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**Research Article**

# HETEROSIS AND INBREEDING DEPRESSION FOR GRAIN YIELD AND ITS COMPONENT TRAITS IN RICE (*Oryza sativa* L)

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**Abstract:** The present investigation was undertaken with a view to generate genetic information on heterosis and inbreeding depression for grain yield and its component traits in four hybrid of rice (*Oryza sativa* L). Hybrids showed higher mean performance than their parents for almost all the characters. Both positive and negative heterosis were observed amongst the hybrids. The expression of heterosis varied with the crosses and characters. Two crosses Gurjari × IR – 64 was identified for exploitation of heterosis and to isolate desirable segregants in later generations. Grains per panicle played important role in the expression of heterosis.

**Keywords:** *Rice, Oryza sativa, Relative heterosis, Heterobeltiosis, Inbreeding depression*

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## Introduction

In plant breeding programme, exploitation of heterosis is vital and considered to be one of the greatest outstanding achievements [1]. The expression of heterosis varied with the crosses and also with characters [2]. To know the potentiality of hybrids, the magnitude and direction of heterosis are important [3]. The magnitude of heterosis depends on the degree of genetic distinctiveness of the parental lines used [4] while, both positive and negative heterosis is useful for crop improvement, depending on objectives of the breeding. The hybrid vigour is the manifestation of heterosis which is percent increase (positive) or decrease (negative) in the average performance of hybrid or cross over the mid-parent (relative heterosis), better parent (heterobeltiosis) and the check variety (standard/useful heterosis). Hybrid rice technology aims to increase the yield potential of rice beyond the level of inbred high yielding varieties (HYV) by exploiting the phenomenon of hybrid vigour or heterosis. Since most of the tropical rice growing countries have a high population growth ratio and limited land for rice cultivation, there must be an increase in the production per unit area in order to obtain food security. Hybrid rice is one of the most time-tested tools for meeting this objective. In the present study, investigation was undertaken to assess the extent of exploitable heterosis in hybrid rice involving six parents and their four hybrids.

## Material and Methods

The experimental materials consisted of six parents *viz*., Gurjari, NWGR-7028, IR-64, IET-20575, GR-7 and NWGR-7064 among which four crosses namely Gurjari × NWGR – 7028, Gurjari × IR – 64, Gurjari × IET – 20575 and GR - 7 × NWGR – 7064 were carried out. The experimental material consisting of four families, each having five generations (P1, P2, F1, F2, and F3) was grown in nursery during 15 June, 2012 at Main Rice Research Station, Nawagam in Gujarat. The final experimental material was planted during 15 July, 2012 in compact family block design with three replications, whereas, different generations viz., P1, P2, F1, F2, and F3 of each family represented individual experimental unit within family. The individual replication was represented by four family blocks, one row each of P1, P2 and F1, four rows each of F2 and F3 generation. Total 12 plants were accommodated in each row. The intra and inter row spacing was 15 cm and 20 cm, respectively. All the recommended agronomical practices and plant protection measures were followed as and when required for raising good crop. The data were recorded on 10 plants per replication in parents and F1's and 40 plants per replication in F2's and F3's for the character days to flowering initiation, plant height (cm), panicle length (cm), number of productive tillers per plant, number of total grains per panicle, test weight of 1000 - grains (g), grain length (mm), grain breadth (mm), L: B ratio, grain yield per plant (g), straw yield per plant (g) and harvest index (%). An individual observation of each generation of each family was considered for statistical analysis. The heterotic effects in term of superiority of F1 over better parent (heterobeltiosis) as per Fonseca and Patterson (1968); over mid parent value (relative heterosis) as per Turner (1953); and inbreeding depression was worked out as loss in vigour due to inbreeding and difference between mean of F1 and F2.

## Results and Discussion

The perusal of results of relative heterosis, heterobeltiosis and inbreeding depression are presented in [Table-1]. The heterosis over mid parent was found significant in desired direction for all the characters except days to flowering initiation and grain breadth in cross I (Gurjari × NWGR – 7028); for plant height, No. of productive tillers per plant, No. of total grains per panicle, grain yield and harvest index in cross II (Gurjari × IR – 64); for days to flowering initiation, plant height, No. of productive tillers per plant, No. of total grains per panicle, grain yield and straw yield in cross III (Gurjari × IET – 20575); for panicle length, number of total grains per panicle, test weight of 1000 - grains, grain yield per plant, straw yield per plant and harvest index in cross IV (GR - 7 × NWGR – 7064). Significant heterobeltiosis in desired direction was observed for number of productive tillers per plant, number of total grains per panicle, test weight of 1000 - grains, grain yield per plant, straw yield per plant and harvest index in cross I (Gurjari × NWGR – 7028); for number of productive tillers per plant, number of total grains per

