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Study of heterosis and inbreeding depression in F_2 generation of rice (*Oryza Sativa* L.)

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Abstract
The experiment was carried out during summer and *kharif* 2018-19 at Main Rice Research Centre, Navsari Agricultural University, Navsari. Six diversified elite lines of rice (IET-24772, IET-24783, GNR-2, GNR-3, GR-11 and GR-15) were used to study heterosis and inbreeding depression for grain yield and its components in three crosses of rice. Heterosis of hybrids over mid parent and better parent varied from cross to cross and character to character. Out of three hybrids studied, only cross-II exhibited significantly positive relative heterosis and heterobeltiosis for grain yield per plant under present study. The highest relative heterosis of 25.08 % and heterobeltiosis of 24.48 % were exhibited by cross GNR-2 x GNR-3. This cross also showed significantly positive relative heterosis for the important yield contributing components *i.e.*, productive tillers per plant while significantly negative relative heterosis was observed for 100 grain weight.

Keywords: Heterosis, inbreeding depression, relative heterosis, heterobeltiosis

Introduction

Rice (*Oryza sativa* L.), the most important agronomical crop, occupies the enviable position around the world. Being a major cereal crop, nutritionally it is one of the world's most important staple foods, with greater portion of the world's population dependant on it for a significant proportion of their caloric intake in the rate of 20 per cent daily calories. India is the largest rice cultivator which accounts for almost thirty per cent rice area of the world's. India is the largest rice growing country, while China is the largest producer of rice.

The superiority of F_1 hybrid over its parents expresses heterosis in term of yield and its contributing traits where as reduction or loss in vigour, fertility and yield reflects inbreeding depression as a result of inbreeding. The magnitude of heterosis helps in the identification of potential cross combinations to be used in conventional breeding programmes to enable and create wide array of variability in segregating generations. The knowledge of heterosis along with extent of inbreeding depression in successive generations provides essential knowledge to exploit maximum heterosis by utilizing appropriate breeding methodology. Genetic component of variation plays significant role in crop improvement since only this component is transmitted to next generation. Heritability expresses heritable portion of variation and its estimates along with genetic advance is most useful in predicting the resultant effect of selecting the best individuals.

Materials and Methods

Six diversified elite lines of rice (IET-24772, IET-24783, GNR-2, GNR-3, GR-11 and GR-15) comprised as experimental material selected on the basis of their variation in morphological characters. The three crosses (IET-24772 x IET-24783, GNR-2 x GNR-3 and GR-11 x GR-15) obtained by crossing of six diverse parents during summer-2018 at Main Rice Research Centre, Navsari Agricultural University, Navsari. F_1s were produced during summer-2018. Selfing of F_1s was done in the *kharif*-2018 to get F_2s. F_3s were produced during summer-2019. The evaluation trial was conducted with all five generations of three crosses along with standard check GNR-7 in *kharif*-2019 at Main Rice Research Centre, Navsari Agricultural University, Navsari. Five generations (P_1, P_2, F_1, F_2 and F_3) of each of the three crosses were sown during *kharif*-2019 in compact family block design with three replications. Each three crosses consisting of five generations were randomly allotted to each plot. Each plot consisted of two rows of parents and F_1s, thirty rows of the F_2 and fifteen rows of the F_3 generations of each cross. Twenty plants were planted in each row.

The per se performance of F_1s and F_2s along with estimates of inbreeding depression and heterosis are mentioned in Table 1 to Table 3. Inbreeding depression in F_2 generation was estimated using the formula.

$$\text{Heterosis (\%)} = \frac{\overline{F}_1 - \overline{MP}}{\overline{MP}} \times 100$$

$$\text{Heterobeltiosis (\%)} = \frac{\overline{F}_1 - \overline{BP}}{\overline{BP}} \times 100$$

Where,

$\overline{F}_1$ = Mean performance of the F1 hybrid

$\overline{(MP)}$ = Mean value of the parents (P1 and P2) of a hybrid

$\overline{(BP)}$ = Mean value of better parent

$$\text{Inbreeding depression(\%)} = \frac{\overline{F}_1 - \overline{F}_2}{\overline{F}_2} \times 100$$

