

EFFECT OF A₂ CYTOPLASM OF *Cajanus scarabaeoides* ON YIELD AND YIELD COMPONENTS IN PIGEONPEA [*Cajanus cajan* (L.) MILLSPAUGH]

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ABSTRACT

Pigeonpea [Cajanus cajan (L.) Millspaugh] is an important food legume crop grown in tropics and sub-tropics. Research efforts for enhancing the productivity of pigeonpea through traditional pure line breeding have not been so successful. The discovery of stable genetic male sterility followed by cytoplasmic male sterility in pigeonpea has spurred the heterosis breeding programme at the national level and a slew of diversified materials have been developed. A₂ cytoplasm has positive impact on seed yield, harvest index and early maturity. The superiority of A₂ cytoplasm was evident in developing better hybrids for harvest index.

KEY WORDS: *Pigeonpea, Cajanus cajan (L.) Millspaugh, cytoplasm*

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millspaugh] is an important food legume crop grown on over four million hectares globally, mainly in tropics and sub-tropics under subsistence agriculture by resource-poor farmers. Research efforts for enhancing the productivity of pigeonpea through traditional pure line breeding have not been so successful and the productivity has remained static at around 700 kg /ha (Saxena *et al.*, 2005) The discovery of stable genetic male sterility (Reddy *et al.*, 1978) followed by cytoplasmic male sterility (Ariyanayagam *et al.*, 1995 and Tikka *et al.* 1997) in pigeonpea has spurred the heterosis breeding programme at the national level and a slew of diversified materials have been developed. Among the different diverse wild species that have been used for development of cytoplasmic genetic male sterility; *Cajanus scarabaeoides* based A₂

cytoplasm has been extensively used in Gujarat. The phenotypic expression is the manifestation of impact of many genetic and non-genetic components among which importance of cytoplasm can not be over emphasized. Since the basic difference between the A and B lines lies in but cytoplasm of wild species *Cajanus scarabaeoides*, it would be worthwhile to ascertain whether the A₂ cytoplasm of *Cajanus scarabaeoides* has any depressing effects on yield and yield components as compared to their fertile counterparts having native cytoplasm.

MATERIALS AND METHODS

The experimental materials for the present investigation comprised 6 lines encompassing 3 diverse CGMS (A) lines having A₂ cytoplasm and their 3 fertile counterpart B lines having native cytoplasm as female and 5 distinct fertility restorers R lines

as testers. Thirty hybrids developed among them in Line x Tester mating design were evaluated along with GTH 1 (hybrid) and GT 101 (stable variety) as checks during *Kharif* 2011 in Randomized Block Design (RBD) with three replications at the Centre of Excellence for Research on Pulses, S.D. Agricultural University, Sardarkrushinagar, Gujarat. Each genotype was grown in a two rows plot having 4 m length spaced 60 cm apart with intra row spacing of 20 cm thereby accommodating 40 plants per plot. The recommended packages of practices were followed. The individual plant observations were recorded on five randomly selected competitive plants for days to flowering, days to maturity, plant height (cm), number of branches per plant, number of pods per plant, pod length (cm), number of seeds per pod, 100 seed weight (g), seed yield (kg/ha), harvest index (%) and total protein content (%). The data were analyzed for the combining ability analysis as per method given by Kempthorne (1957). Heterosis was estimated as per cent increase or decrease in the mean value of F_1 hybrid over mid parents (Relative heterosis), better parents (Heterobeltiosis) and standard check (Standard heterosis) for each character (Fonseca and Patterson, 1968).

RESULTS AND DISCUSSION

The *per se* performance of different hybrids developed on A_2 cytoplasm based CGMS lines (A) and their fertile counterparts (B) is given in Table 1. The data clearly indicated effect of A_2 cytoplasm of *Cajanus scarabaeoides* in A lines on the performance of hybrids. The effect was favourable such that hybrids developed on A_2 cytoplasm based different CGMS lines (A) produced higher seed yield than the hybrids produced on their respective fertile counterpart (B) lines having native cytoplasm. Hybrids derived from CMSGT 301A, CMSGT 308A and CMSGT 311A produced mean seed yield of 1755.10

kg/ha, 1306.15 kg/ha and 1384.79 kg/ha, respectively, as compared to 1336.17 kg/ha, 1122.22 kg/ha and 970.74 kg/ha of hybrids developed on their respective fertile counterparts. The same trend was observed for harvest index. Further, the hybrids derived from A_2 cytoplasm based CGMS lines (A) matured earlier as compared to hybrids from their fertile counterpart (B lines). There was impact on other characters like plant height, number of pod per plant and 100 seed weight too but this impact was not in a predictable direction and varied with genotypes and character. For other yield component traits, no impact was noticed in the mean values. These results palpably indicated that A_2 cytoplasm of *Cajanus scarabaeoides* has no negative impact on seed yield, harvest index and days to maturity. In fact these characters were influenced favourably by A_2 cytoplasm, which harbinger advantage in exploitation of heterosis in pigeonpea.

Number of hybrids that evinced standard heterosis in desirable direction is presented in Table 2. Over all, there were more number of hybrids showing better standard heterosis in A_2 cytoplasm background (A) lines than native cytoplasm background in B lines for number of branches per plant, number of pods per plant, pod length, seed yield and harvest index. In comparison to only 2 hybrids with better standard heterosis in GT 308B, there were 4 and 2 hybrids that exhibited better standard heterosis in CMSGT 301A and CMSGT 308A, respectively, for harvest index. For seed yield the number of hybrids with standard heterosis in desirable direction was 14 in A_2 cytoplasm background (A) lines than 8 in native cytoplasm background in B lines. Contrarily, days to maturity, 100 seed weight and protein content exhibited A_2 cytoplasm to be inferior in yielding number of hybrids with better standard heterosis than native cytoplasm in B lines. For other characters there seemed to

be no impact of A₂ cytoplasm in yielding hybrids with better standard heterosis. Though the superiority of A₂ cytoplasm was evident in developing better hybrids for harvest index, yet there was no clear cut pattern of superiority or inferiority of A₂ cytoplasm in A lines in yielding better *per se* hybrids as compared to native cytoplasm in B lines.