Table-1 Relative Heterosis (RH %), heterobeltiosis (HB %) and inbreeding depression for various characters in four crosses in rice

| Characters | Gurjari × NWGR - 7028 | | | Gurjari × IR - 64 | | | Gurjari × IET - 20575 | | | GR - 7 × NWGR - 7064 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | RH (%) | HB (%) | ID (%) | RH (%) | HB (%) | ID (%) | RH (%) | HB (%) | ID (%) | RH (%) | HB (%) | ID (%) |
| Days to flowering initiation | -0.04 (0.61) | 2.18** (0.72) | -1.04 (0.63) | 0.37 (0.59) | 5.41** (0.67) | -1.06 (0.79) | -3.43** (0.81) | -1.46 (0.86) | 0.96 (0.83) | 7.54** (0.69) | 8.36** (0.74) | 0.26 (0.80) |
| Plant height | 5.59** (1.21) | 11.37** (1.38) | -1.07 (1.27) | 5.98** (1.84) | 6.58** (2.28) | 2.35 (1.66) | 7.39** (2.05) | 12.60** (2.53) | 5.62** (1.87) | -0.48 (1.58) | 3.59** (1.91) | -0.51 (1.46) |
| Panicle length | 5.19** (0.29) | 1.69 (0.34) | 0.99 (0.28) | -1.06 (0.33) | -1.65 (0.40) | -1.64 (0.32) | -0.28 (0.44) | -8.18** (0.54) | -3.94* (0.42) | 9.22** (0.59) | 5.38 (0.77) | 3.98* (0.51) |
| No. of productive tillers per plant | 24.65** (0.56) | 24.41** (0.65) | 19.62** (0.51) | 35.78** (0.62) | 21.87** (0.68) | 23.00* (0.60) | 34.02** (0.57) | 23.4** (0.60) | 17.05** (0.59) | -18.59** (0.46) | -29.64** (0.57) | 3.94 (0.43) |
| No. of total grains per panicle | 26.89** (3.98) | 15.49** (4.58) | 1.92 (3.67) | 30.55** (3.30) | 21.26** (4.34) | -3.00 (4.15) | 29.84** (2.46) | 18.38** (3.12) | -4.71* (2.45) | 30.41** (2.63) | 18.36** (3.55) | -3.76* (2.35) |
| Test weight of 1000 - grains | 17.19** (0.98) | 9.22* (1.05) | 4.81 (0.96) | 1.45 (1.06) | -7.79 (1.38) | -7.47 (1.01) | 4.98 (1.02) | -7.11 (1.38) | 4.45 (0.93) | 8.63* (0.81) | -4.23 (0.94) | 5.89 (0.78) |
| Grain length | 6.74** (0.13) | -1.08** (0.15) | -0.31 (0.14) | -5.39** (0.14) | -9.55** (0.21) | -4.29** (0.12) | 1.09 (0.14) | -2.73 (0.20) | -2.39 (0.12) | 2.05 (0.14) | -3.06 (0.21) | -0.90 (0.11) |
| Grain breadth | -0.50 (0.08) | -5.92 (0.09) | 3.72 (0.08) | 2.54 (0.07) | -10.84** (0.08) | 8.58** (0.07) | -3.77 (0.08) | -16.74** (0.09) | -5.24 (0.08) | 0.63 (0.83) | -10.26** (0.09) | 1.04 (0.08) |
| L:B ratio | 7.93* (0.12) | 5.65 (0.14) | -5.17 (0.13) | -10.34** (0.11) | -24.68** (0.15) | -15.29** (0.12) | 3.24 (0.14) | -13.30** (0.18) | 2.44 (0.14) | 2.74 (0.14) | -3.76 (0.15) | -1.13 (0.14) |
| Grain yield per plant | 29.21** (1.49) | 21.91** (1.72) | -1.56 (1.34) | 42.23** (1.56) | 28.45** (1.80) | -18.22** (1.60) | 21.52** (1.63) | 15.05** (1.88) | -17.59** (1.49) | 28.22** (1.73) | 12.39* (1.31) | -13.77* (1.40) |
| Straw yield per plant | 18.82** (1.22) | 14.09** (1.60) | 3.14 (1.05) | 38.94 (1.31) | 26.90** (1.60) | 12.76** (1.21) | 42.78** (1.22) | 26.00** (1.46) | 7.43 (1.14) | 33.30** (1.27) | 21.30** (1.54) | -0.98 (1.14) |
| Harvest Index | 13.07** (1.71) | 12.44** (2.03) | 4.29 (1.32) | 60.06** (2.32) | 45.46** (2.66) | 11.63* (2.27) | -3.09 (1.95) | -6.84 (2.43) | -7.01* (1.53) | 9.74** (1.45) | 3.69 (1.79) | 2.09 (1.29) |