Where,

$\overline{F}_1$ = Mean value of the F1 hybrid

$\overline{F}_2$ = Mean value of the F2 generation

Table 1: *Per se* performance of five generations for days to flowering, days to maturity, plant height and productive tillers per plant in three crosses of rice

Generations	Cross-I			Cross-II			Cross-III		
	Days to flowering								
	Mean	**±**	**SE**	**Mean**	**±**	**SE**	**Mean**	**±**	**SE**
P_1	87.07	±	0.21	104.43	±	0.21	103.00	±	0.17
P_2	90.83	±	0.15	90.53	±	0.21	91.90	±	0.31
F_1	90.77	±	0.34	100.70	±	0.24	100.30	±	0.48
F_2	90.73	±	0.12	99.38	±	0.14	101.22	±	0.16
F_3	92.79	±	0.16	100.46	±	0.13	97.72	±	0.24
CD (5%)	2.39			2.46			3.64		
	Days to maturity								
P_1	115.77	±	0.18	127.60	±	0.19	125.87	±	0.28
P_2	122.00	±	0.21	115.90	±	0.17	120.17	±	0.30
F_1	122.37	±	0.46	126.07	±	0.22	123.00	±	0.38
F_2	120.91	±	0.14	124.56	±	0.11	124.06	±	0.10
F_3	122.88	±	0.15	125.98	±	0.13	126.07	±	0.12
CD (5%)	3.36			3.09			1.34		
	Plant height (cm)								
P_1	136.73	±	0.17	114.33	±	0.26	127.27	±	0.27
P_2	134.70	±	0.16	122.97	±	0.16	122.97	±	0.16
F_1	134.73	±	0.21	121.83	±	0.21	123.60	±	0.29
F_2	135.32	±	0.06	117.84	±	0.11	120.48	±	0.12
F_3	135.02	±	0.09	117.79	±	0.14	120.71	±	0.19
CD (5%)	1.16			1.34			1.54		
	Productive tillers per plant								
P_1	7.93	±	0.12	9.93	±	0.09	7.97	±	0.11
P_2	10.50	±	0.11	9.30	±	0.12	9.50	±	0.11
F_1	9.97	±	0.17	11.00	±	0.14	8.97	±	0.17
F_2	9.11	±	0.05	9.13	±	0.05	9.63	±	0.05
F_3	9.69	±	0.07	9.73	±	0.07	8.96	±	0.07
CD (5%)	0.94			0.68			0.83		

Table 2: *Per se* performance of five generations for grain per panicle, 100 grain weight (g), grain yield per plant (g) and straw yield per plant (g) in three crosses

Generations	Cross-I			Cross-II			Cross-III		
	Grain per panicle								
	Mean	**±**	**SE**	**Mean**	**±**	**SE**	**Mean**	**±**	**SE**
P_1	213.40	±	1.13	264.93	±	1.07	240.83	±	1.62
P_2	255.17	±	1.59	214.27	±	1.08	257.23	±	1.69
F_1	255.47	±	2.43	262.97	±	1.77	251.80	±	1.93
F_2	245.17	±	0.56	232.50	±	0.59	245.71	±	0.49
F_3	251.84	±	0.78	231.14	±	0.83	239.94	±	0.78
CD (5%)	18.32			28.13			12.18		
	100 grain weight (g)								
P_1	2.44	±	0.01	1.45	±	0.00	1.48	±	0.01
P_2	2.25	±	0.02	3.02	±	0.01	1.94	±	0.02
F_1	2.33	±	0.02	2.12	±	0.01	1.90	±	0.03
F_2	2.42	±	0.01	2.39	±	0.01	1.88	±	0.01
F_3	2.38	±	0.01	2.28	±	0.01	2.16	±	0.01
CD (5%)	0.12			0.25			0.24		
	Grain yield per plant (g)								
P_1	14.31	±	0.13	15.18	±	0.09	15.31	±	0.08
P_2	16.12	±	0.20	15.04	±	0.09	18.52	±	0.10

