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# Heterosis In Pigeonpea and the Implications In Producing Hybrids on Commercial Basis

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Heterotic effects were analysed in 20 hybrid combinations involving 10 diverse parents. for yield and some yield components. Mean heterosis of 39% was obtained for yield and about 16% for days to flowering as well as pods per plant. In general early X late and medium X late combinations resulted in high heterosis for yield. The possible ways of exploiting, this heterosis was discussed, Implications in producing and growing hybrid pigeonpeas was also discussed and some suggestions were made.

With the availability of genetic male sterility in pigeonpea (Reddy *et al.* 1978) a new era has been opened for producing hybrids in this important grain legume. The commercial exploitation of hybrid vigour, already reported in this crop (Srivastava *et al.* 1976 and Reddy *et al.* 1979) involves many practical problems like the extent of natural cross pollination. agents for transferring pollen, relative resistance/susceptibility of male sterile stocks to different diseases, the performance of hybrids over the best cultivars and finally the maintenance of male sterile stock and identifying the male sterile plants.

In the present study an attempt was made to work out the extent of heterosis for yield and its components and to study the relative performance of hybrids produced by using male sterile stocks. Certain related problems have also been discusssd.

## MATERIAL AND METHODS

Ten diverse cultivars of pigeonpea (*Cajanus cajan* (L.) Millsp) representing contrasting agronomic characters (Table 1) from three maturity groups i. e. early ($HPA_2$, Pant $A_2$. $T_{21}$); medium (C 11, 6997) and late (7035, TTB 7, 4726, T 7 and NP (WR)-15) were selected to make 20 hybrid combinations at Banaras Hindu University, during 1978-79 The 20 hybrids and 10 parents were grown in single row plots of 5 m long in two replications during 1979-80 under sole cropping system with a row spacing of 1 metre and plants within each row at 30 cm. Uniform cultural practices were provided to the entire experimental plots. Ten competitive plants from each entry were chosen to record observations on days to flowering, pods per plant, seeds per pod, 100 seed weight (gm) and yield per plant (gm), Heterosis for different characters was calculated. The data on the performance of the hybrids and other best cultivars were taken from the Annual reports of the All India Coordinated Pulse Improvement Project, (1978).

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## RESULTS AND DISCUSSION

The mean values, $F_1$ performance, percent heterosis over better parent and C..D. are given in Tables 1 and 2. *Yield per plant (gm) :* Parental mean was 77.6 and that of $F_1$S 111.3, showing about 47% increase in yield. All the 20 crosses exhibited significantly higher yields than their better parents. Two crosses, C 11 X NP (WR) -15 and $T_7$ X NP (WR)-15 had significantly higher yields than the best parent (NP(WR)-15). The mean yield of these two higher yielding crosses was 200.5 gm against 165.8 gm of the best parent. The overall heterosis among the 20 crosses was 38.4% which appears to be less as compared to the results reported by Sharma *et al.* 1973 (72.2%) and Srivastava *et al.* 1976 (67.5%).

Out of the 20 crosses showing significant heterosis, two involve early X early parents, two early X medium combinations, five early X late combinations, seven medium X late and four late X late combinations. As reported by Reddy *et al.* (1979), high heterosis for yield in early X late and medium X late cultivars was also observed in the present study.

*Other yield components* : The mean heterosis for days to flowering and pods per plant was 15.62 and 15 47 per cent (Table 2) respectively, indicating that these two attributes positively contributed to yield enhancement of the $F_1$S. Due to the increase in duration, the plants had the opportunity for further growth and subsequently producing more pods/plant, thereby improving the yields. Significant positive correlation of pods/plant and negative association of 100-seed weight with yield, as seen in the present study, was also reported by Sharma *et al.* (1971).

Heterosis for pods/plant was high in early X late and late combinations, therefore, it may be concluded that genetic diversity was the key for obtaining hybrid vigour.

More than 50% heterosis in several of the crosses warrants its commercial exploitation. The high amount (27%) of natural cross pollination (Venkateswarlu & Singh, 1980) existing in this crop favours the production of hybrid seeds. By utilizing the genetic male sterility, ICRISAT scientists have developed some hybrids to exploit the existing hybrid vigour. The performance of some of the hybrids tested in ACT-2 trials at 4 locations is given in Table 3.

