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Short Communication

Hybrid vigor in cytoplasmic geneic male sterility system-based hybrids for seed yield and its associated traits in pigeonpea [*Cajanus cajan* (L.) Millsp.]

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Abstract

Six newly converted cytoplasmic male sterile lines were crossed with 12 fertility restorer lines in line x tester mating design. Synthesized hybrids were evaluated with check Gujarat Tur Hybrid 1 at Sardarkrushinagar, Jagudan and Khedbrahma to study the extent of heterosis. Analysis of variance in individual and across the environments revealed significant difference among genotypes and existence of overall heterosis for seed yield/plant. High heterosis was recorded for grain yield/plant, pods/plant and harvest index, while, medium heterosis for plant height, number of branches/plant, 100-seed weight, protein content, biological yield and reproductive period. Days to flowering, days to maturity, number of seeds/pod and pod length recorded low magnitude of heterosis. Five hybrids, namely, CMS GT 087A x GTR 0525 (116.40%) CMS GT 087A x AGTR 0534 (108.93%), CMS GT 0307A x AGTR 0538 (99.21%), CMS GT 0301A x AGTR 0534 (95.51%) and CMS GT 0308A x AGTR 0536 (89.32%) showed standard heterosis for grain yield and its component characters.

Key words : Cytoplasmic male sterile lines, fertility restorers, hybrids, heterosis, pigeonpea, harvest index

A considerable degree of natural out-crossing in pigeonpea is achieved by several species of bees in different areas of the country [1] and has been found sufficient for pod setting on male sterile plants. The identification of genetic male sterility [2] has opened up new vistas for commercial exploitation of hybrid vigour in pigeonpea. The genetic male sterility based hybrid ICPH8 developed at ICRISAT is being successfully cultivated. But due to labour intensiveness and high cost for hybrid seed production, the hybrids could not be popularized among farmers. Later on, efforts were made to develope Cytoplasmic Male Sterile (CMS) lines [3], identification of fertility restorer lines [4], conversion of good agronomical lines in to CMS lines [5] and release of CGMS system based early pigeonpea hybrid, Gujarat Tur Hybrid 1 (GTH1) for general cultivation in Gujarat [6]. In present study, cross combinations were synthesized from available new CMS and pollen fertility restorer lines. These hybrids were evaluated at different locations for grain yield and its associated traits, namely, maturity duration, protein content and harvest index.

The experiment was conducted at three locations *viz.,* Sardarkrushinagar, Jagudan and Khedbrahma during *kharif* 2007-2008. Each location has different type of soils i.e., loamy sand, sandy loam and black respectively. The experimental material comprised three maturity groups i.e., early medium and late. Each group consisted two cytoplasmic male sterile lines (CMSGT87A, CMS GT 311A, CMS GT 301A, CMS GT 307A,CMSGT 306A, CMS GT 308A) and twelve pollinators (AGTR 0532, AGTR 0538, AGTR 0542, AGTR 0543, AGTR 0535, AGTR 0539, AGTR 0540, AGTR 0544, GTR 0524, GTR 0525, AGTR 0534,

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AGTR 536) and standard check, GTH1. The seventy two hybrids were obtained through hand pollination during *kharif* 2006 in line x tester mating design [7]. The experimental material were grown in a randomized block design replicated thrice. Each genotype was represented by a single row plot of 4 m length. The inter and intra row distances were 60 and 20 cms, respectively. Observations were recorded on five randomly selected competitive plants of each genotype in each replication for grain yield and it's component characters. The phenological characters *viz*., days to initiation of flowering, days to flowering and days to maturity were recorded on plot basis. Sample of 100 seeds was taken from bulk harvested from randomly selected five plants for recording the observations. The mean values over replications over environments for different traits were used for the estimation of pooled heterosis over mid-parent, better parent and standard check.

