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Short Communication

Genetic analysis for seed oil content and component fatty acids in American cotton (*Gossypium hirsutum* L.)

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India is one of the largest producers of oilseeds in the world and accounts for about 8-9 per cent of the world oilseed production. Cottonseed is the second most commonly produced oilseed in the world [1] and is also a traditional oilseed of India.

Cotton is mainly grown for fibre and cottonseed is a byproduct of cotton cultivation. In India, about 3.6 million tones of cottonseed are produced annually, from which 545,000 tonnes of oil can be extracted if available seeds are processed properly [2]. This would contribute significantly to the total availability of edible oil in the country and substantially reduce its import. The present study was undertaken to obtain information on heterosis, general and specific combining ability effects and gene action on the per cent seed oil content and component fatty acid profile.

Seven genotypes, namely F 776, F 1861, F 1945, F 1985, LH 1900, RS 2098 and Taskant 3 of American cotton were crossed as female parents with three genotypes as testers, *viz*., F 1977, F 1988 and F 1378 in line x tester mating design to obtain 21 F_1s [3]. Three sets of these 21 F_1s and 10 parents were analysed for seed oil content (%) and component fatty acids, mysteric acid (14:1), palmitic acid (16:1), oleic acid (18:1) and linoleic acid (18:2) as per the procedure given below:

Oil content analysis

Oil content in the intact delinted seeds was estimated by a non-destructive Nuclear Magnetic Resonance (NMR) method [4] using the Newport Analyzer (Model MKIIIA). Oil content in the standard sample was estimated by Soxhlet method.

Fatty acid analysis

For fatty acid analysis, oil was extracted by the method of Kartha and Sethi [5]. The fatty acids were estrified with sodium methoxide and analysed using Gas Liquid Chromatography (AIMIL Model 5700 Series) with 6% butandiole succinate column six feet in length x ¼" outer diameter. The column was operated at 200°C with nitrogen flow rate of 60 ml/min and hydrogen flow rate of 40 ml/min. Data were recorded on data processor Chromatopach El A.

The analysis of variance for the randomized block design involving 21 F_1s and 10 parents were carried out as per Panse and Sukhatme [6]. Heterosis over mid, better and standard (F 1861) parents were calculated as per standard procedure. The line x tester analysis was done as per the method suggested by Kempthorne [3].

Estimates of heterosis (Table 1) revealed that out of 21 crosses, 19 cross combinations for oil content, one for oleic acid and 20 for linoleic acid recorded significant positive standard heterosis over the recommended variety, F 1861, whereas 19 cross combinations exhibited significant negative standard heterosis for palmitic acid. The values of heterosis for seed oil content, oleic, linoleic and palmitic acids over the standard check ranged from 1.93 to 11.11%, – 34.63 to 11.69%, 0.30 to 27, 43%, and –18.36 to 14.10% respectively. The highest standard heterosis (11.11%) for seed oil content was recorded by F 1378 x F 776, followed by F 1977 x F 1945 (10.63%), F 1977 x F 1985 (9.66%), F 1378 x F 1985 (9.66%), F 1378 x LH 1900 (8.70%), and F 1378 x Taskant 3 (8.70%).

