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HETEROSIS AND COMBINING ABILITY FOR OIL CONTENT AND OTHER ECONOMIC TRAITS IN COTTON (*GOSSYPIUM HIRSUTUM* L.)

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ABSTRACT

Pattern of inheritance and nature of heterosis were examined for oil content and seven other economic traits. Small positive heterosis was noticed for oil content over midparent value. Relatively higher heterotic effects were noticed for oil index. Both gca and sca effects were highly significant for oil index. Additive (D) and nonadditive (H1 and H2) gene effects were highly significant for oil percentage and oil index. Dominance component (H1), however, was higher than the additive (D) component. The gca effects were more important for fibre span length, bundle strength, and lint per seed. The sca effects were important for fibre fineness, micronaire, and uniformity ratio. Associations of oil content and oil index with lint yield and the fibre quality attributes were not found to be significant. Moderate heritability (25.53%) was observed for oil content.

Key words: *Gossypium hirsutum*, oil content, combining ability, fibre quality.

Despite an early awareness of the food and industrial uses of the byproducts of cottonseed, systematic investigations on inheritance of the quality components such as oil and protein were initiated rather recently [1–4]. Kohel [1] inferred that the high oil trait in cotton is heritable. Barring isolated instances, little is known about the nature of heterosis, combining ability, and gene effects for oil content in *G. hirsutum*. Meredith [5] pointed out that in most genetic studies of cotton, not all basic assumptions are met, or the number and quality of genotypes and environments are deficient. However, these studies are essential in knowing genetic trends, which would allow the development of more efficient selection methods and genetic populations. The present investigation aims to obtain such information with reference to oil content and some fibre quality and lint productivity traits.

MATERIALS AND METHODS

From the elite working collection at C.I.C.R., Nagpur, four lines were chosen on the basis of comparable maturity duration. L-147, an elite cultivar, and T3-11, an elite selection, were used as low-oil parents, and IC-794, an exotic line, and Khandwa-2, another elite cultivar, were used as high-oil parents. In the crop season of 1984-85, these four lines and the standard cultivar SRT-1 were grown in randomised blocks as one-row plots of 5 plants (0.60 × 0.45 m). The four parents were crossed in all possible combinations. In the next season, parents and crosses were grown in a similar fashion. Within each replication, 10 selfed bolls from each cross and from each parent were hand harvested at maturity. Bolls were ginned individually on a hand operated gin. Weight of lint per boll was recorded in mg. Seeds were delinted with commercial grade sulphuric acid, and dried. Oil content was estimated on a wide-line low-resolution Newport NMR Analyser. Each boll was analysed individually with a 2 ml sample probe. Seed index was expressed as weight per seed in mg. Oil index (weight of oil in mg) was derived from seed index × oil percentage/100. Composite lint samples from each replication were used for the estimation of the fibre quality traits. Fibre span length and uniformity ratio were determined on a Digital Fibrograph machine. Fibre fineness (μg per inch) was estimated with the help of a micronaire instrument. Fibre bundle strength (g/tex) was evaluated with a zero-guage Stelometer Heterosis (%) was worked out over midparent (MP) values. Standard heterosis (EH) over the cv. SRT-1 was also calculated. Analysis of combining ability was based on Griffing's Method I, Model 1 [6]. Estimation of genetic components was done according to Hayman's [7] approach.

RESULTS AND DISCUSSION

Heterosis for oil percentage, oil index, and for lint per seed has been given in Table 1. In Table 2, mean squares from the analysis of combining ability are presented along with components of genetic variance and genetic ratios.

Table 1. Character means and heterosis for oil content, seed index, oil index, and lint per seed in 12 crosses

Parent or cross	Oil content %	heterosis MP	heterosis EH	Seed index mg	heterosis MP	heterosis EH	Oil index mg	heterosis MP	heterosis EH	Lint/seed mg	heterosis MP	heterosis EH
T3-11	20.9			67.8			14.2			47.2		
IC-794	23.4			113.4			26.5			74.7		
L-147	21.0			73.5			15.5			41.8		
Khandwa-2	22.0			71.5			16.0			39.8		
T3 × 794	22.7	2.48	2.65	79.7	−12.08	1.85	18.1	−11.04	−5.06	55.8	−8.45	0.81
794 × T3	22.3	0.81	1.19	85.0	−6.18	8.69	19.0	−6.77	11.0	54.6	−10.32	−1.26
T3 × L147	22.1	5.64	0.13	74.2	5.07	−5.02	16.4	10.77	−4.95	47.7	7.30	−13.76
L147 × T3	22.6	8.03	2.40	74.5	5.41	−4.77	16.9	14.27	0.62	49.6	11.48	−10.40
T3 × K2	22.6	5.29	2.25	87.8	26.05**	12.22*	19.8	31.63**	15.1*	46.1	6.60	−16.71
K2 × T3	22.6	5.29	2.75	86.5	24.28**	10.65*	19.7	30.90**	14.3*	44.5	3.05	−19.59
794 × L147	23.4	5.41	6.03	89.5	−4.24	14.46*	21.4	1.88	15.6**	50.6	−13.11	−16.93
L147 × 794	22.9	3.01	3.61	94.5	1.04	20.76**	21.6	2.73	25.1**	48.9	−16.00	−18.23
794 × K2	21.7	−4.60	−1.83	91.6	−0.89	17.16**	19.9	−6.76	15.0*	50.4	−11.85	−0.92
K2 × 794	22.4	−1.39	2.82	89.9	−2.74	14.97*	20.0	−6.20	15.7*	48.7	−14.92	−11.97
L147 × K2	22.5	4.58	1.64	71.9	−0.77	−8.02	16.1	2.64	−2.43	47.6	10.57	−14.06
K2 × L14	22.3	3.93	1.19	69.0	−4.81	−11.76	15.4	−2.00	−10.6	37.8	−7.30	−31.65

