Table 2). It might be probable that delaying selection reduces the frequency of high yielding genotypes resulting in a greater frequency of low yielding genotypes. Although the results indicate that the improvement obtained by selecting in late generation is just as effective as in early generations, a strong argument for selecting for yield in early generations is to permit testing in many sites and years at an early stage. The results of selection for low yield supported by earlier findings Whan *et al*. (1982). The highest standardized selection differential was recorded based on HY selection followed by LY selection and RPS. High realized h^2 was observed for all characters under different methods of planting in both dates of sowing except in TP in 2nd date of sowing for GPP and GYP plant it might be happened due to environmental variation. Under selection based on HY as well as high realised h^2 was recorded for all the traits in different methods of planting on both dates of sowing suggesting that early generation of selection may be effective. High level of h^2 was also recorded under RPS for all the traits in different methods of planting on different dates of sowing barring PH under DS condition, PPP, and GPP, TP on Istdate of planting which are comprising the low realized h^2 it might be due to influence of environment, while under MTL for PH and PPP low h^2 was recorded in different method of planting as well as on different date of sowing except in DS condition on 2nd date of sowing in PPP, whereas high realized h^2 was recorded in GPP and GYP plant in different method of planting on both dates of sowing except TP on Ist of sowing of GPP.

Based on the above mentioned results conclude that in general high realized h^2 was recorded under LY and HY selection method. These findings are corroborated with the finding of Whan *et al*. (1982), Fasoules (1981), Eshghi *et al*. (2011), Barma *et al*. (2012) and Ahmad *et al*. (2017) while under MTL and RPS variable levels of realized h^2 was recorded it might be due to under MTL, some superior plants might have ignored during the selection in F_2 population and under RPS some inferior plants might have carried over in F_3 population from F_2 generation.

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