From field application point of view, the hybrids exhibiting significant heterosis in desirable direction are more important. Seed yield is the most desirable trait from economic point of view. There were conspicuous 9 A₂ cytoplasm based hybrids with significant heterosis than just 2 in native cytoplasm background. Similar trends of over all superiority of A₂ cytoplasm were observed for plant height, number of branches per plant and harvest index too. However, the trends were just the reverse for number of pod per plant and protein content. For other traits no hybrid with significant standard heterosis was observed. This observation is very encouraging from development of A lines in *Cajanus scarabaeoides* background as no impact of A₂ cytoplasm was observed in hybrids on yield component traits like pod length, number of seeds per pod and 100 seed weight.

These results are in consonance to the findings of Zhu *et al.* (1998), who while assessing the cytoplasmic effect of cytoplasmic male sterile lines in upland cotton reported that yield and yield components were greatly influenced by both CMS cytoplasm and the interaction between cytoplasm and nuclear genotypes. However, Patel and Pathak (2006), reported no difference between fertile and CMS hybrids with respect to all the characters studied except days to flower, stem girth and nicotine content in bidi tobacco (*Nicotiana tabacum* L.). Kumar and Sagar (2010) have also studied the effect of cytoplasm on productivity and combining

ability for grain yield and its contributing traits in pearl millet and reported both positive and negative cytoplasmic effects for grain yield, grain weight, harvest index and growth rate.

CONCLUSION

Thus, from the present study, it can be seemed that A₂ cytoplasm has positive impact on seed yield, harvest index and early maturity in A₂ cytoplasm based hybrids than that developed on their fertile counterpart (B) lines having native cytoplasm. The impact was evident in other characters too but this impact was not in a predictable direction and varied with genotypes and character. Though the superiority of A₂ cytoplasm was evident in developing better hybrids for harvest index, yet there was no clear cut pattern of superiority or inferiority of A₂ cytoplasm in yielding better *per se* hybrids for other traits as compared to native cytoplasm in B lines.

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Table 1 : *Per se* performance of hybrids developed from A₂ cytoplasm based CGMS lines (A) and their fertile counterparts (B) having native cytoplasm.

Hybrids developed using	Days to flowering	Days to maturity	Plant height (cm)	No. of branches per plant	No. of pods per plant	Pod length (cm)	No. of seeds per pod	100 seed weight (g)	Seed yield (kg/ha)	Harvest index (%)	Protein content (%)
CMSGT 301A	116.93	168.93	142.83	310.29	6.92	4.17	4.48	9.65	1755.10	17.48	20.84
CMSGT 308A	116.87	171.73	164.91	315.35	6.63	4.16	4.40	9.89	1306.15	14.07	20.67
CMSGT 311A	115.93	163.60	163.36	349.39	6.88	3.75	4.77	8.29	1384.79	15.21	20.56
GT 301B	116.67	170.27	153.37	313.96	6.93	4.12	4.20	9.43	1336.17	15.51	20.29
GT 308B	116.67	173.00	169.76	338.11	7.40	4.12	4.48	10.11	1122.22	11.75	20.61
GT 311B	116.40	165.33	158.20	228.40	5.47	4.39	4.93	7.86	970.74	14.47	20.81

Table 2 : Number of hybrids that evinced standard heterosis in desirable direction in A₂ cytoplasm based CGMS lines (A) and their fertile counterparts (B) having native cytoplasm (Value with in parenthesis indicated the number of hybrids showing significant standard heterosis in desirable direction)

Hybrids developed using	Days to flowering	Days to maturity	Plant height (cm)	No. of branches per plant	No. of pods per plant	Pod length (cm)	No. of seeds per pod	100 seed weight (g)	Seed yield (kg/ha)	Harvest index (%)	Protein content (%)
CMSGT 301A	0 (0)	0 (0)	5 (2)	5 (3)	3 (1)	3 (0)	1 (0)	1 (0)	5 (5)	4 (1)	4 (1)
CMSGT 308A	1 (0)	0 (0)	3 (0)	5 (4)	3 (0)	4 (0)	0 (0)	3 (0)	4 (2)	2 (0)	4 (2)
CMSGT 311A	1 (0)	3 (0)	3 (0)	5 (4)	2 (1)	0 (0)	1 (0)	0 (0)	5 (2)	0 (0)	5 (0)
GT 301B	0 (0)	0 (0)	5 (1)	5 (4)	3 (1)	3 (0)	0 (0)	1 (0)	4 (2)	2 (0)	4 (1)
GT 308B	1 (0)	1 (0)	1 (0)	5 (4)	3 (3)	2 (0)	1 (0)	5 (0)	3 (0)	0 (0)	5 (1)
GT 311B	1 (0)	3 (0)	5 (0)	1 (1)	1 (0)	1 (0)	1 (0)	0 (0)	1 (0)	0 (0)	5 (3)
Overall											
CMS (A Lines)	2 (0)	3 (0)	11 (2)	15 (11)	8 (2)	7 (0)	2 (0)	4 (0)	14 (9)	6 (1)	13 (3)
Fertile (B lines)	2 (0)	4 (0)	11 (1)	11 (9)	7 (4)	6 (0)	2 (0)	6 (0)	8 (2)	2 (0)	14 (5)

[MS received: January 03, 2013]

[MS accepted: March 04, 2013]