The analysis of variance combined over environments showed that the differences due to genotypes and environments were highly significant for all the characters. The mean squares due to hybrids were highly significant for all the characters. A marked degree of significant heterosis over mid, better and standard parents was observed in many hybrids for various quantitative traits. Out of 72 hybrids, significant relative heterosis, heterobeltiosis and standard heterosis was recorded in desired direction on pooled basis for days to flower (35, 51 and 10), days to maturity (23, 37 and 8), plant height (3, 12 and 45), branches per plant (54, 59 and 52), pods per plant (69, 70 and 29), seeds per pod (60, 43 and 25), pod length (43, 47 and 21), 100-seed weight (54, 60 and 27), seed yield per plant (70, 68 and 25), protein content (28, 17 and 17), biological yield (17, 28 and 64), harvest index (63, 64 and 59), vegetative period (33, 47 and 14) and reproductive period (56, 46 and 56). Significant heterosis in desired direction for individual and across the environments over GTH 1 was observed in several hybrids for days to flowering (2), days to maturity (3), plant height (6), branches per plant (6), pods per plant (24), pod length (2), test weight (7), grain yield/ plant (22), protein content (CMS GT 306A x AGTR 0538), biological yield/plant (48), harvest index (42), vegetative period (CMS GT 311A x GTR 0524) and reproductive period (23). The maximum value of standard heterosis for yield per plant was recorded for hybrid CMS GT 087A x GTR 0525 (116.40%) followed by CMS GT 087A x AGTR 0534 (108.93%), CMS GT 0307A x AGTR 0538 (99.21%), CMS GT 0301A x AGTR 0534 (95.51%) and CMS GT 0308A x AGTR 0536 (89.32%). (Table 1). These results indicated that heterotic hybrids for grain yield did not show high heterosis for all the components but two or three of its contributing traits i.e., number of branches/ plant, number of pods/plants and number of seeds/ pod.

Best performing five hybrids (Table 2) for grain yield and its contributing characters indicated the involvement of early parents namely, CMS GT 0311A and CMS GT 087A. Highest number of branches per

Table 1. Best eight high yielding hybrids with heterosis (%) over better parent and standard check (GTH1) and component traits showing standard heterosis based on pooled analysis in pigeonpea

Hybrids	Mean seed yield/plant (g)	Heterosis (%) over		Significant standard heterosis for component traits in desired direction
		Bp	Sc	
CMS GT 087A x GTR 0525	141.59	213.08**	116.40**	Bp, Pp, Sp
CMS GT 087 A x AGTR 0534	136.70	307.54**	108.93**	Bp, Pp
CMS GT 0307 A x AGTR 0538	130.34	141.74**	99.21**	Bp, Pp, Sp
CMS GT 0301 A x AGTR 0534	127.92	281.38**	95.51**	Bp, Pp, Sp
CMS GT 0308 A x AGTR 0536	123.87	259.63**	89.32**	Bp, Pp, Sp
CMS GT 0306 A x AGTR 0543	121.62	224.22**	85.88**	Bp, Pp, Sp
CMS GT 0301 A x GTR 0525	119.84	164.98**	83.16**	Bp, Pp
CMS GT 087 A x AGTR 0539	118.06	140.62**	80.44**	Bp, Pp, Sp
GTH1	55.76			

*,** significant at 5% and 1% respectively; Bp = Better parent and Sc = Standard check
Bp = Branches per plant; Pp = Pods per plant, Sp = Seeds per pod

Table 2. Best five hybrids for yield and its contributing traits based on pooled basis in pigeonpea

