

RESEARCH ARTICLE

Heterosis and combining ability analysis for yield and its components in rice (*Oryza sativa* L.)

■ Alok Kumar Singh and Sujeet Kumar

SUMMARY

Study of heterosis and combining ability were conducted on 40 F_1 hybrids along with of 2 CMS lines (females), 20 diverse rice varieties/genotypes as testers (males) to know the pattern of inheritance of some morphological traits for selecting superior genotypes. The experiment was carried out according to line x tester mating design. Analysis of variance revealed significant differences among genotypes, crosses, lines, testers and line x tester interactions for all the ten traits, viz., days to 50 per cent flowering, flag leaf area, plant height, panicle bearing tillers plant⁻¹, panicle length, spikelets panicle⁻¹, grain yield plant⁻¹, test weight, biological yield plant⁻¹ and harvest index. The highest heterosis (197.81%) was observed in cross IR 688897A X Sarjoo 52 followed by other eight crosses for yield and most of its related traits. Among the testers high GCA was recorded in Sarjoo 52 and Narendra Usar 3 for harvest index, grain yield plant⁻¹, days to 50 per cent flowering (earliness), plant height (dwarf stature), panicle bearing tillers plant⁻¹ and biological yield. Among the female parental lines, IR 58025 was observed as a good general combiner only for seedling height, panicle length, spikelets panicle⁻¹, test weight, biological yield plant⁻¹. Cross between IR 688897A X Sarjoo 52, IR 58025 A X 21-2-5-B-1-1, IR 58025 A X Narendra Usar 3 and IR 58025 A X IR 71829-3R-73-1-2-B shown favourable *per se* performances and higher significant positive SCA effects in related to grain yield plant⁻¹. These combinations proved to be good hybrids based on CMS system in rice.

Key Words : Heterosis, Combining ability analysis, Yield, Components in rice

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Breeding strategies based on selection of hybrids require expected level of heterosis as well as the specific combining ability. In breeding high yielding varieties of crop plant, the breeders often face with the problem of selecting parents and crosses. Combining ability analysis is one of the powerful tools available to estimate the combining ability effects and aids in selecting

the desirable parents and crosses for the exploitation of heterosis. Line x tester analysis provides information about general combining ability (GCA) and specific combining ability (SCA) effects of parents and is helpful in estimating various types of gene actions. Manivannan and Ganesan (2001) applied line x tester analysis in sesame. Presence of heterosis and SCA effects for yield and its related traits in rice are reported by Roy and Mandal (2001). Sarker *et al.* (2002) observed 100.7 per cent heterosis for grain yield per hill in rice. Zhang *et al.* (2002) studied the heterosis and combining ability of hybrid rice. Ahmed *et al.* (2003) used line x tester technique in summer squash to calculate the combining ability. Singh and Kumar (2004) also identified suitable parents through line x tester analysis in rice.

MATERIAL AND METHODS

The experimental material for this investigation comprised of 2 CMS lines *viz.*, IR 68897 A and IR 58025 A possessing “wild abortive” (WA) cytoplasm as lines (females), 20 diverse rice varieties/genotypes as testers (males) and 40 crosses obtained through crossing in a “line x tester” mating design (Kempthorne, 1957). These diverse elite strains were selected from the collection of genetic stock available in Rice Section of the Department of Genetics and Plant Breeding, N.D. University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad. The resulting sets of 40 F₁'s along with their 22 parents were evaluated in Randomized Complete Block Design with three replications during *Kharif*, 2010. All the recommended cultural practices were followed to raise a good crop. The experimental data collected on ten characters *i.e.* days to 50 per cent

flowering, flag leaf area, plant height, panicle bearing tillers plant⁻¹, panicle length, spikelets panicle⁻¹, grain yield plant⁻¹, test weight, biological yield plant⁻¹ and harvest index .

Data were recorded on five randomly selected plants from parents and F₁'s plant samples. The combining ability analysis was carried out following line x tester mating design outlined by Kempthorne (1957) and further elaborated by Arunachalam (1974). The heterosis was computed as per cent increase or decrease of the mean values of crosses (F₁'s) over better parent (Heterobeltiosis) and standard variety (Standard Heterosis).

RESULTS AND DISCUSSION

The analysis of variance for 62 entries (2 female lines + 20 male lines + 40 crosses) was done for ten characters *viz.*, days to 50 per cent flowering, flag leaf area, plant height, panicle bearing tillers plant⁻¹, panicle length, spikelets panicle⁻¹, grain yield plant⁻¹, test weight, biological yield plant⁻¹ and harvest index. A perusal of Table 1 revealed that variance due to treatments, parent and crosses were highly significant for all the characters indicating sufficient variability existed in the treatments, parent and crosses. Mean squares due to parent vs crosses were highly significant for all the traits except spikelet fertility and test weight indicating the presence of substantial heterosis in the crosses.

Heterosis:

Economic heterosis is usually expressed as an increase or decrease of F₁ value over better parent (heterobeltiosis) but from practical point of view, increase

Tables 1: Analysis of variance including parent and crosses for 10 characters in rice

| Source of variation | Replications | Treatments | Parent (P) | P vs C | Crosses (C) |
|-----------------------------------|--------------|--------------|--------------|----------------|--------------|
| DF | 2 | 61 | 21 | 1 | 39 |
| Days to 50 per cent flowering | 3.57028 | 63.89470** | 74.05534** | 74.57029** | 59.92505** |
| Flag leaf area (cm ²) | 6.54935* | 58.21665** | 29.46020** | 166.66999** | 67.10120** |
| Plant height (cm) | 49.22565** | 332.16561** | 296.37668** | 360.26262** | 345.03441** |
| Panicle bearing tillers per plant | 10.72101** | 30.91970** | 46.28136** | 219.45789** | 21.99606** |
| Panicle length (cm) | 8.29988** | 21.22930** | 20.87312** | 63.13962** | 20.65176** |
| Spikelets per panicle | 111.58668 | 3619.19725** | 3080.81021** | 79434.13423** | 2534.95281** |
| Test weight (g) | 2.83803** | 26.43394** | 23.929.80** | 1.30959 | 27.79352** |
| Biological yield per plant (g) | 1.40810 | 6208.78878** | 1749.81149** | 123148.89195** | 5889.42263** |
| Harvest-index (%) | 54.75425** | 286.97919** | 263.16995** | 68.62616** | 299.55812** |
| Grain yield per plant (g) | 74.93563* | 1020.17782** | 358.40551** | 11471.26994** | 1089.80323** |

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 2 : Estimates of heterosis over better parent (BP) of 40 rice hybrids for 10 characters

| Hybrids | Seedling height (cm) | Number of leaves per seedling | Days to 50% flowering | Flag leaf area (cm ²) | Plant height (cm) | Panicle bearing tillers per plant |
|---------------------------------------|----------------------|-------------------------------|-----------------------|-----------------------------------|-------------------|-----------------------------------|
| IR 688897A X IR 70023-4B-R-12-3-1-1-B | 52.84** | 5.26 | 10.57** | -1.88 | 5.15** | -47.63** |
| IR 688897A X IR 61920-3B-22-2-1 | 42.42** | 19.30** | 4.53 | 1.80 | 2.65 | -46.52** |
| IR 688897A X PNL 1-8-5-17-2 | 33.52** | 8.77 | 8.30** | -0.85 | 0.35 | -36.21** |
| IR 688897A X NDRK 5095 | 37.21** | 0.00 | 10.94** | -3.27 | 7.35** | -38.16** |
| IR 688897A X NDRK 5056 | 38.51** | 5.26 | 7.17* | -2.00 | 5.00** | -37.05** |
| IR 688897A X NDRK 5086 | 47.09** | 5.26 | 10.57** | 0.10 | 1.14 | -34.54** |
| IR 688897A X NDR 9830119 | 14.33** | -1.75 | 11.70** | 2.34 | 2.68 | -36.77** |
| IR 688897A X NDRK 5013 | 65.31** | 3.51 | 6.04* | -2.87 | 0.40 | -49.30** |
| IR 688897A X CST 7-1 | 10.52** | -5.26 | 12.83** | -3.33 | 0.40 | -40.67** |
| IR 688897A X 21-2-5-B-1-1 | 58.11** | 12.28 | 11.32** | -3.39 | 8.86** | -41.78** |
| IR 688897A X IR 64 | 29.80** | -12.28 | 10.94** | -2.25 | 7.02** | -38.16** |
| IR 688897A X NDR 9830148 | 34.24** | -7.02 | 16.60** | 2.30 | 9.23** | -40.53** |
| IR 688897A X CSRC(S) 14-1-4-0 | 51.54** | 7.02 | 9.43** | -1.71 | 13.60** | -38.72** |
| IR 688897A X PNL 5-8-1-7-21 | 41.18** | -10.53 | 8.68** | 1.12 | 2.61 | -34.26** |
| IR 688897A X IR 72048-B-R-2-2-2-1-B | 87.50** | -8.77 | 18.11** | 2.74 | 8.82** | -28.69** |
| IR 688897A X IR 71829-3R-73-1-2-B | 31.31** | 8.77 | 17.74** | -3.30 | -0.33 | -30.36** |
| IR 688897A X NDRK 5094 | 42.64** | 3.51 | 21.51** | -0.62 | 5.74** | -43.45** |
| IR 688897A X 92-H 51-4 | 31.01** | -5.26 | 16.98** | -1.78 | 2.61 | -38.72** |
| IR 688897A X Narendra Usar 3 | 15.34** | -14.04 | 11.70** | -5.38 | 4.08** | -29.25** |
| IR 688897A X Sarjoo 52 | 47.54** | 14.04 | 8.68** | 0.97 | 0.99 | -4.74 |
| IR 58025 A X IR 70023-4B-R-12-3-1-1-B | 79.93** | -18.97* | 15.85** | 19.80** | 37.21** | -11.06 |
| IR 58025 A X IR 61920-3B-22-2-1 | 64.98** | -18.97* | 21.51** | 53.13** | 37.43** | 0.96 |
| IR 58025 A X PNL 1-8-5-17-2 | 81.64** | 10.34 | 27.55** | -0.19 | 9.71** | -7.21 |
| IR 58025 A X NDRK 5095 | 79.33** | 18.97* | 10.94** | 1.44 | 31.76** | -9.62 |
| IR 58025 A X NDRK 5056 | 61.65** | -17.24 | 7.92** | 5.20 | 9.56** | 17.31** |
| IR 58025 A X NDRK 5086 | 70.64** | -8.62 | 7.17* | 9.71** | 27.35** | 17.31** |
| IR 58025 A X NDR 9830119 | 28.37** | -24.14** | 10.57** | 41.90 | 26.40** | -16.83** |
| IR 58025 A X NDRK 5013 | 98.88** | 27.59** | 18.87** | -3.67 | 31.99** | -36.54** |
| IR 58025 A X CST 7-1 | 122.37** | -5.17 | 10.94** | -0.62 | -3.16* | 2.40 |
| IR 58025 A X 21-2-5-B-1-1 | 105.83** | 5.17 | 10.19** | 17.44** | 31.91** | 15.87** |
| IR 58025 A X IR 64 | 126.38** | 15.52 | 15.47** | 13.63** | 6.54** | -35.58** |
| IR 58025 A X NDR 9830148 | 69.69** | 1.72 | 12.83** | 7.66 | 35.07** | -39.42** |
| IR 58025 A X CSRC(S) 14-1-4-0 | 5.50 | -46.55** | 13.58** | 32.62** | 33.53** | -27.88** |
| IR 58025 A X PNL 5-8-1-7-21 | 88.35** | 1.72 | 13.96** | -1.22 | 0.81 | -8.17 |
| IR 58025 A X IR 72048-B-R-2-2-2-1-B | 38.19** | -27.59** | 22.26** | -0.20 | 14.41** | 2.80 |
| IR 58025 A X IR 71829-3R-73-1-2-B | 62.14** | -17.24* | 18.49** | 0.88 | 22.87** | 21.63** |
| IR 58025 A X NDRK 5094 | 67.79** | -3.45 | 22.26** | 35.26** | 11.99** | -14.42* |
| IR 58025 A X 92-H 51-4 | 48.32** | -10.34 | 12.83** | 29.00** | 32.94** | -4.81 |
| IR 58025 A X Narendra Usar 3 | 36.24** | -17.24* | 22.26** | 4.94 | 9.41** | 11.54* |
| IR 58025 A X Sarjoo 52 | 11.17** | -15.52 | 3.40 | -8.79** | 2.35 | 3.13 |
| PUSA 6A X IR 70023-4B-R-12-3-1-1-B | 76.42** | -16.95* | 20.38** | -0.40 | 9.30** | -17.83** |
| PUSA 6A X IR 61920-3B-22-2-1 | 43.27** | 22.03** | 15.09** | 0.10 | 3.71** | -20.87** |