*, **Significant at 5% and 1% levels, respectively.

MP—heterosis over midparent, EH—economic heterosis over cv. SRT-1.

Heterotic effects for seed oil content were small and mostly positive. Small negative heterosis was observed for lint weight per seed. In five crosses, however, increased levels of oil and lint were realised. For an effective evaluation of the seed oil potential, the ancillary parameter seed-oil index has been recommended in cotton [8]. Relatively larger heterosis was realised in terms of seed-oil index, which ranged between 0.06 and 31.63% over midparent (Table 1). When compared with the standard cultivar SRT-1, somewhat higher oil index and little or no loss in lint weight was shown by two hybrids, viz. IC 794 × T3−11 and IC 794 × Khandwa-2. Oil percentage and index were not significantly correlated with lint yield or any of the fibre quality attributes. The range of heterosis observed for the fibre quality attributes was rather narrow. Heterosis in *G. hirsutum* for fibre quality attributes is known to be of limited magnitude [5]. In an earlier study, Dani [9] reported moderate heterosis in some intervarietal crosses of *G. hirsutum*, along with small positive heterosis for the oil characteristics.

Table 2. Mean squares from the ANOVA for combining ability along with components of genetic variance and genetic ratios in the crosses

Source	d.f.	Oil content	Seed index	Oil index	Lint yield
gca	3	0.74	527.09**	36.42**	270.07**
sca	6	0.77	93.60**	8.08**	29.13**
Reciprocal	6	0.10	5.72	0.14	9.00
Error	30	0.37	10.34	1.16	7.12
D		1.13**	4.47**	36.46**	254.60**
H1		4.23**	7.85	67.02**	66.57**
H2		3.15**	6.64	53.31**	44.59**
E		0.38**	0.10	1.16	7.077**
F		2.44**	4.36**	43.66**	145.90**
h^2		0.48**	0.77	−0.23	7.58
$(H1/D)^{1/2}$		1.93	1.32	1.36	0.51
H2/4H1		0.19	0.21	0.19	0.17
h/H2		0.15	0.16	0.04	0.17
r yr (Wr + Vr)		−0.71	0.92	0.86	0.98

*, **Significant at 5% and 1% levels, respectively.

Both gca and sca effects were highly significant in the case of oil index (Table 2). Parent IC 794 gave highest gca effects for oil index and lint per seed. T3-11 was the best general combiner for the fibre quality attributes. The gca variances were relatively larger for seed index, lint per seed, fibre length, and fibre bundle strength. Additive (D) and nonadditive effects (H1 and H2) were highly significant for oil content and oil index. Dominance component (H1), nevertheless, was higher than additive (D). The $(H1/D)^{-1/2}$ ratio indicated the presence of overdominance. These results are consistent with the partial diallel cross analysis by Dani [9], in which dominance effects were found to be more important for the oil characteristics. In a similar study involving four-parent diallel analysis, Young and Murray [10] reported significant gca and sca effects for fibre strength and yield. Most studies in cotton have indicated that for lint yield, and fibre length and strength, additive effects are preponderent, while for fineness, dominance effects are generally more important [5].

Singh et al. [4] concluded that the oil content in cotton is primarily under the control of nonadditive gene effects. A problem in the genetic analysis of seed quality components is that a seed consists of tissues from two generations. The phenotype of a F_2 embryo can be affected by the genotype of its seed coat and its relative size [12]. The present data show little or no maternal influence on the seeds from F_1 plants. Bourland and Bird [12] indicated that the F_1 generation of seed-related traits may be represented by seed having parental seed coats and F_1 embryos, or by seed having F_1 seed coats and F_2 embryos. Heritability in narrow sense for oil percentage and oil index was estimated as 25.53% and 56.38%, respectively, which would be lesser than that estimated from F2/F3 regression analysis by Kohel [1]. Intraseasonal variation in seed quality can result in cultivar × fruiting time interactions, thus, imposing limitations on some genetic models [11].

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