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Short Communication

Effect of cytoplasmic genetic male sterility on combining ability and genetic control of quantitative characters in upland cotton (*Gossypium hirsutum* L.)

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India is a pioneer in commercial exploitation of heterosis in cotton. Many hybrids have been released for general cultivation in the country. The seed of these hybrids is produced through hand emasculation and pollination. The CMS system developed by Meyer [1] has been used to develop cytoplasmic male sterile lines throughout the world. Most of hybrid breeding programmes involve the identification of promising hybrid combinations and convert them into CMS based hybrids to reduce cost of hybrid seed production. However, information is required about possible effect of male sterile cytoplasm on combing ability and genetic control of quantitative characters. The present investigation, therefore, was undertaken to study the effect of cytoplasm conferring male sterility on combining ability and genetic control of quantitative characters in cotton.

Six cytoplasmic male sterile lines (MS 1A to MS 6 A) and their respective maintained lines (MS 1B to MS 6B) were crossed to 11 restorer (R) lines to produce 132 crosses. The A x R and B x R crosses along with B and R parental lines were grown in a randomized complete block design with three replications. The data were recorded on five competitive plants per entry for yield, component and quality traits. The A x R and B x R sets of crosses were considered for Line x Tester analysis separately. The combining ability analysis was done [2, 3].

The comparison of CMS based hybrids with the hybrids developed by pollination of B lines showed that variances due to females for number of bolls, seed cotton yield and ginning outturn were significant only in B x R hybrids but non-significant in A x R hybrids (Data not shown). However, for boll weight reverse was true i.e. variances due to females were significant only for A x R crosses. In case of seed cotton yield the variance due to males was significant for CMS based hybrids and non-significant in B x R crosses. The comparison of variance due to females x males revealed that it was significant for boll weight in B x R hybrids but for CMS based hybrids it was non-significant. For ginning outturn, variance due to interaction (F x M) was significant only for A x R hybrids. Additive gene action was important for boll weight in CMS based hybrids and in B x R crosses it was important for ginning outturn (data not shown), whereas for all other traits additive and non-additive type of gene actions were important. Thus, it is evident that in case of A x R hybrids the magnitude of additive gene action was much higher for boll weight and micronaire value, whereas, for number of bolls, seed cotton yield and 2.5% span length non-additive gene action was higher than that of B x R crosses.

The effect of male sterile cytoplasm on combining ability for seed cotton yield is evident from the observation that all the male sterile lines (A) recorded non significant *gca* effects (Table 1), however, their four fertile counterparts viz. B lines had significant *gca* effects with MS IB and MS 2B as significant positive and MS 4B and MS 6B as significant negative *gca* effects. Four male parents *viz.* TR 4, TR 14, TR 23 and TR 34 recorded significant positive *gca* effects with the crosses of male sterile lines (A) lines but did not differ for *gca* effects in B x R crosses. Similarly, for number of bolls also none of the female parents of A x R hybrids recorded significant *gca* effects. Among B x R crosses four female parents and five male parents had significant *gca* effects

Table 1. Estimates of general combining ability of parents of A x R (I) and B x R (II) hybrids for different characters