Table 1. Estimates of heterosis over mid, better and standard (F 1861) parents

Crosses		Oil content	Palmitic acid	Oleic acid	Linoleic acid
F 776 x F 1977	Mid	0.00	9.47*	8.19*	–7.46*
	Better	–3.59*	5.47*	–1.07	–8.31*
	Standard	3.86*	–5.25*	–19.91*	13.98*
F 1861 x F 1977	Mid	9.58*	–4.22*	–9.47*	2.98*
	Better	7.73	–4.74*	–23.56*	–3.77*
	Standard	7.73	–14.43*	–25.54*	19.63*
F 1945 x F 1977	Mid	13.09*	–7.21*	17.59*	1.30
	Better	10.63*	–8.39*	–0.88	–7.12*
	Standard	10.63*	–17.70*	–3.03	15.46*
F 1985 x F 1977	Mid	9.13*	1.95*	12.50*	–5.36*
	Better	8.61*	–4.74*	–2.82*	–7.12*
	Standard	9.66*	–14.43	–10.39*	15.46*
LH 1900 x F 1977	Mid	2.90*	–10.19*	–11.92*	11.37*
	Better	2.90*	–14.75*	–26.41*	0.48
	Standard	2.90*	–14.75*	–26.41*	24.91*
RS 2098 x F 1977	Mid	6.19*	–7.58*	–8.86*	7.95*
	Better	4.69*	–8.76*	–25.00*	0.66
	Standard	7.73*	–18.03*	–22.08*	25.13*
Taskant 3 x F 1977	Mid	1.93*	–8.93*	–7.99*	8.55*
	Better	1.93	–9.09	–26.36*	–1.61*
	Standard	1.93	–18.03*	–17.75*	22.30*
F776 x F 1988	Mid	3.76*	–1.95*	–16.50*	7.13*
	Better	–0.90	–2.71*	–21.60*	4.45*
	Standard	6.76*	–17.70*	–27.71*	27.43*
F 1861 x F 1988	Mid	7.69*	–5.10*	–1.83*	3.85*
	Better	6.90*	–7.38*	–4.44*	0.32
	Standard	4.83*	–17.70*	–6.93*	16.28*
F1945 x F1988	Mid	10.22*	–4.76*	1.14	5.86*
	Better	8.87*	–6.37*	–1.77	0.26
	Standard	6.76*	–18.03*	–3.90*	16.21*
F 1985 x F 1988	Mid	3.40*	4.03	2.35*	–3.25*
	Better	1.91	0.00	2.35*	–4.78*
	Standard	2.90*	–15.41	–5.63*	13.98*
LH 1900 x F 1988	Mid	2.93*	–10.48*	–27.48*	16.74*
	Better	1.93	–17.38*	–30.30*	8.72*
	Standard	1.93	–17.38*	–30.30*	26.02*
RS 2098 x F 1988	Mid	3.37*	–0.19	–5.96*	1.90*
	Better	0.94	–1.87	–11.25*	–1.80*
	Standard	3.86*	–14.10*	–7.79*	13.83*
Taskant 3 x F 1988	Mid	8.78*	3.19*	9.55*	–7.54*
	Better	7.73*	0.00	0.00	–13.47*
	Standard	7.73*	–9.84*	11.69*	0.30
F 776 x F 1378	Mid	7.48*	–4.60*	0.73	1.92*
	Better	3.14*	–7.09*	–7.96*	–3.17*
	Standard	11.11*	–18.36*	–9.96*	18.14*
F 1861 x F 1378	Mid	8.15*	–3.15*	–12.64*	6.76*
	Better	6.83*	–3.69*	–12.83*	5.89*
	Standard	5.80*	–14.43*	–14.72*	16.28*

F 1945 xF 1378	Mid	5.71*	–5.05*	–7.08*	9.02*
	Better	3.90*	5.22	–7.08*	5.96*
	Standard	2.90*	–16.72*	–9.09*	16.36*
F 1985 x F 1378	Mid	9.66*	6.32*	–30.75*	10.20*
	Better	8.61*	0.37	–32.74*	5.65*
	Standard	9.66*	–11.80*	–34.20*	26.47*
LH 1900 x F 1378	Mid	9.22*	1.57	–28.67*	13.47*
	Better	8.70*	–4.59*	–29.44*	8.40*
	Standard	8.70*	–4.59*	–29.44*	19.03*
RS 2098 x F 1378	Mid	6.70*	–2.06*	–28.76*	12.90*
	Better	4.69*	–2.24*	–30.83*	11.71*
	Standard	7.73*	14.10*	–28.14*	22.68*
Taskant 3 x F 1378	Mid	9.22*	–2.03*	–37.60*	20.80*
	Better	8.70*	–3.27*	–41.47*	15.98*
	Standard	8.70*	12.79*	–34.63*	27.36*
CD at 5%	Mid parent	0.35	0.45	0.39	0.70
	Selected parent	0.40	0.52	0.45	0.81

Table 2. Analysis of variance for line x tester

Source	df	Mean sum of squares			
		Oil content	Palmitic acid	Oleic acid	Linoleic acid
Replications	2	1.100	0.130	0.120	0.642*
Crosses	20	1.103*	0.437*	24.331*	24.891*
Lines	2	1.801	3.027	46.633	23.701
Testers	6	0.360	2.468	23.770	11.721
Lines x testers	12	1.358*	5.549*	20.895*	31.673*
Error	40	0.054	0.102	0.080	0.134
Estimates of $\sigma^2_{sca} = \sigma^2_D$		0.433	1.847	6.940	10.476

Only one cross combination, F 1988 x Taskant 3 exhibited significant positive standard heterosis (11.69%) for oleic acid. Similarly, cross combination F 776 x F 1988 recorded highest significant heterosis (27.43%) for linoleic acid followed by F 1378 x Taskant 3 (27.36%), F 1378 x F 1985 (26.47%), F 1988 x LH 1900 (26.02%) and F 1977 x RS 2098 (25.13%). For palmitic acid, the highest significant negative heterosis (–18.36%) was exhibited by F 1378 x F 776 followed by F 1977 x RS 2098 (–18.03%), F 1977 x Taskant 3 (–18.03 %), F 1988 x F 1945 (-18.03%), and F 1988 x LH 1900 (–17.38%).

