compraed to casava + groundnut comrade cropping. The advantage of raising cassava + groundnut comrade cropping was clearly brought out with application of coir waste at 10 t.ha^{-1}.

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COMBINING ABILITY STUDIES ON OIL CONTENT IN RELATION TO FUZZ GRADES IN COTTON

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ABSTRACT

The seeds of *Gossypium* are usually fuzzy of different grades. The combining ability on oil content in relation to fuzz grades is reported in this paper. Seven cotton lines differing in fuzz grade from fully fuzz to naked seeds were crossed with the fuzzy varieties: MCU.5, MUC.7, MCU.9 and LRA. 5166 in a 'line x tester' fashion. Seed oil percentage exhibited greater range of variation among hybrids (16.55 to 23.58). The naked seed parent, TCH.89/7 recorded the highest significant oil percentage (23.66) and hybrids involving naked seed parent also recorded significantly higher oil percentage. Heritability (broad sense) was as high as 94.6 per cent though, the genetic advance as percentage of mean was low (8.49%). The GCA/SCA ratio was also less than unity indicating the preponderance of non-additive gene action for oil content. Significant relationship between the *per se* performance and *gca* effects of the parents for oil content was noticed with sparsely fuzzed line TCH.65/8 and naked seed line TCH.89/7. But the cross combinations with high *sca* effects with respect to oil content involved poor conbiners. Correlation studies revealed that seed oil content had a significant and negative correlation co-efficient (-0.34) with fuzz grade and had significant and positive correlation co-efficient (0.34) with single seed kernel weight.

KEY WORDS : Cotton, *Gossypium hitsutum*, seed, oil content combining ability

Though cotton seed yields oil with high protein and oil cake is a good feed for animals, only in 1970s, effrots were made to incorporate desirable genes for high oil in cotton. Williams (1906) succeeded in increasing oil content in the seeds of upland cotton in North Carolina by 4 per cent. Rast (1917) noted the existence of significant differences for seed oil in different cotton cultivars and that they were transmitted from generation to generation. Christidis and Harrison (1955) reported that varieties having naked seeds are superior in oil content. India produces as much as 2.6 million tonnes of cotton seed each year. An increase in the seed oil of Indian cultivars would help to meet the annual shortage of nearly a million tonnes of edible oil, which would cost Rs. 8000 million (Dani, 1984). The present study was undertaken to obtain information on general and specific combining ability effects, heritability and genetic advance as percentage of mean for oil content and the nature of association between key characters so that an appropriate breeding methodology for the development of improved lines with respect to oil content could be developed.

MATERIALS AND METHODS

Seven true breeding lines comprising of full fuzzed to naked seeds were utilized for this study. They are : TCH 63/1, TCH 63/4, TCH 104/1 and TCH 70/7 - full fuzzed lines TCH 65/8 and TCH 96/6 - sparsely fuzzed lines, TCH 89/7 - naked line. These were used as males and crossed with fuzzy varieties such as MCU 5, MCU 7, MCU 9 and LRA 5166 as females. Crossing was taken up in a 'line x tester' mating design, during kharif 1992. The seeds of 28 hybrids and the parents were utilised for this study. Representative samples of seed from five individual plants in each of the parents and hybrids for three replications were drawn and the seed oil was analysed by non-destructive NMR technique with a Minispect P.28 at the NMR Unit GKVK, Bangalore. Delinted samples were dried at 28° C for 24 h. It is known that the quantities of gossypol and moisture present after such drying are negligible and the NMR reading measures the oil potential of the seed which is a better estimate (Kohel 1978). The oil content is expressed as percentage (Smithson and Gridley, 1977). Data gathered were subjected to an analysis of variance appropriate for line x tester' (Kempthorne, 1969).

RESULTS AND DISCUSSION

The analysis of variance (Table 1) revealed highly significant differences among hybrids, lines, testers and line x tester for oil content. It was observed that the variance due to specific combining ability effects (σ^2sca) was proportionately high when compared to the variance due to general combining ability effects (σ^2gca) indicating the preponderance of non-allelic interaction of genes in the expression of oil content. Significant relationship between the *per se* performance and gca effects of the parents for oil content was noticed with sparsely fuzzed line TCH.65/8 and naked seed line TCH.89/7. But such a relationship did not exist for other parents. It can, therefore, be presumed that the combining ability cannot be judged based on *per se* performance (Kohel, 1980).