Table 2: Contd.....

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|---------------------------------------|---------------------|-----------------------|------------------------|-----------------|---------------------|-------------------|---------------------------|
| PUSA 6A X PNL 1-8-5-17-2 | 37.97** | -22.03** | 18.87** | 2.16 | 3.79** | -1.30 | |
| PUSA 6A X NDRK 5095 | 62.92** | 5.08 | 20.75** | -5.58* | -0.70 | -9.57 | |
| PUSA 6A X NDRK 5056 | 38.19** | -16.95* | 13.21** | -9.90** | 3.71** | -11.74* | |
| PUSA 6A X NDRK 5086 | 35.32** | 3.39 | 21.51** | -2.07 | -5.11** | -15.22** | |
| PUSA 6A X NDR 9830119 | 39.19** | -8.47 | 16.98** | -2.75 | 4.82** | -12.61* | |
| PUSA 6A X NDRK 5013 | 17.62** | -16.95* | 14.34** | -1.78 | 2.61 | 17.83** | |
| PUSA 6A X CST 7-1 | 36.73** | 8.47 | 18.87** | -0.63 | -7.32** | 21.74** | |
| PUSA 6A X 21-2-5-B-1-1 | 53.02** | -5.08 | 15.09** | -1.33 | 5.92** | -14.78** | |
| PUSA 6A X IR 64 | 47.25** | -13.56 | 18.87** | -0.12 | 0.40 | -16.52** | |
| PUSA 6A X NDR 9830148 | 25.98** | 16.95* | 11.32** | -5.14 | 8.12** | -21.30** | |
| PUSA 6A X CSRC(S) 14-1-4-0 | 56.10** | 1.69 | 13.21** | -4.48 | 10.77** | -22.17** | |
| PUSA 6A X PNL 5-8-1-7-21 | 32.94** | -10.17 | 15.09** | 0.51 | 1.51 | 0.87 | |
| PUSA 6A X IR 72048-B-R-2-2-2-1-B | 58.06** | -1.69 | 9.43** | -10.68** | 4.82 | 2.61 | |
| PUSA 6A X IR 71829-3R-73-1-2-B | 26.43** | -10.17 | 16.23** | -1.54 | -2.90 | -16.52** | |
| PUSA 6A X NDRK 5094 | 61.20** | 0.00 | 12.45** | 0.52 | 0.40 | -12.61* | |
| PUSA 6A X 92-H 51-4 | 29.89** | -8.47 | 17.36** | -2.05 | -0.74 | -16.09** | |
| PUSA 6A X Narendra Usar 3 | 35.05** | 8.47 | 19.25** | 2.76 | 1.51 | -12.61* | |
| PUSA 6A X Sarjoo 52 | 52.46** | -3.39 | 13.58** | -3.27 | 4.01 | 4.69 | |
| Significant +ve heterosis | 59 | 5 | 37 | 5 | 58 | 10 | |
| Significant -ve heterosis | - | 12 | - | 40 | - | 3 | |
| Mean heterosis (%) | 50.423 | -3.162 | 14.251 | 3.183 | 9.118 | -17.135 | |
| S.E.± | 0.770 | 0.316 | 2.466 | 0.961 | 1.218 | 0.784 | |
| Range | 5.50- | (-46.55) | 3.40- | (-10.58) | (-7.32) | (-49.30) | |
| | 126.38 | -27.59 | 27.55 | -53.13 | -37.43 | -21.63 | |
| | Panicle length (cm) | Spikelets per panicle | Spikelet fertility (%) | Test weight (g) | Biological yield(g) | Harvest index (%) | Grain yield per plant (g) |
| IR 688897A X IR 70023-4B-R-12-3-1-1-B | -3.73 | 2.93 | -0.36 | -23.40** | 55.03** | -33.81** | 17.24 |
| IR 688897A X IR 61920-3B-22-2-1 | 6.57 | 10.50 | -7.84** | -20.65** | 48.04** | -27.39** | 20.37 |
| IR 688897A X PNL 1-8-5-17-2 | 1.78 | 9.12 | -2.58 | -21.78** | 52.22** | -25.78** | 58.23** |
| IR 688897A X NDRK 5095 | 1.19 | -5.85 | -5.37* | -15.02** | 12.61** | -28.78** | 36.00** |
| IR 688897A X NDRK 5056 | -1.82 | -7.06 | -1.23 | -29.51** | 29.63** | -44.72** | 17.68 |
| IR 688897A X NDRK 5086 | -4.99 | 3.44 | -18.23** | -26.28** | 9.77* | -35.91** | 19.78 |
| IR 688897A X NDR 9830119 | 2.36 | -8.04 | -2.25 | -24.66** | 12.91** | -37.22** | 42.62** |
| IR 688897A X NDRK 5013 | -2.70 | -0.69 | -29.19** | -6.13** | 17.89** | -43.36** | -6.50 |
| IR 688897A X CST 7-1 | 7.93* | -16.87** | -15.69** | -21.15** | 31.17** | -32.44** | -9.05 |
| IR 688897A X 21-2-5-B-1-1 | 1.02 | 1.72 | -11.76** | -17.27** | 26.91** | -37.70** | 21.59 |
| IR 688897A X IR 64 | -5.04 | -8.95 | 0.58 | -4.26* | 53.62** | -22.18** | 66.38** |
| IR 688897A X NDR 9830148 | 0.00 | 5.85 | -18.59** | -14.77** | 37.45** | -33.57** | 25.01* |
| IR 688897A X CSRC(S) 14-1-4-0 | -2.09 | -0.17 | -11.73** | -13.64** | 30.92** | -26.25** | 41.30** |
| IR 688897A X PNL 5-8-1-7-21 | -3.49 | -3.79 | -11.37 | -13.64** | 22.65** | -28.91** | 14.62 |
| IR 688897A X IR 72048-B-R-2-2-2-1-B | -0.33 | -3.96 | -22.29** | -17.40** | 31.20** | -32.44** | 29.55** |
| IR 688897A X IR 71829-3R-73-1-2-B | 5.14 | 2.93 | -34.28** | -36.92** | 49.47** | -55.34** | -20.56 |
| IR 688897A X NDRK 5094 | 0.71 | -0.86 | -3.05 | -3.13 | 24.20** | -22.73** | 28.70** |
| IR 688897A X 92-H 51-4 | -1.07 | 1.20 | -6.28** | -2.38 | 31.72** | -40.17** | 33.56** |
| IR 688897A X Narendra Usar 3 | -1.60 | 7.04 | -5.16* | -21.03** | 32.95** | -26.35** | 52.21** |
| IR 688897A X Sarjoo 52 | -6.59* | 4.30 | -6.95** | 4.38* | 31.82** | -13.94** | 54.04** |
| IR 58025 A X IR 70023-4B-R-12-3-1-1-B | 10.12** | -46.32** | -19.13** | -35.30** | 46.97** | -76.65** | -65.53** |
| IR 58025 A X IR 61920-3B-22-2-1 | 12.59** | -25.83** | -20.09** | -42.75** | 348.19** | -89.14 | -51.50** |

Table 2: Contd.....

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Table 2: Contd.....