Parents	No. of bolls/		Boll weight (g)		Seed cotton yield (g)/plant		Ginning outturn(%)		2.5 % span length (mm)		Micronaire value		Fibre strength (g/tex)	
Females	I	II	I	II	I	II	I	II	I	II	I	II	I	II
MS 1	0.08	1.49**	0.01	-0.29	-0.85**	3.77*	-0.29	-0.85**	0.33*	0.81**	-0.07	-0.25**	1.16**	0.99**
MS 2	0.51	2.17**	0.06	0.27	-0.07	6.85**	0.27	-0.07	0.23	0.86**	0.14	0.21**	-1.42**	-2.09**
MS 3	-0.41	-1.13*	0.06	0.32	0.76**	-2.38	0.32	0.76**	-0.10	-1.05**	-0.15	-0.20**	-0.10	0.71**
MS 4	-0.53	-1.65**	-0.05	-0.33	-0.73*	-4.32*	-0.33	-0.73*	-0.03	-0.55**	0.05	-0.02	0.52**	0.44*
MS 5	0.67	0.13	0.08	-0.40	0.03	-0.11	-0.40	0.03	0.01	0.61**	-0.11	-0.21**	0.02	0.35*
MS 6	-0.33	-1.01	-0.16**	0.43	0.86**	-3.81*	0.43	0.86**	-0.45*	-0.67**	0.14	0.48**	-0.18	-0.41*
S.E.	0.55	0.57	0.05	0.35	0.33	1.80	0.35	0.33	0.13	0.15	0.08	0.07	0.17	0.18
Males														
TR 4	0.81	-0.48	0.16*	0.04	4.49*	0.74	-1.49**	-0.93*	0.77**	0.94**	0.15	0.27	0.27	0.05
TR 9	-1.50	-1.21	0.23**	0.34**	-1.09	1.28	1.34**	0.76	-0.25	0.25	-0.30**	0.42	0.42	0.78**
TR 10	-1.13	-1.67*	0.07	0.19**	-1.59	-1.63	1.33**	0.12	-0.67**	-0.46*	0.22*	0.05	0.05	-0.83**
TR 12	-4.50**	-1.73*	0.07	-0.10	-11.69**	-6.76**	-1.16*	-0.45	1.53**	1.69**	-0.63**	1.79**	1.79**	2.40**
TR 14	4.75**	0.65	-0.37**	-0.17**	6.85**	-0.92	-3.09**	-0.41	1.17**	-0.35	0.17	0.10	0.10	-0.57*
TR 16	0.22	0.48	-0.14	-0.26**	-1.34	-2.08	2.89**	1.85**	-1.22**	-0.57**	-0.02	-1.71**	-1.71**	-2.96**
TR 19	-0.39	0.56	-0.25**	-0.27**	-3.61	-2.76	3.59**	2.61**	-1.11**	. .0.55**	-0.44**	-1.13**	-1.13**	0.25
TR 23	-0.79	-1.86*	0.53**	0.30**	4.34*	-1.74	-1.65**	-1.70**	-0.22	0.39	0.59**	1.73**	1.73**	1.77**
TR 31	-1.20	1.83*	-0.04	-0.17**	-2.86	2.72	-0.73	-1.67**	-0.96**	-1.14**	0.37**	-2.31**	-2.31**	-1.57**
TR 34	4.18**	0.93	-0.22**	0.13*	7.49**	4.84	-2.39**	-1.38**	1.83**	0.00	-0.30**	2.00**	2.00**	1.64**
TR 101	-0.46	2.51**	-0.03	-0.05	-0.99	6.32*	1.35**	1.21**	-0.87**	-0.20	-0.42**	-1.21**	-1.21**	-0.95**
S.E.	0.78	0.80	0.08	0.06	2.01	2.54	0.50	0.47	0.19	0.21	0.10	0.25	0.25	0.25

* $P \leq 0.05$; **$P \leq 0.01$

with MS 2B as best general combiner female parent (2.17) and TR 101 (2.51) was best combiner male parent. Estimates of general combing ability effects for boll weight showed that only one male sterile line namely MS 6A recorded significant *gca* effect. Three male parents showed significant and positive *gca* effects with TR 23 as best general combiner male parent (0.53). In case of B x R hybrids, females did not differ for *gca* effects for boll weight whereas male parent TR 9 (0.34) was best general combiner for this character.

None of the female parents of male sterility based hybrids exhibited significant *gca* effects for ginning outturn (Table 1), however, their four counterparts having fertile cytoplasm i.e. MS 1B, MS 3B, MS 4B and MS 6B had significant *gca* effects in B x R crosses. The males TR 9, TR 10, TR 12 and TR 14 had significant *gca* effects when crossed with CMS lines whereas had non-significant *gca* effects for crosses with B lines. The comparison of *gca* effects for 2.5% span length showed that only one A line (MS 1A) had significant positive (0.33) *gca* effect. In B x R crosses all the B lines had significant *gca* effects with MS 2B as best general combiner (0.86). TR 34 was best general combiner male in A x R crosses and in B x R crosses TR 12 was best combiner. For fibre fineness none of the female parents (A lines) of CMS based hybrids had significant *gca* effects but their respective maintainer lines (B lines) except MS 4B, exhibited significant *gca* effects. The female parents MS 3A, MS 5A and MS 6A had non significant *gca* effects for fibre strength whereas their respective B line counterparts had significant *gca* effects. Three male parents of A x R crosses *viz.* TR 9, TR 10 and TR 14 recorded non significant general combining ability effects, however, these exhibited significant *gca* effects as male parents of hybrids developed by hand emasculation and pollination of B lines.

The results showed that male sterile cytoplasm affected combining ability and genetic control of parents for different characters in cotton but this effect was not systematic and consistent. For number of bolls, seed cotton yield, ginning outturn and micronaire value the female parents of CMS based hybrids did not differ for general combining ability effects whereas some of their maintainer counterparts exhibited either significant positive or significant negative *gca* effects in B x R crosses. As an instance the female parent MS 2B exhibited significant-positive and MS 4B recorded significant-negative *gca* effects for number of bolls, seed cotton yield and 2.5% span length against non-significant effects produced by MS 2A and MS 4A for these characters. Results of the present study are in confirmatory with previous findings [4].

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