Unfortunately, none of these hybrids could out yield the best cultivars. This could be due to the additive gene action for yield in pigeonpea (Sharma *et al.* 1973, Venkateswarlu and Singh, 1981) where we expect to find most hybrids with no superiority over the highest yielding cultivars. Apart from that the male sterile stocks with narrow genetic base are susceptible to one or the other diseases, ultimately reducing the yields.

*Practical problems for commercialization of hybrid pigeonpeas* :

Producing pigeonpea hybrids on commercial basis involves certain practical problems :

1. The genetic male sterility throws only 50% male sterile plants from the stock which leads to the removal of the remaining 50% fertile plants and ultimately producing only half of the seed per unit area.

2. Though identification of male sterile plants (with translucent anthers) is easy, if timely attention is not paid in identifying and removal of fertile plants, hybrid seed production is not possible.

3. Identification of male sterile plants and removal of fertile plants at flower opening time on large scale is laborious and time consuming.

4. Maintenance of male sterile stock is another time and labour consuming job since male sterile plants are to be lablled and the seed should be harvested only from these plants.

5. The cost of producing hybrid seed under such a system will be much higher and the economics of growing hybrids is also questionable.

*Suggestions for the improvement of this system* :

1. The genetic base of the stocks should be broadened by transferring the male sterile genes to as many lines as possible, preferably to disease resistant sources. This work has already been initiated at ICRISAT and at a few National centres.

2. Search for cytoplasmic-genetic male sterility should continue at a rapid speed.

3. Since locally adopted cultivars are more stable and superior to other varieties (in pigeonpea) local hybrids be produced by using the male sterile stocks till we get an alternative.

4. Morphological markers (leaf marker associated with male sterility, Venkateswarlu *et al.* 1981) associated with male sterility will help in easy identification of male sterile plants even at the seeding stage and reduce certain problems

5. Production of hybrid seed may be taken up on large scale under intercropping system to minimise the crop risks.

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Table 1. Mean values of characters of parents used in the hybrid combinations.

| Parents | Days to flowering | Pods/ Plant | Seeds/ Pod | 100-Seed weight (gm) | Yield/Plant (gm) |
|---|---|---|---|---|---|
| Pant A 2 | 91.40 | 95.65 | 3.70 | 7.51 | 24.72 |
| HPA 2 | 76.30 | 82.12 | 3.75 | 6.94 | 20.25 |
| T 21 | 95.70 | 157.38 | 3.35 | 7.03 | 38.56 |
| TTB 7 | 136.10 | 73.79 | 4.65 | 22.52 | 74.72 |
| C 11 | 128.40 | 250.48 | 3.40 | 10.32 | 72.75 |
| 6997 | 118.70 | 142.75 | 3.80 | 13.50 | 78.45 |
| 4726 | 142.31 | 91.96 | 4.80 | 16.50 | 69.80 |
| 7035 | 134.60 | 82.27 | 4.35 | 21.51 | 80.40 |
| T 7 | 146.80 | 356.57 | 3.85 | 11.02 | 160.20 |
| NP [WR]-15 | 144.58 | 495.20 | 3.80 | 8 73 | 165.75 |
| Mean | 121.49 | 182.82 | 3.95 | 12.46 | 77.56 |

Table 2. Mean and per cent heterosis over better parent of 20 $F_1$S of pigeonpea