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|-------------------------------------|----------|----------|----------|----------|----------|----------|----------|
| IR 58025 A X PNL 1-8-5-17-2 | -8.89* | -17.58** | 0.18 | -7.32** | 22.43** | -25.40** | 12.40 |
| IR 58025 A X NDRK 5095 | 11.53** | -26.12** | -21.17** | -2.44 | 38.32** | -62.39** | -23.46* |
| IR 58025 A X NDRK 5056 | 4.17 | 0.58 | 0.18 | -11.17** | 65.43** | -22.83** | 71.17** |
| IR 58025 A X NDRK 5086 | 11.42** | -17.46** | -42.58** | 1.16 | 44.30** | -60.44** | -14.76 |
| IR 58025 A X NDR 9830119 | 16.23** | 11.40* | 1.00 | -12.20** | 88.60** | -60.75** | 30.89** |
| IR 58025 A X NDRK 5013 | 21.58** | -26.64** | -27.86** | 2.70 | 11.75* | -61.74** | -47.46** |
| IR 58025 A X CST 7-1 | 17.07** | 5.74 | 0.18 | 3.21 | 272.64** | -47.88** | 93.77** |
| IR 58025 A X 21-2-5-B-1-1 | 29.20** | 18.18** | 0.78 | 3.72 | 118.98** | -15.21** | 149.77** |
| IR 58025 A X IR 64 | -8.32* | 4.10 | 0.48 | -40.69** | 34.18** | -64.99** | -42.69** |
| IR 58025 A X NDR 9830148 | 16.84** | -24.65** | 1.89 | -15.79** | 31.80** | -66.13** | -46.45** |
| IR 58025 A X CSRC(S) 14-1-4-0 | -1.04 | -0.87 | -25.71** | -2.95 | 132.84** | -74.39** | -23.19* |
| IR 58025 A X PNL 5-8-1-7-21 | -1.40 | 5.48 | 0.63 | -11.94** | 66.38** | -41.53** | 35.25** |
| IR 58025 A X IR 72048-B-R-2-2-2-1-B | -2.77 | 7.85 | 1.37 | -8.43** | 150.24** | -44.38** | 77.75** |
| IR 58025 A X IR 71829-3R-73-1-2-B | 14.44** | -7.94 | 0.33 | 5.85** | 145.42** | -20.72** | 102.95** |
| IR 58025 A X NDRK 5094 | 23.55** | 6.23 | 1.07 | -3.47 | 41.61** | -26.92** | 46.16** |
| IR 58025 A X 92-H 51-4 | -24.17** | -8.60 | -73.07** | -35.56** | 89.97** | -91.72** | -71.68** |
| IR 58025 A X Narendra Usar 3 | 9.36** | 23.69** | 1.22 | -1.93 | 61.22** | -16.24** | 121.74** |
| IR 58025 A X Sarjoo 52 | 4.23 | -16.59** | 21.58** | -22.61** | -17.38** | -31.33** | -18.14** |
| PUSA 6A X IR 70023-4B-R-12-3-1-1-B | -4.22 | -16.31** | -3.60 | -17.95** | 58.78** | -34.53** | 13.99 |
| PUSA 6A X IR 61920-3B-22-2-1 | -3.36 | -9.38 | -8.78** | -12.09** | 33.18** | -11.38** | 24.64 |
| PUSA 6A X PNL 1-8-5-17-2 | 2.67 | -6.46 | -17.49** | -10.14** | 44.95** | -23.51** | 47.66** |
| PUSA 6A X NDRK 5095 | -4.28 | -7.23 | -1.00 | -6.24** | 23.81** | -10.19 | 27.55** |
| PUSA 6A X NDRK 5056 | -6.12 | 20.15** | -5.45* | -21.85** | 69.40** | -27.90** | 66.52** |
| PUSA 6A X NDRK 5086 | -0.59 | 5.69 | -0.93 | -20.55** | 74.13** | -44.42** | 57.58** |
| PUSA 6A X NDR 9830119 | 3.66 | 11.08* | 0.96 | -19.90** | 49.33** | -37.15** | 37.41** |
| PUSA 6A X NDRK 5013 | 3.41 | -8.15 | -32.13** | -1.93 | 52.11** | -47.39** | 6.81 |
| PUSA 6A X CST 7-1 | -0.14 | -7.08 | -2.22 | -14.69** | 65.99** | -19.40** | 34.28** |
| PUSA 6A X 21-2-5-B-1-1 | 0.00 | 1.08 | -8.86** | -10.14** | 28.48** | -15.95** | 58.19** |
| PUSA 6A X IR 64 | 3.89 | 11.38* | -3.08 | 0.78 | 33.57** | -8.93 | 61.69** |
| PUSA 6A X NDR 9830148 | 3.39 | -11.85* | -32.95** | -7.93** | 25.89** | -46.91** | -12.58 |
| PUSA 6A X CSRC(S) 14-1-4-0 | 3.26 | 1.69 | -5.45* | -8.39** | 31.11** | -14.22** | 56.98** |
| PUSA 6A X PNL 5-8-1-7-21 | 5.87 | -7.38 | 1.22 | -11.57** | 30.25** | -1.96 | 38.46** |
| PUSA 6A X IR 72048-B-R-2-2-2-1-B | -4.10 | -3.54 | -3.41 | -17.95** | 37.76** | -4.60 | 82.83** |
| PUSA 6A X IR 71829-3R-73-1-2-B | -3.06 | 0.62 | -15.68** | -29.52** | 61.48** | -43.07** | 4.23 |
| PUSA 6A X NDRK 5094 | -4.26 | -17.69** | 0.07 | -5.33** | 21.07** | -18.54** | 9.48 |
| PUSA 6A X 92-H 51-4 | -4.74 | 13.38* | 0.11 | -3.25 | 11.29** | -1.33 | 54.11** |
| PUSA 6A X Narendra Usar 3 | 2.67 | 3.85 | -0.93 | -21.72** | 19.99** | -26.18** | 13.44 |
| PUSA 6A X Sarjoo 52 | -0.25 | 2.15 | 14.08** | 0.88 | 26.70** | -5.21 | 41.06** |
| Significant +ve heterosis | 12 | 6 | - | 2 | 59 | - | 32 |
| Significant -ve heterosis | 4 | 13 | 31 | 44 | 1 | 54 | 9 |
| Mean heterosis (%) | 2.378 | -2.776 | -8.964 | -13.434 | 53.922 | -34.875 | 26.735 |
| S.E.± | 0.857 | 12.218 | 2.122 | 0.489 | 4.640 | 2.446 | 3.537 |
| Range | (-24.17) | (-43.32) | (-73.07) | (-42.75) | 9.77 | (-91.72) | (-71.68) |
| | -29.20 | -23.69 | -1.89 | -5.85 | -348.19 | (-1.33) | -149.77 |

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 3 : Estimates of heterosis over standard hybrid (NDRH-2) of 40 rice hybrids for 10 characters

| Hybrids | Seedling height (cm) | Number of leaves per seedling | Days to 50% flowering | Flag leaf area (cm ²) | Plant height (cm) | Panicle bearing tillers per plant |
|---------------------------------------|----------------------|-------------------------------|-----------------------|-----------------------------------|-------------------|-----------------------------------|
| IR 688897A X IR 70023-4B-R-12-3-1-1-B | 23.51** | -7.69 | 2.81 | 17.98** | 0.35 | -30.37** |
| IR 688897A X IR 61920-3B-22-2-1 | 14.32** | 4.62 | -2.81 | 19.98** | -2.04 | -28.89** |
| IR 688897A X PNL 1-8-5-17-2 | 29.73** | -4.62 | 0.70 | 25.60** | -4.23** | -15.19** |
| IR 688897A X NDRK 5095 | 43.51** | -12.31 | 3.16 | 19.64** | 2.46 | -17.78** |
| IR 688897A X NDRK 5056 | 18.11** | -7.69 | -0.35 | 16.67** | 0.21 | -16.30** |
| IR 688897A X NDRK 5086 | 36.76** | -7.69 | 2.81 | 15.36** | -3.47 | -12.96** |
| IR 688897A X NDR 9830119 | 10.00** | -13.85 | 3.86 | 19.52** | -2.00 | -15.93** |
| IR 688897A X NDRK 5013 | 59.73** | -9.23 | -1.40 | 16.67** | -4.18** | -32.59** |
| IR 688897A X CST 7-1 | -10.54** | -16.92* | 4.91 | 10.48** | -4.18** | -21.11** |
| IR 688897A X 21-2-5-B-1-1 | 13.24** | -1.54 | 3.51 | 21.33** | 3.89** | -22.59** |
| IR 688897A X IR 64 | -10.54** | -23.08** | 3.16 | -1.55 | 2.14 | -17.78** |
| IR 688897A X NDR 9830148 | 34.05** | -18.46* | 8.42** | 11.31** | 4.25** | -20.93** |
| IR 688897A X CSRC(S) 14-1-4-0 | 25.95** | -6.15 | 1.75 | 9.76** | 8.42** | -18.52** |
| IR 688897A X PNL 5-8-1-7-21 | 13.51** | -21.54** | 1.05 | 18.69** | -2.07 | -12.59** |
| IR 688897A X IR 72048-B-R-2-2-2-1-B | 54.05** | -20.00** | 9.82** | 22.56** | 3.86** | -5.19 |
| IR 688897A X IR 71829-3R-73-1-2-B | 5.41 | -20.00** | 9.47** | 4.52 | -4.88** | -7.41 |
| IR 688897A X NDRK 5094 | 25.68** | -9.23 | 12.98** | 14.76** | 0.91 | -24.81** |
| IR 688897A X 92-H 51-4 | 26.76** | -16.92* | 8.77** | 31.43** | -2.07 | -18.52** |
| IR 688897A X Narendra Usar 3 | 17.84** | -24.62** | 3.86 | 18.50** | -0.67 | -5.93 |
| IR 688897A X Sarjoo 52 | 21.62** | 0.00 | 1.05 | -0.83 | -3.61** | 26.67** |
| IR 58025 A X IR 70023-4B-R-12-3-1-1-B | 45.41** | -27.69** | 7.72** | 44.05** | 30.95** | -31.48** |
| IR 58025 A X IR 61920-3B-22-2-1 | 32.43** | -27.69** | 12.98** | 80.48** | 31.16** | -22.22** |
| IR 58025 A X PNL 1-8-5-17-2 | 76.49** | -1.54 | 18.60** | 26.43** | 4.70** | -28.52** |
| IR 58025 A X NDRK 5095 | 87.57** | 6.15 | 3.16 | 25.48** | 25.75** | -30.37** |
| IR 58025 A X NDRK 5056 | 37.84** | -26.15** | 0.35 | 25.24** | 4.56** | -9.63* |
| IR 58025 A X NDRK 5086 | 58.65** | -18.46* | -0.35 | 26.43** | 21.54** | -9.63* |
| IR 58025 A X NDR 9830119 | 23.51** | -32.31** | 2.81 | 65.71** | 20.63** | -35.93** |
| IR 58025 A X NDRK 5013 | 92.16** | 13.85 | 10.53** | 15.71** | 25.96** | -51.11** |
| IR 58025 A X CST 7-1 | 80.00** | -15.38** | 3.16 | 13.57** | -7.58** | -21.11** |
| IR 58025 A X 21-2-5-B-1-1 | 71.89** | -6.15 | 2.46 | 47.50** | 25.89** | -10.74** |
| IR 58025 A X IR 64 | 89.05** | 3.08 | 7.37** | 23.10** | 1.68 | -50.37** |
| IR 58025 A X NDR 9830148 | 69.46** | -9.23 | 4.91 | 17.14** | 28.91** | -53.33** |
| IR 58025 A X CSRC(S) 14-1-4-0 | -11.89** | -52.31** | 5.61* | 48.10** | 27.44** | -44.44** |
| IR 58025 A X PNL 5-8-1-7-21 | 57.30** | -9.23 | 5.96* | 15.95** | -3.79** | -29.26** |
| IR 58025 A X IR 72048-B-R-2-2-2-1-B | 15.41** | -35.38** | 13.68** | 19.05** | 9.19** | -18.52** |
| IR 58025 A X IR 71829-3R-73-1-2-B | 35.41** | -26.15** | 10.18** | 9.29** | 17.26** | -6.30 |
| IR 58025 A X NDRK 5094 | 47.84** | -13.85 | 13.68** | 56.19** | 6.88** | -34.07** |
| IR 58025 A X 92-H 51-4 | 43.51** | -20.00** | 4.91 | 72.62** | 26.88** | -26.67** |
| IR 58025 A X Narendra Usar 3 | 39.19** | -26.15** | 13.68** | 19.05** | 4.42** | -14.07** |
| IR 58025 A X Sarjoo 52 | -7.16* | -24.62** | -3.86 | -1.19 | -2.32 | 22.22** |
| PUSA 6A X IR 70023-4B-R-12-3-1-1-B | 42.57** | -24.62** | 11.93** | 19.76** | 4.32** | -30.00** |
| PUSA 6A X IR 61920-3B-22-2-1 | 15.00** | 10.77 | 7.02** | 17.98** | -1.07 | -32.59** |

