Indian J. Genet., **53** (3): 273–278 (1993)

GENETIC VARIATION FOR HARVEST INDEX AND DEVELOPMENTAL TRAITS IN PIGEONPEA HYBRIDS

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(Received: July 15, 1991; accepted: December 22, 1992)

ABSTRACT

Evaluation of 60 pigeonpea hybrids involving three genetic male sterile lines, 11 and 9 medium and short duration pollinators, revealed importance of both additive and nonadditive components of genetic variance in the inheritance of harvest index, days to flowering, plant height, per day production, and reproductive period. The nonadditive portion was predominant for all the traits except days to flower where additive genetic variance played a major role. The parents and hybrids were characterized for their genetic worth through estimates of combining ability effects. It was found that 50 hybrids significantly exceeded their parents in respect of harvest index which seemed to be an important attribute for increased vigour of hybrids. The crosses with high harvest index were associated with either early flowering or shorter plant height or both.

Key words: Pigeonpea, genetic male sterility, harvest index, genetic analysis, developmental characters.

In pigeonpea, availability of stable genetic male sterility systems [1, 2], a considerable degree of natural outcrossing [3], and presence of high degree of hybrid vigour for seed yield and other characters in crosses involving male sterile lines [4–6] have opened up the possibilities for development and commercial cultivation of hybrids. The first pigeonpea hybrid, ICPH 8, developed by ICRISAT has already been released in Central Zone of India [7]. The information on kind and quantum of genetic variation vis-a-vis knowledge of genetic worth of the parents and hybrids is essential for deciding their prospects in a hybrid breeding programme. The information available on genetic variation with respect to harvest index and other morpho-physiological attributes of pigeonpea hybrids is extremely limited. An attempt has been made in this paper to present results of one such study.

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MATERIALS AND METHODS

Three genetic male sterile lines were crossed with a set of 11 medium duration and 9 short duration pollinators (Table 2) in a line x tester mating design. Among the females, MS Prabhat-DT was early, and MS 3A and MS 4A were medium in maturity. Sixty hybrids and their parents were evaluated in randomized block design replicated thrice in two-row plots for each entry at the Pulses Research Station, Sardar Krushinagar. The row length was 3.0 m with inter- and intra-row spacings of 75 and 25 cm, respectively. Observations were recorded using five competitive plants for five characters (Table 1). The reproductive period was calculated as difference between days to maturity and days to flowering to achieve quantitative grading of various genotypes with respect to longevity of their reproductive phase. The method of Kempthorne [8] was followed to carry out genetic analysis.

RESULTS AND DISCUSSION

The analysis of variance for combining ability revealed significant differences among lines, testers and line x tester interactions for all the characters studied (Table 1). It showed the importance of additive and nonadditive genetic variation in the expression of these traits. However, substantial contribution of nonadditive component could be recognised in the genetic control of different characters except days to flower through ratios of variance due to gca and sca components (Table 1). Thus, it is evident that dominance and epistasis involving dominance genetic variance played a major role in the expression of hybrid vigour in the material studied. The importance of both the components of genetic variance for days to flowering and plant height [9, 10] as well as reproductive period and per day productivity [11, 12] has been reported in pigeonpea.

Table 1. ANOVA (mean squares) for combining ability for five characters in pigeonpea

Source	d.f.	Harvest index	Days to flowering	Plant height	Per day production	Reproductive period
Hybrids	59	62.5**	485.4**	587.9**	0.18**	110.7**
Lines (L)	2	517.1**	7570.8**	5465.7**	0.017**	578.8**
Testers (T)	19	52.6**	606.5**	682.6**	0.021**	44.3**
L x T	38	43.5**	51.9**	283.8**	0.017**	119.3**
Error	118	1.2	1.7	17.0	0.001	3.4
σ^2gca/σ^2sca		0.07	3.7	0.5	0.2	0.2

**Significant at P = 0.01.

The gca estimates (Table 2) showed MS Prabhat-DT to be the best combiner for imparting high harvest index, early flowering and reduced plant height, but poor for the