Characters	Best performing hybrids	Characters	Best performing hybrids
Days to flowering	CMS GT 0311A x GTR 0524 CMS GT 0301A x AGTR 0535 CMS GT 0306A x GTR 0524 CMS GT 0301A x AGTR 0539 CMS GT 087A x AGTR 0544	Branches/plant	CMS GT 0301A x GTR 0525 CMS GT 0311A x AGTR 0538 CMS GT 0301A x AGTR 0536 CMS GT 087A x AGTR 0539 CMS GT 087A x GTR 0524
Days to maturity	CMS GT 0311A x GTR 0524 CMS GT 0306A x GTR 0524 CMS GT 0307A x AGTR 0539 CMS GT 0301A x AGTR 0535 CMS GT 087A x AGTR 0544	Pods/plant	CMS GT 087A x AGTR 0534 CMS GT 087A x GTR 0525 CMS GT 0308A x AGTR 0536 CMS GT 0307A x AGTR 0538 CMS GT 0311A x AGTR 0540
Plant height	CMS GT 0301A x AGTR 0543 CMS GT 087A x AGTR 0540 CMS GT 087A x AGTR 0544 CMS GT 0311A x AGTR 0536 CMS GT 087A x AGTR 0532	Seeds/pod	CMS GT 0301A x AGTR 0543 CMS GT 0308A x AGTR 0542 CMS GT 0306A x AGTR 0543 CMS GT 087A x AGTR 0542 CMS GT 087A x AGTR 0532
Seeds/pod	CMS GT 0301A x AGTR 0543 CMS GT 0308A x AGTR 0542 CMS GT 0306A x AGTR 0543 CMS GT 087A x AGTR 0542 CMS GT 087A x AGTR 0532	100-Seed weight	CMS GT 087A x GTR 0524 CMS GT 0301A x AGTR 0540 CMS GT 0306A x AGTR 0532 CMS GT 0301A x AGTR 0543 CMS GT 0307A x AGTR 0540

plant were observed in hybrids CMS GT 0301A x AGTR 0543 and CMS GT 0311A x AGTR 0538; more number of pods per plant was recorded in CMS GT 087A x AGTR 0534 and CMS GT 087A x GTR 0525, while hybrids, CMS GT 087A x AGTR 0524 and CMS GT 0301A x AGTR 0540 produced bold seed. Hybrids, CMS GT 0307A x AGTR 0538 and CMS GT 0301A x AGTR 0534 recorded highest harvest index whereas hybrids CMS GT 0306A x AGTR 0538 and CMS GT 0308A x AGTR 0534 had the highest protein content. Longer reproductive period was observed in hybrids CMS GT 0301A x AGTR 0544 and CMS GT 0308A x AGTR 0542.

The present results are supported by earlier researchers who recorded high heterosis for seed yield per plant For plant height, and number of pods per plant [8-14]. Medium to high heterosis was reported [12], medium heterosis for branches per plant [9], 100-seed weight [9, 11] and reproductive period [8, 12]. The medium to low heterosis for protein content was in conformity with the results obtained by Patel (2004). Low heterosis observed for no. of seeds per pod [16, 17], for days to flowering and days to maturity [8, 17] and for pod length. The utility of hybrid breeding approach lies in the fact that though the overall heterosis for various characters may be of any extent, the identification of most heterotic and useful crosses is important. Out of 72 hybrids evaluated, 8 hybrids were highly promising (Table 1) for seed yield based on the magnitude of heterosis over standard check. All the eight hybrids had positive heterobeltiosis for seed yield per plant. Majority of these hybrids also showed significant heterosis for the component traits like pods per plant, seeds per pod and branches per plant in desired direction. In general, for one to three component traits in 15 hybrids were significant for high heterosis in desired direction. Based on the results presented above, it could be concluded that female parents *viz*., CMS GT 307 A, CMS GT 087A and CMS GT 0308 A along with male parents, AGTR 0534, GTR 0525 and AGTR 0536 had high mean performance for seed yield and its contributing traits. Thus these parents can be used for developing high yielding hybrids. Predominance of non-additive gene action for seed yield per plant and its related traits in the present investigation favors hybrid breeding programme. The evaluation of hybrids suggested that a substantial degree of heterosis over mid parent, better parent and standard check was available in several hybrids. Unlike other pulses, presence of considerable natural out crossing, availability of cytoplasmic male sterile lines with their maintainers and male parent with pollen fertility restorer genes in pigeonpea favours commercial exploitation of heterosis. The present investigation identified five hybrids *viz*., CMS GT 087A x GTR 0525, CMS GT 087A x AGTR 0534, CMS GT 0307A x AGTR 0538, CMS GT 0301A x AGTR 0534 and CMS GT 0308A x AGTR 0536 which gave high mean performance, high heterosis over mid-parent, better parent and standard check for grain yield per plant. These hybrids also exhibited higher mean for component traits like no. of pods per plant, no. of branches per plant and 100-seed weight. Thus these hybrids could be valuable for large scale testing for their general adaptability and subsequently for their commercial exploitation.

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