Table 3: Contd.....

Heterosis & combining ability analysis for yield & its components in rice

Table 3: Contd.....

| | | | | | | | |
|---------------------------------------|------------------------|-----------------------------|------------------------------|--------------------|--------------------------------------|----------------------|---------------------------------|
| PUSA 6A X PNL 1-8-5-17-2 | 34.05** | -29.23** | 10.53** | 29.40** | -0.95 | -15.93** | |
| PUSA 6A X NDRK 5095 | 70.41** | -4.62 | 12.28** | 16.79** | -5.23** | -22.96** | |
| PUSA 6A X NDRK 5056 | 17.84** | -24.62** | 5.26* | 7.26* | -1.02 | -24.81** | |
| PUSA 6A X NDRK 5086 | 25.81** | -6.15 | 12.98** | 12.86** | -9.44** | -27.78** | |
| PUSA 6A X NDR 9830119 | 33.92** | -16.92* | 8.77** | 13.57** | 0.04 | -25.56** | |
| PUSA 6A X NDRK 5013 | 13.65** | -24.62** | 6.32* | 17.98** | -2.07 | -30.00** | |
| PUSA 6A X CST 7-1 | 10.68** | -1.54 | 10.53** | 13.57** | -11.54** | -33.33 | |
| PUSA 6A X 21-2-5-B-1-1 | 9.59** | -13.85 | 7.02** | 23.93** | 1.09 | -27.41** | |
| PUSA 6A X IR 64 | 1.49 | -21.54** | 10.53** | 0.60 | -4.18** | -28.89** | |
| PUSA 6A X NDR 9830148 | 25.81** | 6.15 | 3.51 | 3.21 | 3.19 | -32.96** | |
| PUSA 6A X CSRC(S) 14-1-4-0 | 29.73** | -7.69 | 5.26* | 6.67 | 5.72** | -33.70** | |
| PUSA 6A X PNL 5-8-1-7-21 | 6.89* | -18.46* | 7.02** | 17.98** | -3.12* | -14.07** | |
| PUSA 6A X IR 72048-B-R-2-2-1-B | 29.86** | -10.77 | 1.75 | 6.55 | 0.04 | -12.59** | |
| PUSA 6A X IR 71829-3R-73-1-2-B | 1.49 | -18.46* | 8.07** | 6.43 | -7.33** | -28.89** | |
| PUSA 6A X NDRK 5094 | 42.03** | -9.23 | 4.56 | 16.07** | -4.18** | -25.56** | |
| PUSA 6A X 92-H 51-4 | 25.68** | -16.92* | 9.12** | 31.07** | -5.26** | -28.52** | |
| PUSA 6A X Narendra Usar 3 | 37.97** | -1.54 | 10.88** | 28.69** | -3.12* | -25.56** | |
| PUSA 6A X Sarjoo 52 | 25.68** | -12.31 | 5.61* | -5.00 | -8.39** | 24.07** | |
| Significant +ve heterosis | 53 | - | 33 | - | 23 | 3 | |
| Significant -ve heterosis | 4 | 29 | - | 50 | 18 | 53 | |
| Mean heterosis (%) | 32.282 | -13.872 | 6.234 | 20.794 | 4.012 | -21.689 | |
| S.E.± | 0.770 | 0.316 | 2.466 | 0.961 | 1.218 | 0.784 | |
| Range | (-11.89)-92.16 | (-52.31)-13.85 | (-3.86)- | (-5.00)- | (-11.54)- | (-53.33)- | |
| | | | 18.60 | 80.48 | 31.16 | 26.67 | |
| | Panicle length (cm) | Spikelets per panicle | Spikelet fertility (%) | Test weight (g) | Biological yield per plant (g) | Harvest index (%) | Grain yield per plant (g) |
| IR 688897A X IR 70023-4B-R-12-3-1-1-B | 2.44 | -9.80 | 7.61** | -7.27** | 35.92** | -19.28** | 10.46 |
| IR 688897A X IR 61920-3B-22-2-1 | -2.31 | -3.17 | -0.47 | -3.94 | 25.83** | -11.45* | 13.41 |
| IR 688897A X PNL 1-8-5-17-2 | -12.18** | -4.37 | 5.22* | -5.30* | 63.04** | -9.49 | 49.08** |
| IR 688897A X NDRK 5095 | 9.10** | -17.50** | 2.20 | 2.88 | 46.05** | -13.15* | 28.14** |
| IR 688897A X NDRK 5056 | -3.33 | -18.55** | 6.67** | -15.15** | 63.33** | -32.59** | 10.88 |
| IR 688897A X NDRK 5086 | -16.92** | -9.35 | -11.69** | -10.76** | 43.46** | -21.83** | 12.86 |
| IR 688897A X NDR 9830119 | 0.26 | -7.84 | 5.57* | -8.79** | 73.77** | -23.44** | 34.38** |
| IR 688897A X NDRK 5013 | -12.31** | -12.97* | -23.53** | 13.64** | 26.32** | -30.93** | -11.91 |
| IR 688897A X CST 7-1 | -16.67** | -27.15** | -8.94** | -4.55* | 2.98 | -17.61** | -14.30 |
| IR 688897A X 21-2-5-B-1-1 | -11.41** | -10.86 | -4.71 | 0.15 | 48.95** | -24.03** | 14.56 |
| IR 688897A X IR 64 | -15.51** | -20.21** | 8.63** | 15.91** | 63.60** | -5.10 | 56.77** |
| IR 688897A X NDR 9830148 | -2.56 | -7.24 | -12.08** | 3.18 | 43.90** | -18.99** | 17.79 |
| IR 688897A X CSRC(S) 14-1-4-0 | -3.85 | -12.52* | -4.67 | 4.55* | 46.54** | -10.05 | 33.13** |
| IR 688897A X PNL 5-8-1-7-21 | -11.41** | -15.69** | -4.27 | 4.55* | 55.70** | -13.30* | 36.87** |
| IR 688897A X IR 72048-B-R-2-2-1-B | 15.38** | -15.84** | -16.08** | 0.00 | 46.62** | -17.60** | 22.06* |
| IR 688897A X IR 71829-3R-73-1-2-B | -2.95 | -9.80 | -29.02** | -23.64** | 35.96** | -45.53** | -25.15* |
| IR 688897A X NDRK 5094 | -9.10** | -13.12* | 4.71 | 17.27** | 56.67** | -5.77 | 49.12** |
| IR 688897A X 92-H 51-4 | 7.05* | -11.31* | 1.22 | 18.18** | 110.75** | -27.04** | 55.28** |
| IR 688897A X Narendra Usar 3 | -5.64 | 1.36 | 2.43 | -4.39 | 94.30** | -10.18 | 77.29** |
| IR 688897A X Sarjoo 52 | -3.72 | -8.60 | 0.78 | 26.36** | 181.10** | 4.95 | 197.81** |
| IR 58025 A X IR 70023-4B-R-12-3-1-1-B | 17.18** | -43.89** | -14.27** | -23.64** | 28.51** | -69.74** | -60.67** |
| IR 58025 A X IR 61920-3B-22-2-1 | 3.21 | -22.47** | -15.29** | -32.42** | 290.79** | -85.92** | -44.65** |

Table 3: Contd.....