panicle, grain yield per plant, straw yield per plant and harvest index in cross II (Gurjari × IR – 64); for number productive tillers per plant, number of total grains per panicle, grain yield per plant and harvest index in cross III (Gurjari × IET – 20575); for number of total grains per panicle, grain yield per plant and straw yield per plant in cross IV (GR - 7 × NWGR – 7064). Several research workers have also reported heterosis in desired direction for various characters in rice like days to flowering initiation, number of grains per panicle, test weight of 1000 grains and grain yield per plant. Similar results were reported by scientist [5-10]. High inbreeding depression for grain yield and its component traits is undesirable in rice crop as vigour decline from generation to generation and delay the development of inbred lines. The estimates for inbreeding depression was found significant but negative for none of the characters in cross I (Gurjari × NWGR – 7028); for grain length, L:B ratio and grain yield per plant in cross II (Gurjari × IR – 64); for panicle length, No. of total grains per panicle, grain yield per plant and harvest index in cross III (Gurjari × IET – 20575); for No. of total grains per panicle and grain yield per plant in cross IV (GR - 7 × NWGR – 7064). The crosses with significant and positive inbreeding depression was observed for No. of productive tillers per plant in cross I (Gurjari × NWGR – 7028); for No. of productive tillers per plant, grain breadth, straw yield per plant and harvest index in cross II (Gurjari × IR – 64); for plant height and No. of productive tillers per plant in cross III (Gurjari × IET – 20575); for panicle length in cross IV (GR - 7 × NWGR – 7064). The significant and positive inbreeding depression was reported by Scientists [11-13], which supports the results obtained in the present study. It is desirable to have high, significant and positive heterosis with low inbreeding depression for seed yield and its components. This is equally applicable to developmental traits.

**Application of research:** Study were undertaken to assess the extent of exploitable heterosis in hybrid rice involving six parents and their four hybrids. Significant heterobeltiosis in desired direction was observed for number of productive tillers per plant, number of total grains per panicle, grain yield per plant, straw yield per plant and harvest index. Significant negative/negative inbreeding depression observed for panicle length, number of total grains per panicle, test weight of 1000 - grains, grain length, L : B ratio and grain yield per plant. The results suggested that selection of desired recombinants can be done in cross II (Gurjari × IR – 64).

**Research Category:** Genetics and Plant Breeding

**Abbreviations:** RH- Relative Heterosis, HB- Heterobeltiosis, ID- Inbreeding Depression

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**Cultivar / Variety / Breed name:** Rice (*Oryza sativa* L), Gurjari, NWGR-7028, IR-64, IET-20575, GR-7 and NWGR-7064

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**References**


[1] Jones J. W. (1926) *J. Am. Soc. Agron*., 18, 423-428.

[2] Lokaprakash R. G., Shivashankar M., Mahadeveppa G., Shankare and Kulkarni R. S. (1992) *Oryza*, 29, 293-297.

[3] Singh P. K., Thakur R., Chaudhary C. K. and Singh N. B. (1995) *Crop Res*., 19, 6-12.

[4] Akhter Z., Shamsuddin A.K.M., Rohman M.M., Shalim Uddin M., Mohi-Ud-din M. and Alam A.K.M.M. (2003) *J. Biol. Sci*., 3, 892-897.

[5] Ganesan K., Manuel W. W. and Vivekanandan P. (1997) *Madras Agric. J*, 84(9), 566-568.

[6] Selvarani M. and Rangasamy P. (1997) *Madras Agric. J*., 84(3), 166-167.

[7] Janardhanam V., Nandarajan N. and Jebaraj S. (2001) *Madras Agric. J*., 88(10-12), 721-723.

[8] Veni B. K., Rani N. S. and Prasad A. S. R. (2005) *Oryza*, 42 (4), 256-259.
[9] Borah S.P and Barman D. (2010) *Oryza*, 47(1), 13-16.
[10] Vennila S., Anbuselvam Y. and Palaniraja K. (2011) *International Journal of Recent Scientific Research*, 2(9), 261-262.
[11] Reddy J. N. (1996) *Madras Agric. J*., 83(6), 390-392.
[12] Vivekanandan P. and Giridharan S. (1996) *Madras Agric. J*., 83(12), 773-774.
[13] Agrawal K.B. (2003) *Ann. Agric. Res*., 24(2), 375-378.