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Genetic Studies on Oil Content in Upland Cotton

(*Gossypium hirsutum* L.)

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ABSTRACT

2 x n analysis was carried out by using 2 females and 14 male parents of cotton (*Gossypium hirsutum*, L.) alongwith their 28 hybrids and were evaluated for oil content. Non-additive type of gene action was prevailing. Among the parents JR 11 and 13433 were good general combiners. Four crosses viz., G.cot 100 x EL 505, G.cot 10 x 5920, G.cot 10 x A 51-9 and G.cot 100 x 13433 were the most promising based on the high mean performance, specific combining ability effects, heterosis and heterobeltiosis.

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INTRODUCTION

For cotton to compete better with other high yielding crops, it is necessary that by-products of the cotton crop i.e. cotton seed should also be fully utilised. Cotton seed oil is useful, rich and important product. It is being used for edible purposes, manufacture of soaps, paints, lubricants and varnishes. Since very little work has been reported so far on the genetics of oil content in cotton, an attempt was made to work out the heterosis, combining ability and gene action for oil content using 2 x n crosses of cotton.

MATERIALS AND METHODS

The research material comprised of two lines used as females, 14 lines used as males and their 28 crosses. These 44 entries were sown in a randomised block design with two replications and a spacing of 120 cm x 60 cm. Each entry was sown in 3 rows of 15 plants each. Seed samples were taken from five randomly selected perfectly spaced plants from the middle row leaving border plants in each entry and were bulked. For oil anlysis two samples from the bulked lot were drawn from each entry for determination of oil content and were analysed by cold percolation method described by Motiramani and Wankhede (1964).

Combining ability analysis was carried out according to the model suggested by Kempthorne (1957). Expression of relative heterosis and heterobeltiosis (in percentage) was measured as the deviation of hybrid from its mid-parent and better parent respectively.

RESULTS AND DISCUSSION

Significant differences were observed among the entries for the oil content

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(Table-1). Further the variability was also tested between and within homogeneous groups. The differences among the parents selected for the study and their hybrids were significant. Significant mean square due to hybrids *vs* parents indicated presence of heterosis for this character. There was considerable variability among the males.

TABLE 1

Analysis of variance for the randomised block design.

Source	*df*	*Mean square*
Replications	1	0.330
Treatments	43	2.458**
Hybrids	27	2.109*
Parents	15	2.721*
Hybrids *vs* Parents	1	7.940*
Females	1	0.010
Males	13	2.949**
Females *vs* Males	1	2.470
Error	43	1.113

*p=0.05, **p=0.01

The observed range of heterosis over mid-parent (Table-2) for this character was -11.03 (G. cot 10 x AG 106) to 8.71 (G. cot 10 x A 51-9) per cent. Several hybrids exhibited conspicuous heterotic effect over mid-parental values for oil content. The F_1's manifesting desirable positive heterosis were G. cot 10 x A 51-9, G. cot 100 x EL 505, G. cot 10 x 5920, G. cot 100 x 13433, G. cot 10 x 13426, G. cot 100 x 5980 and G. cot 10 x JR 11. Mean heterosis was 1.38. The measure of heterosis over mid-parent value has limited commercial value. Therefore, from practical application point of view, the heterosis may better be measured in terms of superiority of F_1 over better parent (heterobeltiosis). Heterobeltiosis estimate ranged from -11.60 (G. cot 10 x AG 106) to 6.59% (G.cot 100 x 13433) (Table 2). Mean heterobeltiosis was negative (-1.04). There were five crosses which yielded significant heterobeltiosis out of which only two hybrids were significant and positive (G. cot 100 x 13433 and G. cot 100 x EL 505). These two hybrids also had significant positive heterosis (Table 2).

The pollinator parents involved in these crosses (G. cot 100 x 13433 and G. cot 100 x EL 505) namely 13433 and EL 505 were from the diverse origin, which might have influenced the expression of heterosis. Joshi *et al.* (1960) observed heterosis in crosses involving parents from different geographic diversity which was related to the genetic diversity. Dabir (1964) reported that the (134 Co2 Meade x S.I.) F_1 was rich in oil content of intra and interspecific crosses. Singh *et al.* (1964) observed increase in oil content in 11 out of 35 interspecific crosses over mid-parental value.

For employing an efficient breeding approaches, it is desirable to have the knowledge about the nature and magnitude of gene action. The mean squares due to males and females x males were significant when tested against error variance (Table 3). Whereas the mean square due to males and females was non-significant when tested against females x males interaction. The specific combining ability variance was only prevailing for this character as was revealed from highly significant females x males interaction. Further the general combining ability variance components (Table-3) of males (σ^2_m) and females (σ^2_f) were non-significant (0.006 and-0.076 respectively). The only specific combining ability variance component (σ^2_{sca}) was 0.863 and signifi-

TABLE 2

Mean performance, Heterosis (%) over mid parent (MP), Heterobeltiosis (%) over better parent (BP), *gca* and *sca* effects.