Table 3: Contd.....

| | | | | | | | |
|-------------------------------------|----------|----------|----------|----------|----------|----------|----------|
| IR 58025 A X PNL 1-8-5-17-2 | -17.18** | -13.85* | 6.20* | 9.39** | 31.14** | -3.33 | 28.26** |
| IR 58025 A X NDRK 5095 | 20.26** | -22.78** | -16.55** | 15.15** | 79.39** | -51.26** | -11.73 |
| IR 58025 A X NDRK 5056 | 2.56 | 5.13 | 6.20* | 4.85* | 93.51** | -0.01 | 95.35** |
| IR 58025 A X NDRK 5086 | 1.28 | -13.73* | -39.14** | 19.39** | 88.60** | -48.74** | -2.72 |
| IR 58025 A X NDR 9830119 | 13.85** | 16.44** | 7.06** | 3.64 | 190.26** | -49.14** | 49.38** |
| IR 58025 A X NDRK 5013 | 10.51** | -20.18** | -23.53** | 21.21** | 19.74** | -50.43** | -40.04** |
| IR 58025 A X CST 7-1 | 6.41 | 10.53 | 6.20* | 21.82** | 224.91** | -32.46** | 121.14** |
| IR 58025 A X 21-2-5-B-1-1 | 17.44** | 23.53** | 6.82** | 22.42** | 157.02** | 9.87 | 185.04** |
| IR 58025 A X IR 64 | -16.67** | 8.81 | 6.51* | -30.00** | 42.89** | -54.64** | -34.59** |
| IR 58025 A X NDR 9830148 | 13.85** | -21.24** | 8.00** | -0.61 | 37.98** | -56.11** | -38.89** |
| IR 58025 A X CSRC(S) 14-1-4-0 | -2.82 | 3.62 | -21.25** | 14.55** | 160.61** | -66.82** | -12.34 |
| IR 58025 A X PNL 5-8-1-7-21 | -6.92* | 10.26 | 6.67** | 3.94 | 111.23** | -24.23** | 61.50** |
| IR 58025 A X IR 72048-B-R-2-2-2-1-B | 12.56** | 12.73* | 7.45** | 8.08** | 179.65** | -27.93** | 102.85** |
| IR 58025 A X IR 71829-3R-73-1-2-B | 5.64 | -3.77 | 6.35* | 24.94** | 123.25** | 2.73 | 131.61** |
| IR 58025 A X NDRK 5094 | 12.31** | 11.04* | 7.14** | 13.94** | 78.63** | -5.31 | 69.36** |
| IR 58025 A X 92-H 51-4 | -17.95** | -4.46 | -71.45** | -23.94** | 203.95** | -89.27** | -67.08** |
| IR 58025 A X Narendra Usar 3 | 4.87 | 29.29** | 7.29** | 15.76** | 135.61** | 8.53 | 158.28** |
| IR 58025 A X Sarjoo 52 | 7.44* | -12.82* | -15.06** | -6.67** | 76.18** | -11.01* | 58.25** |
| PUSA 6A X IR 70023-4B-R-12-3-1-1-B | 1.92 | -17.95** | 2.00 | -4.39 | 39.21** | -33.85** | -6.58 |
| PUSA 6A X IR 61920-3B-22-2-1 | -11.41** | -11.16* | -3.49 | 2.42 | 13.20* | -10.47 | 2.15 |
| PUSA 6A X PNL 1-8-5-17-2 | -11.41** | -8.30 | -12.71** | 4.70* | 55.26** | -22.72** | 21.01* |
| PUSA 6A X NDRK 5095 | 3.21 | -9.05 | 4.75 | 9.24** | 60.57** | -9.27 | 47.10** |
| PUSA 6A X NDRK 5056 | -7.56* | 17.80** | 0.04 | -8.94** | 98.16** | -27.16** | 45.60** |
| PUSA 6A X NDRK 5086 | -13.08** | 3.62 | 4.82 | -7.42** | 127.59** | -43.85** | 29.15** |
| PUSA 6A X NDR 9830119 | 1.54 | 11.31* | 6.82** | -6.67** | 129.82** | -36.51** | 47.38** |
| PUSA 6A X NDRK 5013 | -6.79* | -9.95 | -28.20** | 15.61** | 62.98** | -46.85** | -12.46 |
| PUSA 6A X CST 7-1 | -9.62** | -8.90 | 3.45 | -0.61 | 33.51** | -18.57** | 10.05 |
| PUSA 6A X 21-2-5-B-1-1 | -12.31** | -0.90 | -3.57 | 4.70* | 50.79** | -15.09** | 29.64** |
| PUSA 6A X IR 64 | -7.56* | -13.12* | 2.55 | 17.42** | 42.24** | -7.99 | 32.52** |
| PUSA 6A X NDR 9830148 | -2.18 | -13.57* | -29.06** | 7.27** | 31.80** | -46.36** | -28.36** |
| PUSA 6A X CSRC(S) 14-1-4-0 | 1.41 | -0.30 | 0.04 | 6.74** | 46.75** | -13.34* | 28.65** |
| PUSA 6A X PNL 5-8-1-7-21 | -2.82 | -9.20 | 7.10** | 3.03 | 65.35** | -0.95 | 65.34** |
| PUSA 6A X IR 72048-B-R-2-2-2-1-B | 11.03** | -5.43 | 2020 | -4.39 | 53.95** | -3.61 | 49.84** |
| PUSA 6A X IR 71829-3R-73-1-2-B | -10.51** | -1.36 | -10.78** | -17.88** | 46.89** | -42.48** | -14.58 |
| PUSA 6A X NDRK 5094 | -13.59** | -19.31** | 5.88* | 10.30** | 52.72** | -17.71** | 26.85* |
| PUSA 6A X 92-H 51-4 | 3.08 | 11.16* | 5.92* | 12.73** | 78.07** | -0.31 | 79.17** |
| PUSA 6A X Narendra Usar 3 | -1.54 | 1.81 | 4.82 | -8.79** | 75.35** | -25.42** | 32.14** |
| PUSA 6A X Sarjoo 52 | 2.82 | 0.15 | -6.94** | 21.67** | 170.18** | -0.01 | 172.71** |
| Significant +ve heterosis | 13 | 8 | 18 | 28 | 59 | - | 36 |
| Significant -ve heterosis | 22 | 23 | 19 | 17 | - | 41 | 8 |
| Mean heterosis (%) | -1.553 | -6.083 | 29.473 | 2.690 | 80.884 | -24.669 | 34.569 |
| S.E.± | 0.857 | 12.218 | 2.122 | 0.489 | 4.640 | 2.446 | 3.537 |
| Range | (-17.95) | (-43.89) | (-71.45) | (-32.42) | 2.98 | (-89.27) | (-67.08) |
| | -20.26 | -29.29 | -8.63 | -26.36 | -290.79 | -9.87 | -197.81 |

*and ** indicate significance of values at P=0.05 and 0.1, respectively

Table 4 : Estimates of general combining ability effects (GCA) of parent (males and females) for 13 characters in rice

| Parental lines | Seedling height (cm) | Number of leaves per seedling | Days to 50% flowering | Flag leaf area (cm ²) | Plant height (cm) | Panicle bearing tillers per plant |
|--------------------------|----------------------|-------------------------------|-----------------------|-----------------------------------|-------------------|-----------------------------------|
| Male | | | | | | |
| IR 70023-4B-R-12-3-1-1-B | 1.204** | -0.266* | 1.189 | 1.811** | 7.465** | -1.607** |
| IR 61920-3B-22-2-1 | -2.885** | 0.423** | -0.478 | 5.231** | 5.088** | -1.118** |
| PNL 1-8-5-17-2 | 3.571** | 0.090 | 3.522** | 1.778** | -3.963** | 0.326 |
| NDRK 5095 | 8.604** | 0.446** | -0.033 | -0.044 | 3.465** | -0.363 |
| NDRK 5056 | -1.896** | -0.243 | -4.256** | -1.233** | -2.624** | 0.859** |
| NDRK 5086 | 2.004** | 0.134 | -1.033 | -0.722 | -1.079* | 0.882** |
| NDR 9830119 | -2.418** | -0.310* | -1.033 | 3.400** | 2.099** | -0.741* |
| NDRK 5013 | 5.648** | 0.312* | -1.033 | -1.122** | 2.432** | -2.918** |
| CST 7-1 | -1.374** | 0.112 | -0.033 | 2.311** | -11.190** | -0.629 |
| 21-2-5-B-1-1 | -0.174 | 0.290* | -1.811 | 2.836** | 5.965** | 0.259 |
| IR 64 | -1.385** | 0.001 | 0.744 | -3.756** | -3.924** | -1.918** |
| NDR 9830148 | 2.671** | 0.290* | -0.589 | -2.867** | 7.699** | -2.529** |
| CSRC(S) 14-1-4-0 | -4.363** | -0.354** | -1.922 | 0.200 | 9.354** | -1.896** |
| PNL 5-8-1-7-21 | -1.574** | -0.110 | -1.478 | -0.911* | -6.657** | 0.548 |
| IR 72048-B-R-2-2-2-1-B | 0.204 | -0.354** | 2.078* | -1.328** | 0.332 | 1.726** |
| IR 71829-3R-73-1-2-B | -4.485** | -0.332* | 2.856** | -3.933** | -2.213** | 1.348** |
| NDRK 5094 | 1.537** | 0.134 | 3.967** | 2.300** | -2.668** | -1.163** |
| 92-H 51-4 | -0.074 | -0.177 | 1.300 | 6.789** | 2.376** | -0.518 |
| Narendra Usar 3 | -0.152 | -0.154 | 3.078** | 0.360 | -3.613** | 1.171** |
| Sarjoo 52 | -4.663 | 0.068 | -5.033** | -6.478** | -8.346 | 8.282** |
| S.E. (gi) | 0.3145 | 0.1290 | 1.0066 | 0.3923 | 0.4974 | 0.3202 |
| S.E. (gi-gj) | 0.4448 | 0.1825 | 1.4235 | 0.5548 | 0.7034 | 0.4528 |
| C.D. (P=0.01) | 0.8234 | 0.3378 | 2.6354 | 1.0272 | 1.3022 | 0.8383 |
| C.D. (P=0.05) | 0.6228 | 0.2555 | 1.9933 | 0.7769 | 0.9850 | 0.6341 |
| Female | | | | | | |
| IR 688897A | -2.379** | 0.088 | -2.239** | -1.449** | -4.410** | 1.036** |
| IR 58025 A | 4.174** | -0.156** | 0.611 | 3.276** | 10.444** | -0.646** |
| PUSA 6A | -1.794** | 0.068 | 1.628** | -1.827** | -6.304** | -0.389** |
| S.E. (gj) | 0.1218 | 0.0500 | 0.3899 | 0.1519 | 0.1926 | 0.1240 |
| S.E. (gi-gj) | 0.1723 | 0.0707 | 0.5513 | 0.2149 | 0.2724 | 0.1754 |
| C.D. (P=0.01) | 0.3189 | 0.1308 | 1.0207 | 0.3978 | 0.7133 | 0.3247 |
| C.D. (P=0.05) | 0.2412 | 0.0990 | 0.7720 | 0.3009 | 0.5395 | 0.2456 |

Table 4: Contd.....