F_1	15.74	±	0.27	18.90	±	0.10	17.51	±	0.17
F_2	15.88	±	0.05	16.31	±	0.04	16.94	±	0.05
F_3	14.56	±	0.08	16.24	±	0.06	17.42	±	0.07
CD (5%)	1.20			1.82			1.49		
	Straw yield per plant (g)								
P_1	20.99	±	0.31	21.49	±	0.31	21.69	±	0.29
P_2	24.62	±	0.32	24.39	±	0.18	24.73	±	0.24
F_1	24.54	±	0.40	25.06	±	0.29	23.65	±	0.35
F_2	23.80	±	0.10	24.59	±	0.09	23.56	±	0.11
F_3	25.02	±	0.15	24.77	±	0.13	24.93	±	0.16
CD (5%)	2.31			1.83			2.15		

Table 3: Per se performance of five generations for L:B ratio, protein content (%) and amylose content (%) in three crosses of rice

Generations	Cross-I			Cross-II			Cross-III		
	L:B ratio								
	Mean	**±**	**SE**	**Mean**	**±**	**SE**	**Mean**	**±**	**SE**
P_1	2.94	±	0.01	2.96	±	0.01	2.96	±	0.01
P_2	2.75	±	0.02	2.69	±	0.01	2.71	±	0.01
F_1	2.91	±	0.01	2.89	±	0.01	2.92	±	0.01
F_2	2.82	±	0.00	2.80	±	0.00	2.84	±	0.00
F3	2.83	±	0.00	2.73	±	0.00	2.88	±	0.01
CD (5%)	0.06			0.18			0.11		
	Protein content (%)								
P_1	9.21	±	0.03	7.40	±	0.04	5.62	±	0.05
P_2	9.01	±	0.02	5.16	±	0.05	6.69	±	0.05
F_1	9.14	±	0.04	5.13	±	0.07	6.22	±	0.09
F_2	8.94	±	0.01	5.22	±	0.02	5.61	±	0.02
F3	9.09	±	0.01	5.65	±	0.03	5.64	±	0.03
CD (5%)	0.14			0.58			0.44		
	Amylose content (%)								
P_1	24.23	±	0.13	23.03	±	0.14	26.81	±	0.25
P_2	23.17	±	0.14	23.75	±	0.13	24.66	±	0.19
F_1	23.87	±	0.15	23.65	±	0.19	25.72	±	0.27
F_2	23.21	±	0.04	24.35	±	0.04	24.84	±	0.06
F3	22.52	±	0.06	23.02	±	0.06	25.03	±	0.09
CD (5%)	1.11			0.91			1.05		

Results and Discussion

The manifestation of heterosis, heterobeltiosis and inbreeding depression are presented in Table 4 and Table 5. The results revealed significant positive and negative mid parent and better parent's heterosis in many crosses for different characters studied. The high values for heterotic effects also indicated that the parents used for the study were widely diverse.

Out of three hybrids studied, only cross-II exhibited highly positive and significant relative heterosis and heterobeltiosis for grain yield per plant. The highest relative heterosis of 25.08 % and heterobeltiosis of 24.48 % were exhibited by cross GNR-2 x GNR-3. Higher positive heterosis for grain yield per plant in rice had been observed by earlier workers *viz*., Adilakshmi and Reddy (2011) [1], Patil *et al*. (2011) [8], Soni and Sharma (2011) [12], Reddy *et al*. (2013) [9], Venkanna *et al*. (2014) [13], Anis *et al*. (2016) [2], Borah *et al*. (2017) [3] and Rumanti *et al*. (2017) [10].

Yield is a very complex character. Grafius (1956) [5], while analyzing the phenomenon of heterosis, remarked that there could be no separate gene system for grain yield *per se* since yields is an end product of multiplicative interactions between the yield components. In rice, productive tillers per plant, grains per panicle and 100 grain weight are the three major yield components. The data revealed that heterotic hybrids for grain yield did not show significant heterosis for all the yield components. In fact, appreciable heterosis for one or two components was sufficient to manifest heterosis for grain yield. The results are in agreement with the findings of Anis *et al*. (2016) [2], Borah *et al*. (2017) [3] and Rumanti *et al*. (2017) [10].

The cross GNR-2 x GNR-3 showed positive and significant relative heterosis for the important yields contributing components *i.e*., productive tillers per plant while negative and significant relative heterosis was observed for 100 grain weight. From these results, it is apparent that adjustment of two vital yield components of this cross has potentiality for improving yield.

