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# HETEROSIS AND COMBINING ABILITY STUDIES IN SOME NON- RESTORER AND RESTORER LINES OF PEARL MILLET (*Pennisetum americanum* (L) LEEKE).

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**ABSTRACT**

Investigations were carried out to estimate the extent of heterosis and combining ability in two sets consisting of eight non restorers viz., ICMS 81 B, L 111 B, J 126$D_2$B, Tift 23$D_2$B, Tift 239 $D_2$B, MS 5141B, PT 248/5B and PT 732/2B and eight restorers viz. PT 1824, PT 1921, PT 2584, PT 2598, PT 2784, PT 3095, K-560 and J 104 in pearl millet. Diallel crosses without reciprocals were effected in each set seperately. Most of the hybrid combinations exhibited significant heterosis for majority of the characters in both the sets. In grain yield, the hybrids L 111B x J 126$D_2$B and K 560 x PT 1824 exhibited the highest significant heterosis of 97.45 percent and 52.56 percent over the better parents in set I and II respectively. In combining ability studies, the variances due to genotypes and the hybrids were significant for all the characters in set I, while in set II, the variances due to hybrids were not significant in respect of panicle width and leaf width. For grain yield, the ratio of general combining ability to specific combining ability was 0.28 : 1 in set I, while in set II the ratio was 0.34 : 1.

KEY WORDS : Pearl Mellet, Heterosis, Combining ability.

Improvement of hybrids and varietal yield levels is a continuous process. Breeding pearl millet lines received a set back in India as Tift 23A, the female parent of most of the commercial pearl millet hybrids released, became susceptible to downy mildew. Hence the need for improvement of parental lines was felt essential so that the new hybrids better than the existing ones could exhibit further increase in yield combining disease resistance. Gardner (1972) suggested that improved inbred performance could in turn naturally improve the hybrid performance. The heterosis registered by the single crosses were examined in the light of combining ability of the parents and their utility in breeding productive three-way crosses which could serve as good source for generating superior inbreds to be used as parents of super hybrids. The work reported here, is an attempt towards this.

## MATERIALS AND METHODS

Diallel crosses were effected among the eight inbreds in each set (B and R sets) to obtain 28 direct crosses during summe 1984 at the Millet Breeding Statio Coimbatore. All the 56 hybrids along wi their parents were raised in 1984 mons season, in two sets of 28 each randomised block design, replicated times. Each plot consisted of a singl of 20 plants 15 cm apart with a spacir 45 cm. Out of 5 replications, three utilized for recording observation the fourth for selfing to obtain $F_2$S/ last for effecting three-way Measurements were recorded on t randomly chosen from each replic the mean values were used for analysis.

Heterosis was recorded as perc of superiority over the mid, better a

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s and the standard check. The combining ability analysis was based on the fixed effect model (Griffing, 1958).

## RESULTS AND DISCUSSION

The present study has provided information regarding diversity among parents, extent of heterosis, nature of gene action and the combining ability of the parental stocks for the various yield component characters. Among the non-restorers, Tift $239DB_2$ and J $126D_2B$ were useful for increasing panicle length, panicle width, grain weight, while MS 5141B was a superior general combiner for tiller number and days to flowering.

Among the restorer parents, PT 2598 and PT 1824 were the best general combiners for panicle length and panicle width while K 560 was a good combiner for tiller number and earliness.

The parental material used in the present investigation represents diverse geographic areas where the forces of natural selection are expected to differ. Diversity among the parents is indicated when we examine the analysis of combining ability for 56 hybrids for various characters.