Table 4: Contd.....

| Parental lines | Panicle length (cm) | Spikelets per panicle | Spikelet fertility (%) | Test weight (g) | Biological yield per plant (g) | Harvest index (%) | Grain yield per plant (g) |
|--------------------------|---------------------|-----------------------|------------------------|-----------------|--------------------------------|-------------------|---------------------------|
| Male | | | | | | | |
| IR 70023-4B-R-12-3-1-1-B | 2.271** | -39.333** | 2.212* | -3.181** | -35.216** | -7.287** | -18.016** |
| IR 61920-3B-22-2-1 | -0.507 | -13.667** | -1.922* | -3.081** | 22.084** | -5.045** | -14.907** |
| PNL 1-8-5-17-2 | -3.129** | -6.089 | 3.167** | 0.053 | -23.612** | 5.736** | -0.601 |
| NDRK 5095 | 3.226** | -22.889** | 0.812 | 1.408** | -14.350** | 0.049 | -4.512** |
| NDRK 5056 | -0.318 | 16.669** | 7.189** | -2.003** | 3.128 | 2.126* | 5.401** |
| NDRK 5086 | -2.085** | -0.889 | -9.499** | -0.503* | 4.306* | -6.025** | -7.232** |
| NDR 9830119 | 1.759** | 28.111** | 9.045** | -1.459** | 38.306** | -5.230** | 3.079* |
| NDRK 5013 | -0.341 | -18.311** | -17.788** | 3.108** | -33.850** | -8.081** | -18.872** |
| CST 7-1 | -1.318** | -5.356 | 3.734** | 0.630** | 4.750* | 0.800 | 1.479 |
| 21-2-5-B-1-1 | -0.141 | 22.111** | 3.123** | 1.408** | 3.573 | 6.673** | 14.093** |
| IR 64 | -3.041** | -4.622 | 8.545** | -0.347 | -23.794** | 0.937 | -5.503** |
| NDR 9830148 | 1.193** | -17.533** | -5.855** | 0.130 | -32.672** | -7.074** | -17.194** |
| CSRC(S) 14-1-4-0 | -0.052 | 6.667 | -3.799** | 1.303** | 2.850 | -2.415* | --6.092** |
| PNL 5-8-1-7-21 | -1.429** | 2.667 | 6.223** | 0.253 | -2.627 | 5.296** | 6.735** |
| IR 72048-B-R-2-2-2-1-B | 3.782** | 7.155 | 1.712 | -0.322 | 9.517** | 3.707** | 7.975** |
| IR 71829-3R-73-1-2-B | -0.274 | 2.444 | -5.944** | -1.807** | -9.261** | -1.682 | -1.327 |
| NDRK 5094 | -0.496 | -2.311 | 8.556** | 2.453** | -13.841** | 6.743** | 4.673** |
| 92-H 51-4 | -0.274 | 10.044* | -14.688** | -0.081 | 38.028** | -6.353** | --4.079** |
| Narendra Usar 3 | 0.204 | 37.355** | 7.656** | -0.403* | 15.862** | 6.999** | 18.410** |
| Sarjoo 52 | 0.971** | -2.222 | -2.477** | 2.441** | 46.817** | 10.128** | 36.490** |
| S.E. (gi) | 0.3497 | 4.9879 | 0.8664 | 0.1996 | 1.8941 | 0.9988 | |
| S.E. (gi-gj) | 0.4945 | 7.0539 | 1.2253 | 0.2822 | 2.6786 | 1.4125 | |
| C.D. (P=0.01) | 0.9155 | 13.0590 | 2.2685 | 0.5225 | 4.9589 | 2.6150 | |
| C.D. (P=0.05) | 0.6925 | 9.8774 | 1.7158 | 0.3952 | 3.7508 | 1.9779 | |
| Female | | | | | | | |
| IR 688897A | -0.839*** | -12.472*** | 0.541 | -0.340*** | -17.209*** | 3.153*** | -0.385 |
| IR 58025 A | 1.546*** | 8.161*** | -2.189*** | 0.308*** | 27.975*** | -4.738*** | 0.958 |
| PUSA 6A | -0.706*** | 4.311* | 1.649*** | 0.032 | -10.765*** | 1.585*** | -0.574 |
| S.E. (gj) | 0.1354 | 1.9318 | 0.3356 | 0.0773 | 0.7336 | 0.3868 | 0.5593 |
| S.E. (gi-gj) | 0.1915 | 2.7320 | 0.4746 | 0.1093 | 1.0374 | 0.5471 | 0.7909 |
| C.D. (P=0.01) | 0.3546 | 5.0577 | 0.8786 | 0.2023 | 1.9206 | 1.0128 | 1.4642 |
| C.D. (P=0.05) | 0.2682 | 3.8255 | 0.6645 | 0.1530 | 1.4527 | 0.7660 | 1.1075 |

*, ** and *** indicate significance of values at P=0.05, 0.01 and 0.01, respectively

Table 5 : Estimates of specific combining ability effects (SCA) of hybrids for 13 characters in rice

| Hybrids | Seedling height (cm) | Number of leaves seedling ⁻¹ | Days to 50% flowering | Flag leaf length (cm) | Plant height (cm) | Panicle bearing tillers plant ⁻¹ |
|---------------------------------------|----------------------|---|-----------------------|-----------------------|-------------------|---|
| IR 688897A X IR 70023-4B-R-12-3-1-1-B | -0.987 | 0.446* | -2.206 | -1.151 | -6.804** | -0.991 |
| IR 688897A X IR 61920-3B-22-2-1 | 0.835 | 0.290 | -5.872** | -4.011** | -6.693** | -1.213* |
| IR 688897A X PNL 1-8-5-17-2 | -1.821** | 0.223 | -6.539** | 1.016 | 0.273 | -0.191 |
| IR 688897A X NDRK 5095 | -3.454** | -0.466* | -0.650 | 1.171 | -0.804 | 0.031 |
| IR 688897A X NDRK 5056 | 0.779 | 0.223 | 0.239 | 1.527* | 3.151** | -0.924 |
| IR 688897A X NDRK 5086 | 1.479** | 0.046 | 0.017 | 0.649 | -1.893* | -0.347 |
| IR 688897A X NDR 9830119 | -0.698 | 0.223 | 1.017 | -2.307** | -3.671** | 0.742 |
| IR 688897A X NDRK 5013 | 3.502** | -0.199 | -3.983* | 1.416* | -6.071** | -0.080 |
| IR 688897A X CST 7-1 | -6.809** | -0.332 | 1.017 | 0.871 | 7.551** | -0.302 |
| IR 688897A X 21-2-5-B-1-1 | -2.143** | 0.157 | 1.461 | -1.235 | -1.938* | -1.458** |
| IR 688897A X IR 64 | -6.798** | -0.488* | -1.428 | -1.051 | 6.284** | 1.587** |
| IR 688897A X NDR 9830148 | 0.146 | -0.557* | 4.906** | 1.660* | -3.338** | 1.631** |
| IR 688897A X CSRC(S) 14-1-4-0 | 5.179** | 0.601** | -0.094 | -1.840** | -1.027 | 1.431* |
| IR 688897A X PNL 5-8-1-7-21 | -0.676 | -0.310 | -1.206 | 1.771* | 5.018** | 0.053 |
| IR 688897A X IR 72048-B-R-2-2-2-1-B | 7.546** | 0.001 | 3.572* | 3.271** | 3.662** | 0.209 |
| IR 688897A X IR 71829-3R-73-1-2-B | 0.235 | -0.021 | 2.461 | 0.827 | -2.093* | 0.187 |
| IR 688897A X NDRK 5094 | -0.787 | -0.021 | 4.683** | -2.540** | 3.862** | -0.436 |
| IR 688897A X 92-H 51-4 | 1.091* | -0.043 | 3.550 | -2.362** | -4.016** | 0.053 |
| IR 688897A X Narendra Usar 3 | -1.032 | -0.399 | -3.094 | 0.447 | 3.307** | 0.631 |
| IR 688897A X Sarjoo 52 | 4.413** | 0.446* | 2.350 | 1.871 | 5.240** | -0.613 |
| IR 58025 A X IR 70023-4B-R-12-3-1-1-B | -2.141** | -0.178 | -0.389 | 1.424* | 7.678** | 0.491 |
| IR 58025 A X IR 61920-3B-22-2-1 | -1.252* | -0.867** | 6.278** | 8.204** | 10.256** | 1.668** |
| IR 58025 A X PNL 1-8-5-17-2 | 3.159** | 0.600** | 7.611** | -3.476** | -5.828** | -0.909 |
| IR 58025 A X NDRK 5095 | 0.859 | 0.578* | -3.500* | -1.921** | 6.745** | -0.554 |
| IR 58025 A X NDRK 5056 | -0.907 | -0.133 | -1.944 | -0.798 | -7.300** | 1.957** |
| IR 58025 A X NDRK 5086 | 0.326 | -0.178 | -5.833** | -0.976 | 7.289** | 1.935** |
| IR 58025 A X NDR 9830119 | -3.918** | -0.333 | -2.833 | 5.902** | 3.245** | -1.176* |
| IR 58025 A X NDRK 5013 | 4.948** | 1.044** | 4.500* | -3.576** | 7.978** | -1.732** |
| IR 58025 A X CST 7-1 | 8.971** | -0.022 | -3.500* | -2.987** | -10.266** | 1.379* |
| IR 58025 A X 21-2-5-B-1-1 | 5.771** | 0.200 | -2.389 | 1.366* | 4.378** | 2.357** |
| IR 58025 A X IR 64 | 11.215** | 0.889** | -0.278 | 1.124 | -8.733** | -2.598** |
| IR 58025 A X NDR 9830148 | 2.326** | 0.067 | -1.278 | -1.432* | 5.511** | -2.521** |
| IR 58025 A X CSRC(S) 14-1-4-0 | -10.707** | -1.156** | 0.722 | 4.168** | 2.456** | -1.554** |
| IR 58025 A X PNL 5-8-1-7-21 | 3.571** | 0.467* | 0.611 | -3.721** | -11.200** | -1.265* |
| IR 58025 A X IR 72048-B-R-2-2-2-1-B | -8.541** | -0.422 | 4.389* | -2.437** | -5.855** | -0.509 |
| IR 58025 A X IR 71829-3R-73-1-2-B | 1.082* | -0.044 | 0.278 | -2.565** | 4.356** | 2.068** |
| IR 58025 A X NDRK 5094 | -1.874** | 0.022 | 0.500 | 4.335** | -5.055** | -0.421 |
| IR 58025 A X 92-H 51-4 | -1.329* | 0.067 | -3.167 | 4.446** | 8.900** | 0.268 |
| IR 58025 A X Narendra Usar 3 | -2.318** | -0.222 | 3.389 | -4.125** | -6.444** | 0.846 |
| IR 58025 A X Sarjoo 52 | -9.241** | -0.378 | -5.167** | -2.954** | -8.111** | 0.268 |
| PUSA 6A X IR 70023-4B-R-12-3-1-1-B | 3.128** | -0.268 | 2.594 | -0.273 | -0.874 | 0.501 |
| PUSA 6A X IR 61920-3B-22-2-1 | 0.417 | 0.577* | -0.406 | -4.193** | -3.563** | -0.455 |