Male	Mean	*gca* effect	Female G. cot 10				Female G. cot 100			
			Mean	Heterosis	Hetero beltiosis	*sca* effect	Mean	Heterosis	Hetero beltiosis	*sca* effect
1 5579	20.50	–0.830*	21.84	0.22	–5.72	–0.383	22.56	3.29	–2.71	0.383
2 5920	21.82	0.153	24.05	7.12**	4.15	0.845	22.31	0.84	–3.79	–0.845
3 5929	21.76	0.283	23.33	4.05	1.03	–0.005	23.29	3.64	–0.43	0.005
4 5980	22.28	0.660	23.34	2.91	1.08	–0.372	24.04	5.76*	3.66	0.372
5 8235	23.21	–0.080	23.98	3.58	3.85	1.003*	21.92	–5.51*	–5.55	–1.003*
6 13426	21.98	0.413	23.91	6.12*	3.55	0.440	22.98	1.77	–0.90	–0.440
7 13433	23.02	0.955**	23.25	0.86	0.69	–0.762	24.72	7.01**	6.59*	0.762
8 A 51-9	21.22	0.260	24.08	8.71**	4.28	0.763	22.50	1.35	–2.97	–0.763
9 AG 106	23.22	–1.215**	20.56	–11.03**	–11.60**	–1.277*	23.09	0.60	–0.73	1.277*
10 EL 505	22.27	0.500	22.51	– 0.92	– 2.60	–1.088*	24.59	8.18**	6.03*	1.088*
11 JR 11	23.90	0.993**	24.69	5.10*	3.30	0.640	23.36	–0.84	–2.25	–0.640
12 LSS	24.08	–0.097	23.38	– 0.84	– 2.90	0.420	22.49	–4.82	–6.60*	–0.420
13 Mix acala	23.00	–1.230**	21.36	– 7.29*	– 7.49*	–0.462	22.24	–3.82	–4.09	0.462
14 SGL 5284	19.92	–0.760*	22.54	4.83	– 2.71	0.243	22.00	2.08	–5.13	–0.243
						Mean		1.38	–1.04	
SE ($\bar{d}$)		0.466				SE($\bar{d}$)		0.570	0.659	0.659

*P = 0.05, ** P = 0.01.

Mean of G.cot 10 and G.cot 100 is 23.09 and 23.19 respectively.

gca effects of G.cot 10 and G.cot 100 are 0.025 and –0.025 respectively.

cant. This indicated importance of non-additive genetic variance for oil content in cotton.

TABLE 3

Analysis of variance for combining ability in line x tester crosses.

Source	*df*	*Mean square*
Combining ability analysis		
Hybrids	27	2.092**
Females	1	0.026
Males	13	2.183**
Females x males	13	2.160**
Error	27	0.434
Variance components		
Females		–0.076
Males		0.006
Females x males		0.863
σ^2gca		–0.066
σ^2sca		0.863

** p=0.01.

To identify superior genotype which could be utilised as parents in future breeding programme, the combining ability effects are useful. The general combining ability (*gca*) effects were significant in six pollinators (Table-2), out of which male JR-11 (0.993) and 13433 (0.955) had only positive significant *gca* effects. This revealed the significant contribution of these parents for increasing oil content. High *gca* effects are related to additive genetic effects or additive × additive effects (Griffing 1956 a; b; Sprague, 1966). Thus these lines may be useful in future cotton improvement programmes. For exploitation of prospective hybrids, the estimates of specific combining ability (*sca*) effects indicated that three hybrids (G. cot 100 × AG 106, G. cot 100 × EL 505 and G. cot 10 × 8235) manifested significant positive *sca* effects (Table 2). It was interesting to study the *sca* effects of these crosses in relation to the *gca* effects of the parents involved. The parents were either average × everage or average × poor combiners. None of the good general combiner yielded desirable significant *sca* effects. Such type of genetic combination can be attributed to complementary type of epistasis which is non-fixable and hence no chance of success in isolating high yielding segragants by adopting simple selection procedures. On considering high *per se* performance, *sca* effects, heterosis and heterobeltiosis, several cross combinations have given encouraging performance especially crosses G. cot 100 × ES 505, G.cot 10 × 5920, G.cot 10 × A 51-9 and G.cot 100 × 13433.

An over all appraisal, non-additive (*sca*) genetic variance played an important role for oil content. In fact, the nature and megnitude of gene action varies with the material, analytical procedure used and the environment under which the study is carried out. However, a trend showed to be emerging, that when non-additive variance is present some variation of reciprocal recurrent selection scheme (Comstock *et al.*, 1949) and recurrent selection for specific combining ability (Hall, 1945) are equal to each other, which utilises additive, dominance, over dominance and epistatic gene action and is designed to improve the population and would be most effective breeding method.

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