Table 1. Analysis of variance in a line x tester crosses for oil content

Source	df	Mean square
Hybrids	27	4.02**
Lines	6	13.01**
Testers	3	1.73**
Line x Tester	18	1.40**
Error	76	0.08
GCA		0.36
SCA		0.44
GCA/SCA		0.89

** Significant at P = 0.01

The estimates for general combining ability effect of parents (lines and testers) and specific combining ability effects of hybrids (Table 2) indicated that, sparsely fuzzed line TCH.65/8, full fuzzed line TCH 70/7 and naked line TCH 89/7 and the testers LRA 5166 are the best combiners. And

Table 2. *gca* effect of parents and *sca* effects of hybrids for oil content

Lines	Testers				*gca* of lines
	MCU 5	MCU 7	MCU 9	LRA 5166	
	(sca of hybrids)				
TCH 63/1	-1.78*	0.40	0.64	0.73*	-0.50*
TCH 63/4	0.23	-0.04	0.27	-0.46*	-0.99*
TCH 104/1	0.43	-0.44	-0.19	0.19	-0.41*
TCH 65/8	0.35	0.11	0.02	0.22	0.49*
TCH 96/6	1.44*	0.51*	-0.49*	-0.45	-0.81*
TCH 70/7	0.11	0.14	0.04	0.29	0.36*
TCH 89/7	-0.10	0.33	-0.30	0.05	2.06*
gca of testers	-0.30*	-0.18*	0.15	0.32*	

	SE	CD (0.05)
gca (lines)	0.08	0.23
gca (testers)	0.06	0.18
sca (hybrids)	0.16	0.46

* Significant at P = 0.05

Table 3. **Association of different traits**

	Halo length	Fuzz grade	Single seed weight	Single seed coat weight	Single seed kernel weight
Oil content	0.31	-0.34*	0.05	0.06	0.34*
Halo length		0.33*	0.27	0.37*	0.42*
Fuzz grade			-0.27	-0.31**	-0.53**
Single seed weight				0.70**	0.75**
Single seed coat weight					0.63**

* Significant at 5 per cent level ; ** Significant at 1 per cent level

the cross combinations with high *sca* effects with respect to oil content involved poor combining parents. The superiority of poor x poor combination may be attributed to the genetic diversity of the parents. The transgressive segregants from such crosses involving good and/or average combiners are expected which can be identified following conventional breeding programme.

The oil content recorded the following genetic parameters, broad sense heritability of 94.06 %, genotypic co-efficient of variation of 4.25, phenotypic co-efficient of variation of 4.38 and genetic advance as percentage of mean as 8.49. On the basis of the close estimates of genotypic and phenotypic co-efficients of variability and high heriability percentage, it can be persumed that the differences were mostely genetic although the expected gain from selection would be low (Dani, 1984). Significant cultivar variation and estimates of heritability ranging between 42 and 66 % were reported in American upland cotton (Kohel, 1980) confirming that seed oil is heritable and can be readily transferred.

Interrelationship between the percentage of seed oil, halo length, fuzz grade, single seed weight, single seed coat weight and single seed kernel weight was estimated (Table 3). There was a significant and positive association of seed oil percentage with single seed kernel weight (0.34) and significant negative association with fuzz grade (-0.34). There was a significant and positive association of seed oil percentage with seed size as observed by Kohel (1980) and Shaver and Dilday (1982) with diverse germplasm lines of *G. hirsutum*.

It can be concluded that the hybrids involving the naked seeded line TCH 89/7 recorded negative association with fuzz grade and oil content indicating that, naked seeds will have more oil than the fuzzy seeds. There was also an association between oil content and single seed kernel weight and single seed weight was negatively correlated with fuzz grade. Hence, it was apparant that breeding for lesser fuzzy to naked seed will increase kernel weight and oil content with the advantage of easy extraction of oil without delinting through naked seeds.

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