Table 5: Contd.....

Table 5: Contd.....

| | | | | | | | |
|---------------------------------------|---------------------|-----------------------|------------------------|-----------------|--------------------------------|-------------------|---------------------------|
| PUSA 6A X PNL 1-8-5-17-2 | -1.339** | -0.823** | -1.072 | 2.460** | 5.554** | 1.101* | |
| PUSA 6A X NDRK 5095 | 2.594** | -0.112 | 4.150* | 0.749 | -5.940** | 0.523 | |
| PUSA 6A X NDRK 5056 | 0.128 | -0.290 | 1.706 | -0.728 | 4.149** | -1.033 | |
| PUSA 6A X NDRK 5086 | -1.806** | 0.132 | 5.817** | 0.327 | -5.396** | -1.588** | |
| PUSA 6A X NDR 9830119 | 4.617** | 0.110 | 1.817 | -3.595** | 0.426 | 0.434** | |
| PUSA 6A X NDRK 5013 | -8.450** | -0.846** | 0.517 | 2.160** | -1.907* | 1.812** | |
| PUSA 6A X CST 7-1 | -2.161** | 0.354 | 2.483 | 2.116** | 2.715** | -1.077 | |
| PUSA 6A X 21-2-5-B-1-1 | -3.628** | -0.357 | 0.978 | -0.131 | -2.440** | -0.899 | |
| PUSA 6A X IR 64 | -4.417** | -0.401 | 1.706 | -0.073 | 2.449** | 1.012 | |
| PUSA 6A X NDR 9830148 | -2.472** | 0.510* | -3.628* | -0.228 | -2.174* | 0.889 | |
| PUSA 6A X CSRC(S) 14-1-4-0 | 5.528** | 0.554* | -0.628 | -2.328** | -1.429 | 0.123 | |
| PUSA 6A X PNL 5-8-1-7-21 | -2.894** | -0.157 | 0.594 | 1.949** | 6.182** | 1.212* | |
| PUSA 6A X IR 72048-B-R-2-2-2-1-B | 0.994 | 0.421 | -7.661** | -0.834 | 2.193* | 0.301 | |
| PUSA 6A X IR 71829-3R-73-1-2-B | -1.317* | 0.066 | -2.739 | 1.738* | -2.263** | -2.255** | |
| PUSA 6A X NDRK 5094 | 2.661** | -0.001 | -7.183** | -1.795** | 1.193 | 0.856 | |
| PUSA 6A X 92-H 51-4 | 0.239 | -0.023 | -0.183 | -2.084** | -4.885** | -0.322 | |
| PUSA 6A X Narendra Usar 3 | 3.350** | 0.621** | -0.294 | 3.678** | 3.138** | -1.477** | |
| PUSA 6A X Sarjoo 52 | 4.828** | -0.068 | -2.817 | 1.083 | 2.871** | 0.345 | |
| S.E. (Sij) | 0.545 | 0.224 | 1.744 | 0.680 | 0.862 | 0.555 | |
| S.E. (Sij-Skl) | 0.7704 | 0.3160 | 2.4656 | 0.9610 | 1.2183 | 0.7843 | |
| C.D. (P=0.01) | 2.0169 | 0.8274 | 6.4554 | 2.5161 | 3.1898 | 2.0534 | |
| C.D. (P=0.05) | 1.5255 | 0.6258 | 4.8827 | 1.9031 | 2.4126 | 1.5531 | |
| | Panicle length (cm) | Spikelets per panicle | Spikelet fertility (%) | Test weight (g) | Biological yield per plant (g) | Harvest index (%) | Grain yield per plant (g) |
| IR 688897A X IR 70023-4B-R-12-3-1-1-B | -0.394 | 43.583** | 7.248** | 1.329** | 18.254** | 6.545** | 10.283** |
| IR 688897A X IR 61920-3B-22-2-1 | 1.151 | 32.583** | 4.515** | 1.962** | -46.713** | 7.803** | 8.167** |
| IR 688897A X PNL 1-8-5-17-2 | 1.206* | 22.339* | 4.259** | -1.471** | 27.263** | -2.098 | 5.874* |
| IR 688897A X NDRK 5095 | 0.384 | 10.139 | 4.048** | -1.026** | 5.087 | 1.952 | 2.732 |
| IR 688897A X NDRK 5056 | 0.695 | -31.752** | 1.471 | -1.582** | 0.743 | -8.821** | -12.995** |
| IR 688897A X NDRK 5086 | -1.072 | 6.139 | 2.559 | -2.115** | -15.535** | 4.140* | 0.305 |
| IR 688897A X NDR 9830119 | -0.449 | -19.528* | -1.318 | -0.726* | -26.502** | 2.628 | -2.760 |
| IR 688897A X NDRK 5013 | -1.616** | 15.561 | 0.782 | -0.360 | 9.587** | 2.129 | 3.605 |
| IR 688897A X CST 7-1 | -1.772** | -28.728** | -8.341** | -1.882** | -46.746** | -0.795 | -17.553** |
| IR 688897A X 21-2-5-B-1-1 | -1.583* | -20.194* | -4.129** | -1.626** | -10.635** | -9.539** | -20.446** |
| IR 688897A X IR 64 | 0.251 | -14.128 | 1.782 | 3.596** | 27.865** | 4.665** | 13.363** |
| IR 688897A X NDR 9830148 | -0.616 | 27.450** | -1.418 | 0.318 | 21.776** | 6.462** | 11.927** |
| IR 688897A X CSRC(S) 14-1-4-0 | 0.295 | -8.417 | 2.826 | -0.554 | -11.746** | 5.800** | 5.992* |
| IR 688897A X PNL 5-8-1-7-21 | -0.294 | -11.417 | 6.863** | 0.496 | 0.698 | -3.364 | -5.575* |
| IR 688897A X IR 72048-B-R-2-2-2-1-B | 1.462* | -16.239 | -12.385** | 0.070 | -18.346** | -3.699* | -11.802** |
| IR 688897A X IR 71829-3R-73-1-2-B | 0.751 | 1.806 | -15.729** | -3.644** | -7.668* | -10.803** | -18.400** |
| IR 688897A X NDRK 5094 | -0.627 | -0.772 | -1.563 | 1.096** | 12.645*** | -1.442 | 0.614 |
| IR 688897A X 92-H 51-4 | 3.351** | -9.128 | 18.715** | 3.829** | 1.876 | 2.141 | 11.438** |
| IR 688897A X Narendra Usar 3 | -0.427 | -8.439 | -2.596 | -0.815* | 11.543** | -3.671 | -3.637 |
| IR 688897A X Sarjoo 52 | -0.694 | 9.139 | 6.137** | 3.107** | 46.554** | -0.033 | 18.869** |

Table 5 : Contd.....