Table 4: Estimates of relative heterosis (%), heterobeltiosis (%) and inbreeding depression (%) for days to flowering, days to maturity, plant height (cm), productive tillers per plant, grain per panicle and 100 grain weight in cross-I, II, III

Particulars	Days to flowering			Days to maturity			Plant height (cm)			Productive tillers per plant			Grains per panicle			100 grain weight (g)		
	Cross-I (IET-24772 x IET-24783)																	
RH % ± SE	2.04	±	1.26	2.93*	±	1.78	-0.72	±	0.74	8.14	±	0.48	9.04*	±	9.78	-0.69	±	0.06
HB % ± SE	4.25**	±	1.03	5.70**	±	1.45	0.02	±	0.60	-5.07	±	0.40	0.12	±	7.98	-4.44*	±	0.05
ID % ± SE	0.03	±	5.34	1.19	±	5.90	-0.43	±	2.71	8.61	±	2.12	4.03	±	26.03	-4.05	±	0.91
	Cross-II (GNR-2 x GNR-3)																	
RH % ± SE	3.30*	±	1.37	3.55*	±	1.64	2.68**	±	0.70	14.38**	±	0.34	9.75	±	14.91	-5.09*	±	0.13
HB % ± SE	11.23*	±	1.12	8.77*	±	1.34	6.56*	±	0.58	10.73**	±	0.28	-0.74	±	12.17	-29.69*	±	0.10

ID % ± SE	1.30	±	5.63	1.19	±	4.38	3.27	±	4.31	16.97	±	2.15	11.58	±	25.11	-12.80	±	0.34
Cross-III (GR-11 x GR-15)																		
RH % ± SE	2.92	±	1.84	-0.01	±	0.71	-1.21	±	0.83	2.67	±	0.44	1.11	±	6.49	10.93	±	0.12
HB % ± SE	9.14*	±	1.50	2.36**	±	0.57	0.51	±	0.67	-5.61	±	0.36	-2.11	±	5.29	-2.29	±	0.10
ID % ± SE	-0.92	±	6.67	-0.86	±	4.61	2.52	±	5.04	-7.43	±	2.17	2.42	±	22.31	0.95	±	0.39

*,** significant at 5% and 1% level of significance respectively

Table 5: Estimates of relative heterosis (%), heterobeltiosis (%) and inbreeding depression (%) for grain yield per plant (g), straw yield per plant (g), L:B ratio, protein content (%) and amylose content (%) in cross-I, II, III

Particulars	**Grain yield per plant (g)**			**Straw yield per plant (g)**			**L:B ratio**			**Protein content (%)**			**Amylose content (%)**		
Cross-I (IET-24772 x IET-24783)															
RH % ± SE	3.44	±	0.62	7.59	±	1.22	2.51*	±	0.03	0.32	±	0.07	0.71	±	0.58
HB % ± SE	-2.35	±	0.50	-0.30	±	0.99	-0.78	±	0.02	-0.78	±	0.06	-1.49	±	0.48
ID % ± SE	-0.91	±	2.64	2.99	±	4.85	3.25	±	0.17	2.18	±	0.45	-2.95	±	1.81
Cross-II (GNR-2 x GNR-3)															
RH % ± SE	25.08**	±	0.96	9.23*	±	0.97	2.07	±	0.09	-18.36*	±	0.30	1.13	±	0.48
HB % ± SE	24.48**	±	0.79	2.73	±	0.79	-2.56	±	0.07	-30.71*	±	0.25	-0.39	±	0.39
ID % ± SE	13.68	±	1.56	1.88	±	3.84	2.91	±	0.17	-1.83	±	0.87	-1.13	±	1.79
Cross-III (GR-11 x GR-15)															
RH % ± SE	3.48	±	0.79	1.87	±	1.13	3.12	±	0.05	0.98	±	0.23	-0.06	±	0.55
HB % ± SE	-5.49	±	0.64	-4.37	±	0.92	-1.20	±	0.04	-7.10*	±	0.18	-4.07*	±	0.45
ID % ± SE	3.22	±	2.09	0.38	±	4.74	2.95	±	0.14	9.78	±	0.99	3.41	±	2.86

*,** significant at 5% and 1% level of significance respectively

It is pertinent to note that some hybrids of low x low and low x high yielding parents manifested relatively high heterobeltiosis while some hybrids involving high x high yielding parents exhibited low heterobeltiosis. The probable explanation for this type of behavior is that poor yielding parents might have different constellations of genes with complementary action when brought together in a hybrid combination. It is therefore, desirable to select hybrid based on their mean performance rather than heterotic effect.