| Cross | Days to flowering | | Pods/Plant | | Seeds/Pod | | 100 Seed weight | | Yield/Plant | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $F_1$ | BP | $F_1$ | BP | $F_1$ | BP | $F_1$ (gm) | BP | $F_1$ (gm) | BP |
| Pant $A_2$ x $HPA_2$ | 87.93 | 15.24 | 118.21 | 18.36 | 3.45 | -8.00 | 6.93 | -7.72 | 29.72 | 20.26 |
| ,, x T 21 | 88.52 | -3.15 | 175.67 | 11.62 | 3.35 | -9 45 | 7.02 | -6.52 | 48.75 | 26.42 |
| ,, x TTB 7 | 119.10 | 30.31 | 117.20 | 22.53 | 5.55 | -2.15 | 10 51 | -53.33 | 98.11 | 31.30 |
| ,, x 6997 | 88.56 | -3.10 | 158.71 | 10 98 | 4.00 | 5 26 | 10.60 | -21.48 | 88 55 | 12.87 |
| ,, x 4726 | 113.08 | 23.72 | 121.20 | 26.71 | 4.35 | -9.38 | 12.15 | -26.36 | 85.96 | 23.15 |
| ,, x 7035 | 122.25 | 33.75 | 98.21 | 2.68 | 4.15 | -4.59 | 13.14 | -38.91 | 92.34 | 14.64 |
| HPA2 x TTB7 | 115.72 | 51.66 | 100.30 | 22.14 | 4 65 | 0.00 | 10.77 | -52.18 | 91.25 | 22.12 |
| ,, x C 11 | 116.60 | 52.82 | 271.50 | 8.39 | 4.05 | 8.00 | 8 80 | -14.72 | 105.71 | 45.31 |
| ,, x 7035 | 116,32 | 52.45 | 139.50 | 69.56 | 4.55 | 4.60 | 14.20 | -33.98 | 135.65 | 68.72 |
| TTB 7 x C 11 | 135.20 | 5.29 | 211.50 | -15·56 | 3.50 | -24.73 | 13.57 | -39.74 | 130.21 | 74.26 |
| ,, x 6997 | 135.91 | 14.50 | 152.50 | 6.83 | 3.70 | -20.43 | 14.62 | 35.08 | 124.71 | 66.90 |
| ,, x 4726 | 138.30 | 1,62 | 92.15 | 0,21 | 3.85 | -19.79 | 14.52 | 35.52 | 122,12 | 63.44 |
| ,, x 7035 | 137.78 | 2.36 | 78.12 | -5,04 | 3.75 | -19.35 | 13.87 | -38.41 | 141.23 | 75.65 |
| C11 x 7035 | 135.25 | -5.33 | 274.18 | 9.46 | 4.35 | 0.00 | 12 32 | 42.72 | 98.52 | 22.54 |
| ,, x T7 | 130.83 | 1.89 | 473.19 | 32.71 | 4.15 | 7.79 | 10.31 | -6.44 | 170 68 | 6.54 |
| ,, x NP (WR)-15 | 132.75 | 3.39 | 562.15 | 13.52 | 4.75 | 25.00 | 10.51 | 1.84 | 195,76 | 18.11 |
| 6997 x 4726 | 132.80 | 11.88 | 150.29 | 5.28 | 4.85 | 1.04 | 14.15 | -14,24 | 129.59 | 65.19 |
| ,, x 7035 | 126.95 | 6.95 | 149.52 | 4.74 | 4.50 | 3.45 | 11.66 | -45.79 | 115.72 | 43.93 |
| 4726 x 7035 | 141.75 | 5.31 | 147.57 | 60.47 | 4.65 | -3.13 | 14.62 | -32.03 | 115.42 | 43.56 |
| T7 x NP (WR)-15 | 144.85 | 0.19 | 514.15 | 3.83 | 3.50 | -9.09 | 10.62 | -3.63 | 205.14 | 23.75 |
| Mean | 123 02 | 15 62 | 205 04 | 15.47 | 3.94 | -3.75 | 11.74 | -27.35 | 111.28 | 38.43 |
| C. D. 5% | 10.94 | | 6.63 | | 0.29 | | 0 57 | | 9.22 | |
| C. D. 1% | 14.74 | | 8.93 | | 0.39 | | 0.77 | | 12.43 | |

Table 3. Relative performance of pigeonpea hybrids (ICPH No.) in Act-2 [1979-80] compared with high yielding cultivars

| Variety | Grain yield (kg/ha) | Maturity (days) | CD of Trial (kg/ha) |
|---|---|---|---|
| *Varanasi* | | | |
| Lam RG-30 | 1516 | 195 | 373.00 |
| Lam RG-36 | 1413 | 198 | |
| GS-1 | 1258 | 195 | |
| C-11 | 1231 | 195 | |
| ICPH-1 | 1143 | 195 | |
| *Baroda* | | | |
| B-12 | 2132 | 168 | 417.00 |
| Lam RG-30 | 1981 | 174 | |
| T-15-15 | 1926 | 176 | |
| GS-1 | 1779 | 180 | |
| ICPH-1 | 1125 | 178 | |
| *Junagarh* | | | |
| Lam RG-30 | 644 | 162 | NS |
| ICPL-42 | 600 | 159 | |
| BDN-2 | 575 | 126 | |
| ICPH-1 | 542 | 150 | |
| T-15-15 | 538 | 126 | |
| *Gulbarga* | | | |
| C-28 | 733 | 194 | NS |
| BDN-2 | 676 | 207 | |
| ICPL-43 | 641 | 213 | |
| ICPL-42 | 633 | 213 | |
| ICPH-2 | 605 | 203 | |
| ICPH-4 | 307 | 209 | |