The differences among the genetypes and the hybrids were significant for all the character in the non-restorers and

**Table 1. Range of heterosis and heterosis (over better parent) for the best two crosses for six characters.**

| Character | Set | Cross | Heterosis over better parent (%) | Range of heterosis (%) |
|---|---|---|---|---|
| Plant height | I | ICMS 81B x MS 5141B | 44.01 | -9.93 to 44.01 |
| | I | Ms 5141B x PT 248/SB. | 32.90 | |
| | II | PT 2598 x PT 2584. | 19.59 | -14.19 to 19.59S |
| | II | K 560 x PT 3095. | 13.45 | |
| nicle length | I | Tift $239DB_2$ x PT 248/5B. | 20.92 | -27.0 to 20.92 |
| | I | J 126D2B x Tift $239DB_2$ | 14.67 | |
| | II | J 104 x K 560. | 14.23 | -7.47 to 14.23 |
| | II | PT 2584 x PT 1921. | 13.35 | |
| umber | I | ICMS 81B x Tift $239DB_2$. | 43.46 | -17.85 to 43.46 |
| | I | Tift $239DB_2$ x MS 5141B. | 36.98 | |
| | II | J 104 x PT 2784. | 41.63 | -8.58 to 41.63 |
| | II | J 104 x PT 1824. | 30.04 | |
| wering | I | L 111B x MS 5141B. | -7.55 | 20.83 to 7.55 |
| | I | J $126D_2B$ x Tift $239DB_2$. | -7.14 | |
| | II | PT 3095 x PT 1824. | -6.04 | 8.77 to 6.04 |
| | II | J 104 x PT 2584. | -5.96 | |
| plant | I | L 111B x J $126D_2B$. | 97.45 | -14.44 to 97.45 |
| | I | J $126D_2B$ x PT 248/5B. | 96.42 | |
| | II | PT 2784 x PT 3095. | 52.56 | -21.63 to 52.56 |
| | II | K 60 x PT 1824. | 46.90 | |
| ight | I | ICMS 81B x L 111B. | 28.16 | -15.65 to 28.16 |
| | I | ICMS 81B x PT 248 | 21.82 | |
| | II | PT 25911 x PT 1921. | 13.34 | -13.45 to 13.34 |
| | II | PT 1921 x PT 1924. | 11.81 | |

Table 2. combining ability analysis of hybrids for six characters in pearl millet.

| Due to | DF | Plant height | | Panicle length | | Tiller number | | Days to 50% flowering | | Grain yield per plant | | Grain weight | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NR | R | NR | R | NR | R | NR | R | NR | R | NR | R |
| General combining ability | 7 | 2134.74** | 222.62** | 25.73** | 11.09** | 0.12 | 0.17** | 38.98** | 8.99** | 59.98** | 8.58 | 4.47** | 1.28** |
| Specific combining ability | 28 | 211.93** | 77.93** | 3.98** | 1.66** | 0.21** | 0.06** | 7.94** | 2.34** | 32.11** | 5.52 | 1.39** | 0.45** |
| Error | 70 | 25.69 | 14.69 | 1.08 | 0.59 | 0.07 | 0.02 | 0.16 | 0.26 | 12.11 | 4.21 | 0.05 | 0.08 |
| GCA/SCA | | 2.06:1 | 0.45:1 | 1.50:1 | 1.76:1 | - | 0.55:1 | 0.79:1 | 0.64:1 | 0.28:1 | 0.34:1 | 0.46:1 | 0.40 |
| $Var_g$ | | 384.42 | 28.93 | 44.35 | 1.88 | - | 0.02 | 6.21 | 1.33 | 5.57 | 0.44 | 0.61 | 0.16 |
| $Var_{sij}$ | | 186.25 | 62.23 | 2.89 | 1.07 | 0.143 | 0.04 | 7.78 | 2.08 | 19.99 | 1.31 | 1.34 | 0.37 |

* Significant at 5% level. + Ignored as -ve variance was recorded.

** Significant at 1% level. NR : Non restorers R : Restorers.

Table 3 . A Comparison of Nature of Gene Action for Six Characters in Pearl Millet.

| Character | Present Study. | Previous Reports. | |
|---|---|---|---|
| 1. Plant height | Additive | Additive : | Bhamare et al (1983) |
| | Non-additive | | |
| 2. Panicle length | Additive | Additive: | Sundaresan (1982) |
| | | Non-Additive: | |
| | | Non-Additive : | Ravindran (1982) |
| 3. Tiller number | Additive | Additive : | Ravindran (1982) |
| | Non-Additive | Additive: | Basavaraju et al (1980) |
| | | Non-Additive: | |
| 4. Days to flowering | Additive | Additive : | Bhamare et al (1983) |
| | Non-Additive | Non-Additive : | Basavaraju et al (1980) |
| 5. Grain yield per plant | Non-Additive | Additive : | Singh & Lal (1969) |
| | | Non-Additive: | Pokhriyal et al (1967) |
| | | | Singh & Lal (1969) |
| | | | Vaidya et al (1983) |
| 6. Grain weight | Non-Additive | Additive : | Singh & Lal (1969) |
| | | Non-Additive : | Singh & Lal (1969) |
| | | | Vaidya et al (1983) |

restoreres except for panicle width and leaf width in the restorer lines.