In case of days to flowering significant and positive relative heterosis was observed for cross-II. Significantly positive heterobeltiosis was depicted by all the three crosses. Same results were obtained by Patil *et al.* (2011) [8] and Soni and Sharma (2011) [12].

For days to maturity, highly significant relative heterosis was recorded for cross-I and cross-II where as highly significant and positive heterobeltiosis was depicted by all the three crosses. These results are in conformity with those obtained by Patil *et al.* (2011) [8] and Soni and Sharma (2011) [12].

The mid parent heterosis and heterobeltiosis in desired direction was low to moderate with respect to plant height. Only cross-II shows significantly positive relative heterosis and heterobeltiosis. Patil *et al.* (2011) [8], Soni and Sharma (2011) [12] and Vennila *et al.* (2011) [14] reported the similar results.

In case of productive tillers per plant, all three crosses depicted positive relative heterosis. Cross-II shows significant and positive relative heterosis. One out of the three crosses *i.e.,* cross-II showed positive and significant heterobeltiosis. Similar results were obtained by Soni and Sharma (2011) [12], Vennila *et al.* (2011) [14], Ghara *et al.* (2014) [4], Venkanna *et al.* (2014) [13], Anis *et al.* (2016) [2], Borah *et al.* (2017) [3] and Rumanti *et al.* (2017) [10].

The heterosis for grains per panicle recorded and significantly positive relative heterosis for cross-I. None of the three cross depicted significant heterobeltiosis. Similar results were obtained by Ghara *et al.* (2014) [4], Venkanna *et al.* (2014) [13], Anis *et al.* (2016) [2], Borah *et al.* (2017) [3] and Rumanti *et al.* (2017) [10].

Positive relative heterosis for 100 grain weight was recorded in cross-III (GR-11 x GR-15) while cross-I exhibited negative relative heterosis. Cross-II (GNR-2 x GNR-3) exhibited significant negative relative heterosis. Thus dominance effect seems to be the control the trait. Two out of three crosses *i.e.,* cross-I and cross-II exhibited significantly negative heterobeltiosis for this trait. Similar results were reported by Soni and Sharma (2011) [12], Latha *et al.* (2013) [6], Venkanna *et al.* (2014) [13], Anis *et al.* (2016) [2], Borah *et al.* (2017) [3] and Rumanti *et al.* (2017) [10].

Cross-II GNR-2 x GNR-3 had shown significantly positive relative heterosis where as none of the cross shows significant heterobeltiosis in case of straw yield per plant. The results are in conformity with the findings of Venkanna *et al.* (2014) [13].

For L:B ratio, out of three crosses only cross-I had showed significantly positive relative heterosis. None of the three crosses depicted significant heterobeltiosis. The results are in conformity with the findings of Venkanna *et al.* (2014) [13].

For protein content, cross GNR-2 x GNR-3 had negative and significant relative heterosis where as cross GNR-2 x GNR-3 and cross GR-11 x GR-15 exhibited negative and significant heterobeltiosis. The results are in conformity with the findings with those obtained by Rumanti *et al.* (2017) [10].

Out of three crosses, none of the cross exhibited significantly positive relative heterosis and heterobeltiosis for amylose content. Similar results were obtained by Adilakshmi and Reddy (2011) [1], Patil *et al.* (2011) [8], Nagesh *et al.* (2012) [7] and Shahi *et al.* (2012) [11].

Out of three crosses, none of the cross recorded significant inbreeding depression with respect to all the eleven characters studied. Similar results were obtained by Adilakshmi and Reddy (2011) [1], Reddy *et al.* (2013) [9] and Venkanna *et al.* (2014) [13].

Significantly positive heterosis for grain yield per plant and its related traits followed by non-significant inbreeding depression indicated major role of additive gene actions in the inheritance of this traits and its attributes. Cross-II with positively higher estimates of heterosis for grain yield and its related traits recorded negative heterosis for quality traits like protein content. For improvement of these characters along with high grain yield and earliness population improvement approach plays a significant role.