Heterosis & combining ability analysis for yield & its components in rice

Table 5: Contd.....

| | | | | | | | |
|---------------------------------------|----------|-----------|-----------|----------|-----------|-----------|-----------|
| IR 58025 A X IR 70023-4B-R-12-3-1-1-B | 1.054 | -52.384** | -8.622** | -2.919** | -32.563** | -8.138** | -15.014** |
| IR 58025 A X IR 61920-3B-22-2-1 | 0.199 | -30.717** | -5.355** | -4.952** | 109.470** | -17.616** | -12.730** |
| IR 58025 A X PNL 1-8-5-17-2 | -2.479** | -19.228* | 7.823** | 1.114** | -42.168** | 8.547** | -2.483 |
| IR 58025 A X NDRK 5095 | 0.899 | -22.161* | -9.155** | 1.025** | -14.763** | -7.207** | -12.038** |
| IR 58025 A X NDRK 5056 | -0.157 | -0.046 | 3.801* | 2.170** | -21.508** | 13.643** | 14.108** |
| IR 58025 A X NDRK 5086 | 1.270* | -24.161** | -18.044** | 3.817** | -26.419** | -0.002 | -6.285* |
| IR 58025 A X NDR 9830119 | 0.699 | 13.505 | 2.678 | 1.359** | 16.848** | -0.978 | 0.950 |
| IR 58025 A X NDRK 5013 | 1.932** | -21.006* | 3.512* | 0.659 | -40.597** | 1.297 | -7.212** |
| IR 58025 A X CST 7-1 | 1.843** | 33.905** | 7.256** | 3.270** | 76.737** | 0.452 | 26.717** |
| IR 58025 A X 21-2-5-B-1-1 | 3.532** | 35.172** | 8.401** | 2.625** | 26.314** | 13.512** | 35.624** |
| IR 58025 A X IR 64 | -2.434** | 29.372** | 2.712 | -7.152** | -33.052** | -9.604** | -18.747** |
| IR 58025 A X NDR 9830148 | 1.266* | -24.117** | 18.378** | -1.164** | -27.908** | -2.250 | -8.503** |
| IR 58025 A X CSRC(S) 14-1-4-0 | -1.823** | 6.616 | -8.544** | 0.998** | 29.777** | -11.699** | -10.665** |
| IR 58025 A X PNL 5-8-1-7-21 | -1.552* | 25.283** | 5.167** | -0.286 | -2.286 | -0.363 | 1.375 |
| IR 58025 A X IR 72048-B-R-2-2-2-1-B | -1.657** | 26.261** | 10.345** | 1.199** | 37.570** | -0.428 | 14.062** |
| IR 58025 A X IR 71829-3R-73-1-2-B | 0.599 | -5.495 | 17.067** | 6.394** | 13.481** | 18.674** | 33.050** |
| IR 58025 A X NDRK 5094 | 2.554** | 31.994** | 3.234* | -0.286 | -15.846** | 6.656** | 6.084* |
| IR 58025 A X 92-H 51-4 | -5.534** | -14.628 | -40.322** | -6.086** | 27.525** | -17.804** | -31.112** |
| IR 58025 A X Narendra Usar 3 | -0.079 | 32.661** | 4.267** | 2.970** | -2.241 | 12.590** | 22.293** |
| IR 58025 A X Sarjoo 52 | -0.179 | -20.828* | -4.599** | -4.808** | -78.363** | 0.718 | -29.474** |
| PUSA 6A X IR 70023-4B-R-12-3-1-1-B | -0.661 | 8.800 | 1.373 | 1.590** | 14.310** | 1.593 | 4.731 |
| PUSA 6A X IR 61920-3B-22-2-1 | -1.349* | -1.867 | 0.840 | 2.990** | -62.757** | 9.812** | 4.562 |
| PUSA 6A X PNL 1-8-5-17-2 | 1.273* | -3.111 | -12.082** | 0.357 | 14.905** | -6.449** | -3.391 |
| PUSA 6A X NDRK 5095 | -1.283* | 12.022 | 5.107** | 0.001 | 9.676** | 5.254** | 9.307** |
| PUSA 6A X NDRK 5056 | -0.538 | 31.798** | -5.271** | -0.588 | 20.765** | -4.822** | -1.113 |
| PUSA 6A X NDRK 5086 | -0.205 | 18.022* | 15.484** | -1.755** | 41.954** | -4.138* | 5.980* |
| PUSA 6A X NDR 9830119 | -0.249 | 6.022 | -1.360 | -0.632 | 9.654** | -1.650 | 1.809 |
| PUSA 6A X NDRK 5013 | -0.316 | 5.445 | -4.293** | -0.299 | 31.010** | -3.426 | 3.607 |
| PUSA 6A X CST 7-1 | -0.072 | -5.178 | 1.084 | -1.388** | -29.990** | -0.343 | -9.164** |
| PUSA 6A X 21-2-5-B-1-1 | -1.949** | -14.978 | -4.271** | -0.999** | -15.679** | -3.973* | -15.178** |
| PUSA 6A X IR 64 | 2.184** | -15.244 | -4.493** | 3.557** | 5.187 | 4.940** | 5.385* |
| PUSA 6A X NDR 9830148 | -0.649 | -3.333 | -16.960** | 0.846* | 6.132 | -4.212* | -3.424 |
| PUSA 6A X CSRC(S) 14-1-4-0 | 1.528* | 1.800 | 5.718** | -0.443 | -18.024** | 5.899** | 4.674 |
| PUSA 6A X PNL 5-8-1-7-21 | 1.806** | -13.867 | 1.696 | -0.210 | 1.587 | 3.728* | 4.200 |
| PUSA 6A X IR 72048-B-R-2-2-2-1-B | 0.195 | -10.022 | 2.040 | -1.269** | -19.224** | 4.127* | -2.260 |
| PUSA 6A X IR 71829-3R-73-1-2-B | -1.349* | 3.689 | -1.338 | -2.750** | -5.813 | -7.871** | -14.651** |
| PUSA 6A X NDRK 5094 | -1.927** | -31.222** | -1.671 | -0.810* | 3.201 | -5.213** | -6.698** |
| PUSA 6A X 92-H 51-4 | 2.184** | 23.756** | 21.607** | 2.257** | -29.402** | 15.663** | 19.674** |
| PUSA 6A X Narendra Usar 3 | 0.506 | -24.222 | -1.671 | -2.155** | -9.302** | -8.919** | -18.665** |
| PUSA 6A X Sarjoo 52 | 0.873 | 11.689 | -1.538 | 1.701** | 31.810** | -0.685 | 10.605** |
| SE (Sij) | 0.606 | 8.639 | 1.500 | 0.346 | 3.281 | 1.730 | 2.501 |
| SE (Sij-Skl) | 0.8566 | 12.2177 | 2.1223 | 0.4888 | 4.6395 | 2.4465 | 3.5371 |
| C.D. (P=0.01) | 2.2426 | 31.9878 | 5.5566 | 1.2798 | 12.1468 | 6.4053 | 9.2605 |
| C.D. (P=0.05) | 1.6962 | 24.1945 | 4.2028 | 0.9680 | 9.1874 | 4.8448 | 7.0044 |

* and ** indicate significance of values at P=0.05 and 0.01, respectively

of F_1 value over the best commercial variety (standard heterosis) is more relevant. In the present investigation, the relative magnitude of heterosis over pollen parent and SH (NDRH 2) have been studied for ten characters in 40 hybrids (Table 2 and 3). The results suggested that the magnitude of hybrid vigour differed from character to character depending upon hybrid combinations. None of the crosses were consistently good for all the characters.

Among 40 hybrids, 32 hybrids showed significant heterosis over better parent for grain yield plant⁻¹. However, over the SH (NDRH-2) heterosis was manifested in 36 crosses. Top 5 hybrids exhibiting highest heterosis over SH (NDRH-2) are IR 688897A X Sarjoo 52 (197.81%) followed by IR 58025 A X 21-2-5-B-1-1 (185.04, IR 58025 A X Narendra Usar 3 (158.28%) and IR 58025 A X IR 71829-3R-73-1-2-B (131.61%). Heterosis for grain yield plant⁻¹ in saline-alkali soil was also reported by Ghara *et al.* (2014). The quantum of heterosis obtained in present study fully justify the commercial exploitation of heterosis in rice as a yield advantage of 20-30 per cent over BP is obtained to be sufficient to encourage farmers to take up hybrid rice cultivation. The results obtained from present study indicated that the yield heterosis was mainly influenced by spikelets panicle⁻¹, panicle length, spikelet fertility and test weight did contribute to increased yield heterosis. A wide range of variations in the expression of heterosis for grain yield was reported by many workers.

General combining ability effects:

The GCA effects of parent have been presented in Table 4. It is noted that top two males, NDRK 5095 and NDRK 5013 proved the best general combiner for seedling height and number of leaves seedling⁻¹; Sarjoo 52 and NDRK 5056 for days to 50 per cent flowering (earliness); 92-H 51-4 and IR 61920-3B-22-2-1 for flag leaf area; CST 7-1 and Sarjoo 52 for plant height (dwarf stature); Sarjoo 52 and IR 72048-B-R-2-2-2-1-B for panicle bearing tillers plant⁻¹; IR 72048-B-R-2-2-2-1-B and NDRK 5095 for panicle length; Narendra Usar 3 and NDR 9830119 for spikelets panicle⁻¹; NDR 9830119 and NDRK 5094 for spikelet fertility; NDRK 5013 and NDRK 5094 for test weight; Sarjoo 52 and NDR 9830119 for biological yield; Sarjoo 52 and Narendra Usar 3 for harvest index and grain yield plant⁻¹. Similar findings are also reported by Rosamma and Vijayakumar (2005); Priyanka *et al.* (2014) and Dorosti and Monajjem (2014).

Among the female parental lines, IR 58025 was

observed as a good general combiner only for seedling height, panicle length, spikelets panicle⁻¹, test weight, biological yield plant⁻¹. Whereas, IR 688897 A was good combiner for panicle bearing tillers plant⁻¹ and harvest index. These findings are supported by Patial *et al.* (2016) and Prasad *et al.* (2013) also reported IR 58025 A as good general combiner for seedling vigour.

Specific combining ability effects:

In the present investigation, none of the 40 hybrids manifested consistently high SCA effects for all the characters. The SCA effects of parent have been presented in Table 5. The present findings revealed that cross IR 58025 A X 21-2-5-B-1-1, IR 58025 A X IR 71829-3R-73-1-2-B, IR 58025 A X CST 7-1, IR 58025 A X Narendra Usar 3 and IR 688897A X Sarjoo 52 exhibited high SCA effects for grain yield plant⁻¹. The effect of IR 58025 A X CST 7-1 for grain yield was due to desirable SCA effect of seedling height, plant height, spikelets panicle⁻¹, test weight and biological yield plant⁻¹. The common crosses based on *per se* performance and SCA effects for all the characters (Table 4) were also in close correspondence. Similar pattern of association between SCA effects for grain yield plant⁻¹ with other yield attributing traits were reported by Hasan *et al.* (2013) and Adilakshmi and Reddy (2012) have suggested that about 20-30 per cent standard heterosis may be considered sufficient to offset the extra cost of hybrid seeds. The favourable *per se* performances and higher significant positive SCA effects in related to grain yield plant⁻¹ were found in hybrid IR 688897A X Sarjoo 52, IR 58025 A X 21-2-5-B-1-1, IR 58025 A X Narendra Usar 3 and IR 58025 A X IR 71829-3R-73-1-2-B. These combinations proved to be good hybrids based on CMS system in rice.

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