Heterosis for plant height over the mid parent was observed in 21 out of 28 and 19 out of 28 conbinations in non-restorers and restorers, respectively. Heterobeltiosis in the restorers (i.e. superiority of the F1 hybrid over the superior parent involved in that particular cross) was observed in 10 crosses for earliness, 8 crosses for leaf number, 6 croses for grain weight, 5 crosses each for tiller number and grain number and 3 crosses for grain yield. However, the number of crosses that showed heterobeltiosis for plant height was high (13 crosses).

The increase in the character expression of the F1 hybrids, in general, was high in the non-restorers as compared to the restorers (Table 1). The increase in plant height ranged between - 9.93 to 44.01 per cent in the non-restorers, while in restorers it was from 14.19 to 19.59 percent. Hybrid ICMS 81B x MS 5141B recorded the highest significant heterosis for plant height, while the highest value for grain yield was observed in L111B x J 126$D_2$B. For panicle lenght, the increase in the non-restorers ranged between -27.0 to 20.92 percent, while the range in the restorers was from -7.47 to 14.23 per cent. Hybrid Tift 239$DB_2$ PT 248/5B recorded the highest heterosis of 20.92 percent.

The highest values of heterosis recorded for tiller numer was slightly higher in non-restorers i.e. 43.46 per cent in the non- restorers and 41.63 per cent in the restorers. In respect of earliness also, the hybrids under non-restorer, lines exhibited higher heterosis values than the restorers. Hybrid L 111B x MS 5141B recorded the highest negative value (-7.55 per cent) which is an advantageous attribute.

The heterosis for grain yield has been of a higher order in the non-restorer than in the restorers, the highest heterosis values over better parent being 97.45 per cent and 52.56 per cent in the non-restorers and the restorers, respectively.

For grain weight, the F1 hybrids from non-restorers recorded rather twice the value of heterosis recorded by the restorers; the average values being 24.99 per cent and 12.57 per cent, respectively. These results support the earlier reports of Ahulwalia and Patnaik (1963), Singh and Lal (1969) and Shinde *et al* (1984).

The estimates of general and specific combining ability *gca* and *sca* variances for six characters are presented in Table 2 for non-restorers and restorers. It appears that the variances due to *gca* were the highest than that due to *sca* for plant height, panicle length, while the variances due to *sca* were predominant for grain yield and grain weight. For days to flowering, both *gca* and *sca* are important in the non- restorer lines.

In the crosses involving restorer lines, additive gene action was predominent for panicle length, while dominance gene action played an important role for the remaining characters.

The nature of gene action provides valuable information from the breeding point of view. It helps in the formulation of breeding procedure for obtaining maximum genetic advance in yield and yield components. Present results together with previous reports for the particular characters are presented in Table 3.

When the results of the present study and those previously reported are examined, it appears that there are divergent results in regard to the nature of gene action for the characters studied. The gene action is mostly non-additive for grain yield, grain weight, while both additive and non-additive genes are important for plant height, tiller number and days to flowering. For panicle length, additive genes appear to play a prominant role. There could be serveral causes that might account for these divergent results. The non-additive gene action could be effectively exploited by producing F1 hybrids or synthetics.

The non-restorer parents Tift $239DB_2$ and J $126D_2B$ which recorded higher positive *gca* values for grain yield, grain weight and panicle length could be utilised for developing improved population from which the productive parents could be derived. Similarly, the restorer parents PT 2598, PT 1824 which are the best general combiners for panicle length and width, K 560 for tiller number and earliness would be useful for future breeding work.

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