Heterosis followed by absence of inbreeding depression were

recorded in all the eleven characters except amylose content indicated that absence of inbreeding depression and increase in performance of F_2 was accompanied by fixation of genes *i.e.*, additive gene action.
The results are in conformity with the findings with those obtained by Adilakshmi and Reddy (2011) [1], Nagesh *et al.* (2012) [7], Shahi *et al.* (2012) [11] and Venkanna *et al.* (2014) [13].

Conclusion

The significant mid parent heterosis in positive direction were recorded for days to flowering, plant height, productive tillers per plant, grain yield per plant (g) and L:B ratio therefore heterosis breeding would be more appropriate approach for higher grain yield in rice. Though the most of traits had negative estimates of heterobeltiosis in most of the crosses. For improvement of high grain yield and yield contributing traits, population improvement methods such as biparental and diallel selective mating would be most desirable breeding approach.

References

1. Adilakshmi D, Reddy PR. Heterosis and inbreeding depression for grain quality traits in rice *(Oryza sativa* L.). *Research on Crops*, 2011;12(2):489-492.
2. Anis G, El-Sabagh A, El-badry A, Barutcular C. Improving grain yield of rice (*Oryza sativa* L.) by estimation of heterosis, genetic components and correlation coefficient. Int. J. Current Res. 2016;8(1):25080-25085.
3. Borah P, Sharma D, Hazarika GN. Magnitude of heterosis for yield and its components in hybrid rice (*Oryza sativa* L.). Int. J. Agri. Sci. Res. 2017;7(2):2250-2257.
4. Ghara AG, Nematzadeh G, Oladi NBM, Bagheri A. Heritability and heterosis of agronomic traits in rice lines. *Int. J. Farming and Alli. Sci.*, 2014;3(1):66-70.
5. Graffius JE. Components of yield in oats, a geometrical interpretation. *Agron. J.*, 1956;48:419-423.
6. Latha S, Sharma D, Sanghera GS. Combining ability and heterosis for grain yield and its component traits in rice (*Oryza sativa* L.). *Notulae Scientia Biologicae*, 2013;5(1):90-97.
7. Nagesh V, Ravindrababu G, Reddy T. Heterosis studies for grain iron and zinc content in rice. *Annals Biol. Res.* 2012;3(1):179-184.
8. Patil PP, Vashi RD, Shinde DA, Lodam VA. Nature and magnitude of heterosis for grain yield and yield attributing traits in Rice (*Oryza sativa* L.) Plant Archives 2011;11(1):423-427.
9. Reddy MR, Raju CS, Sravani D, Reddy SM, Reddy N. Estimation of heterosis, residual heterosis and inbreeding depression for yield characteristics in F_2 generation involving aromatic rice genotypes (*Oryza sativa* L.). Res. on Crops, 2013;14(1):28-32.
10. Rumanti IA, Purwoko BS, Dewi IS, Aswidinnoor H, Widyastuti Y. Combining ability for yield and agronomic traits in hybrid rice derived from wild abortive, gambiaca and kalinga cytoplasmic male sterile lines. SABRAO J., 2017;49(1):69-76.
11. Shahi K, Dwivedi S, Devi A, Dwivedi R, Singh P, Dwivedi D. Heterosis in diverse ecotypes of rice under saline-alkali environment. Int. J. Current Res., 2012;4(9): 106-110.
12. Soni S, Sharma D. Studies on heterosis for grain yield and its component traits for developing new plant type hybrids in rice (*Oryza sativa* L.). Elec. J. of Plant Breed., 2011;2(4):543-548.
13. Venkanna V, Raju CS, Lingaiah N, Rao VT. Studies on heterosis and inbreeding depression for grain yield and grain quality traits in rice (*Oryza Sativa* L.). Int. J. Sci., Envt. and Technol., 2014;3(3):910-916.
14. Vennila S, Anbuselvam Y, Palaniraja K. Heterosis study for yield and its components in rice (*Oryza sativa* L.*)* Int. J. of Recent Scientific Res. 2011:2(9):261-262.