Table 2. Estimates of general combining ability effects of parents in pigeonpea

Parent	Harvest index	Days to flowering	Plant height	Per day production	Reproductive period
Females:					
MS Prabhat-DT	3.3**	-12.9**	-10.6**	-0.01**	-3.2**
MS 3A	-1.0**	7.5**	7.9**	0.02**	0.2
MS 4A	-2.3**	5.4**	2.7**	-0.01**	3.0**
SE ±	0.1	0.1	0.4	0.002	0.2
Mid-late males:					
T 15-15	2.2**	1.8**	7.1**	0.07**	3.4**
B 12	0.6**	2.9**	7.5**	0.07**	-2.0**
ICPL 6997	-0.9**	3.6**	0.8	0.05**	0.8
ICPL 8504	2.8**	8.9**	10.4**	0.11**	-1.1*
ICPL 7979	2.6**	8.6**	6.6**	0.06**	-1.1*
BDN-2	-1.1**	3.4**	-3.7**	-0.05**	-1.1*
HY 3A	-1.8**	6.7**	3.3**	-0.01	-0.5
AGS 498	-8.4**	5.1**	9.9**	0.01	-1.9**
AGS 521	1.2**	8.0	12.0**	-0.06**	2.8**
AGS 579	-2.5**	3.4**	12.1**	-0.05**	4.4**
ICPL 384	-3.3**	12.1**	-3.5**	-0.01	1.4**
Early males:					
S 5	4.2**	-7.5**	-9.0**	-0.01	-0.3
ICPL 87	2.0**	-9.0**	-11.1**	0.01	-1.3**
ICPL 6	0.4	-6.3**	-11.7**	-0.4**	1.7**
GAUT 82-53	1.5**	2.8**	3.0**	-0.4**	2.8**
GAUT 82-55	-3.9**	-0.2	-2.1	-0.05**	-3.5**
T 21	-1.3**	-5.1**	-7.4**	-0.03**	0.4
DL 78-1	3.5**	-20.0**	-17.4**	0.04**	-0.9
HY 6	0.7**	-1.7**	-0.2	-0.04**	-0.2
UPAS 120	-0.9**	-14.1**	-6.4**	-0.01	-3.9**
± SE	0.3	0.4	1.1	0.01	0.5

*,**Significant at P=0.05 and 0.01, respectively.

remaining two traits. Favourable genes for per day productivity and reproductive period were noticed in MS 3A and MS 4A, respectively. Among the males, nine genotypes had significant positive gca effect for harvest index, the best two being the short duration pollinators S 5 (4.2) and DL 78-1 (3.5). All the early males except GAUT 82-53 possess desirable alleles for early flowering and short stature. Such parents would be of great use in the breeding programmes aimed at developing early, dwarf hybrids. For these two characters, however, all the medium duration males, with two exceptions for plant height, recorded significantly positive gca effects. Six male parents, mostly from the medium maturity group, were recognised to be good general combiners for per day productivity and reproductive period.

Table 3. Mean and specific combining ability effects (sca) for harvest index and desired sca effects for other traits in pigeonpea crosses involving mid-late and early male parents

Cros.	Mean	Sca	Useful traits
Mid-late males:			
MSP (DT) x BDN 2	35.0	2.5**	PH, PDP
MSP (DT) x HY 3A	33.7	1.9**	PDP, RP
MSP (DT) x AGS 579	34.3	3.1**	DF, RP
MSP (DT) x ICPL 384	36.3	5.7**	PDP
MS 3A x ICPL 8504	37.3	5.0**	DF, PH, PDP, RP
MS 3A x ICPL 7979	35.3	3.3**	DF
MS 3A x BDN 2	31.5	3.2**	DF, PDP
MS 3A x AGS 579	29.1	2.2**	DF, PDP, PH
MS 4A x T 15-15	32.4	2.1**	DF, PH, RP
MS 4A x B 12	33.0	4.3**	PDP
MS 4A x ICPL 6997	28.4	1.3**	RP
MS 4A x ICPL 7979	32.9	2.2**	DF, PH, PDP, RP
MS 4A x AGS 498	26.2	1.6**	PDP
MS 4A x AGS 521	29.3	2.5**	DF, PDP
Early males:			
MSP (DT) x GAUT-82-53	37.7	2.6**	DF, PH, RP
MSP (DT) x T 21	37.5	5.3**	DF, PH
MSP (DT) x HY 6	36.7	2.4**	DF, PDP
MS 3A x UPAS 120	29.4	0.9**	DF
MS 4A x DL 78-1	35.1	3.7**	—
MS 4A x UPAS-120	30.8	3.7**	PDP

**Significant at P=0.01.

DF—days to flowering, PH—plant height, PDP—per day production, and RP—reproductive period.

Partitioning of photosynthates in favour of grains leads to high productivity. This is measurable in terms of harvest index. Out of the 60 hybrids studied, 35 and 15 hybrids significantly exceeded both the parents and their female parents, respectively, for harvest index. Therefore, the performance of hybrids was associated with their harvest index. As observed in the present study, physiological studies of pigeonpea hybrids [5] have shown that the high yield of heterotic hybrids was primarily related to their increased biomass production. The use of MS Prabhat-DT resulted into high harvest index hybrids. It was noted that the hybrids with high harvest index also had desirable sca effect for per day production (Table 3). Significantly positive sca effect for harvest index was recognised in 22 hybrids. These hybrids were associated with desirable sca effects for other developmental characters. This was observed in 25, 24, 20 and 20 hybrids, respectively, for days to flowering, plant height, per day production, and reproductive period. It seems that early flowering, reduced plant height associated with longer reproductive phase, and higher plant productivity per day have contributed in favour of high harvest index.

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