Mean squares due to lines and testers was non-significant for all the four traits, whereas mean squares due to lines x testers was significant for all the four traits (Table 2). Hence, the general combining ability (*gca*) effects of the parents were not computed. However, parental line F 1988 appeared to have the tendency to contribute positive alleles for enhancing seed oil characteristics since it was one of the parents in five of the eight promising crosses identified in the present study. These hybrids possessed desirable specific combining ability (*sca*) effects for all or most of the seed oil traits studied.

The estimates of *sca* effects (Table 4) revealed that cross combinations namely F 1977 x F 1861, F 1977 x F 1945, F 1977 x F 1985, F 1988 x F 1945, F 1988 x Taskant 3 and F 1378 x F 776 exhibited positive *sca* effects for oil content. For palmitic acid, the cross combinations F 1977 x LH 1900, F 1977 x RS 2098, F 1977 x Taskant 3, F 1988 x F 776, F 1988 x LH 1900, and F 1378 x F 776 exhibited significant negative sea effects. Eleven cross combinations *viz.*, F 1977 x F 1945, F 1977 x F 1985, F 1977 x LH 1900, F 1988 x F 1861, F 1988 x F 1985, F 1988 x RS 2098, F 1988 x Taskant 3, F 1378 x F 776, F 1378 x F 1861, F 1378 x F 1945

Table 3. Estimates of specific combining ability effects for the traits exhibiting significant ms due to lines x testers

Crosses	Oil content	Palmitic acid	Oleic acid	Linoleic acid
F 776 x F 1977	–0.695*	2.633*	0.048	–2.919*
F 1861 x F1977	0.338*	0.367	–2.052*	0.714*
F 1945 x F 1977	0.805*	–0.033	0.748*	–0.530
F 1985 x F 1977	0.471*	–0.133	1.681*	–1.708*
LH 1900 x F 1977	–0.329*	–0.733*	0.748*	0.425
RS 2098 x F 1977	0.271	–0.767*	–0.419*	1.770*
Taskant 3 x F 1977	–0.862*	–1.333*	–0.752*	2.248*
F 776 x F 1988	0.190	–0.838*	–3.552*	4.576*
F 1861 x F1988	0.024	–0.305	0.448*	0.676*
F 1945 x F 1988	0.290*	0.195	–1.252*	1.265*
F 1985 x F 1988	–0.643*	–0.105	0.981*	–0.913*
LH 1900 x F 1988	–0.243	–1.205*	–1.952*	2.387*
RS 2098 x F 1988	–0.243	0.762*	1.081*	–1.835*
Taskant 3 x F 1988	0.624*	1.495*	4.248*	–6.157*
F 776 x F 1378	0.505*	–1.795*	3.505*	–1.657*
F 1861 x F1378	–0.362*	–0.062	1.605*	–1.390*
F 1945 x F 1378	–1.0095*	–0.162	0.505*	–0.735*
F 1985 x F 1378	0.171	0.238	–2.662*	2.621*
LH 1900 x F 1378	0.571	1.938*	1.205*	–2.813*
RS 2098 x F 1378	–0.029	0.005	–0.662*	0.065
Taskant 3 x F 1378	0.238	–0.162	–3.495*	3.910*

and F 1378 x LH 1900 exhibited significant positive *sca* effects for oleic acid. For linoleic acid, nine cross combinations namely F 1977 x F 1861, F 1977 x RS 2098, F 1977 x Taskant 3, F 1988 x F 776, F 1988 x F 1861, F 1988 x F 1985, F 1988 x LH 1900, F 1378 x F 1985and F 1378 x Taskant 3 recorded significant positive while an equal number of crosses depicted significant negative *sca* effects.

The *gca* variance for all the four traits was non-significant which suggested the absence of additive gene action for these traits. Non additive gene action was operative in the control of all the traits studied (Table 2). Nagarajan [7] has also reported the preponderance of non-additive gene action for seed oil content in *G. hirsutum.*

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