Table 6. Reaction of TVC 31 to important pest and disease at Oilseeds Research Station, Tindivanam (Mean for 3 years)

Culture/Check	Pest Score			Disease Score		
	Jassids Pop / 3 leaves	Semilooper larvae/plant	Capsule borer (% damage)	Wilt (%)	Rust (1-9 scale)	Alternaria leaf blight
TVC 31	3.5	3.5	25.6	5.3	3.1	3.0
TMV 5	5.2	4.6	51.7	5.8	3.2	3.6

Days to 50% flowering : 45-80

Days to maturity : 155 - 165

Maturity group : Medium

Because of its superior performance in yield and high oil content, the culture TVC 31 was released as TMV 6 castor during 1997 for pure and mixed/intercropping conditions during June-September in Salem, Dharmapuri and Erode districts of Tamil Nadu.

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DIALLEL CROSS ANALYSIS FOR COMBINING ABILITY IN UPLAND COTTON (*G. hirsutum* L.)

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ABSTRACT

A diallel set of 10 parents of upland cotton was evaluated under artificial American bollworm infestation for seed cotton yield per plant, boll number and bollworm damage. A significant role of both additive and dominance components of gene action was observed for all the characters studied. Epistasis influenced the performance of seed cotton yield per plant, number of bolls and eggs of *H. armigera*. The net directional dominance was operative towards high mean performance for egg and larval count, green boll damage, open boll damage open locule damage and seed cotton yield per plant. A greater frequency of dominant alleles for all the traits studied except seed cotton yield per plant where equal proportion of dominance and recessive alleles were observed. In general the parents AET 5, Okra and JK 276-4 were the best parents and in particular the pigmented line 9-1487 for bollworm damage in desired direction. Okra x 9-1487 and Frego x 9-1487 were good sources of desirable selections in further generations. In view of the selections for favourable recessive alleles any form of recurrent selection which allow intermating among selects may be more effective as the potentiality of recessive alleles remains hidden in the heterozygous condition.

KEY WORDS : Upland cotton,tolerant donor, American bollworm

Cotton is one of the important commercial crops of Andhra Pradesh. In recent times,cotton cultivation in Andhra Pradesh has become risk prone particularly due to whitefly initially and later *Helicoverpa armigera* outbreaks. Host plant resistance is considered as one of the most important ecofriendly approaches to contain the pest attack. Combining ability studies help in selecting the parents and the breeding method to be employed for improving a particular trait, as it provides information on the genetic nature of the characters. Therefore, the present study was carried out to gather information on genetic nature of the ten bollworm tolerant donor lines of American cotton (*Gossypic hirsutum* L.) to help in formulating an efficient breeding programme for development of high yielding lines/hybrids with built-in resistance to bollworms that can fit into IPM strategy.

MATERIALS AND METHODS

A complete diallel set (excluding reciprocals) involving 10 bollworm tolerant donor lines viz., High gossypol line (83 HTT 217-218), High tannin line (L 57 X 1124-4-3), Okra line (6-4TL 63-1-70), Fregobract line (407-14-4 X R2-8-73X), AET 5 race stock, densely hairy line (B 1007), Glabrous line (S X 77-3840-1W-78), bollworm resistant variety (JK 276-4), nectariless (American nectariless), pigmented plant body (9-1487) was studied. The above ten parents along with their 45 F_1 S were grown in a randomized block design with two replication. Each line was covered by plastic netting which prevented the entry of other insects. The plants in each net were bombarded by artificial release of a pair of first,second and third instar larvae (*Helicoverpa armigera*) on each plant to study their resistance pattern. To find out the preference of *Helicoverpa* moths for oviposition at peak squaring stage, a pair of laboratory reared adults were released in each plot. These moths had been paired and held in the laboratory for two days before release to ensure a uniform infestation in all plots. After egg count, the eggs were removed. Data from five competitive plants were recorded on larval count, square damage, green boll damage (GBD), boll number, seed cotton yield per plant. Data on boll and locule damage were collected at the time of harvest. Even when one locule of a boll was damaged, it was considered as damaged but the good kapas from that boll was included in yield. Combining ability was analysed according to the Method II and Model I of Griffing (1954). The genetic components of variation were estimated as per the method proposed by Hayman (1954).

RESULTS AND DISCUSSION

The analysis of variance of combining ability for eight traits in 10 X 10 diallel cross of upland cotton is presented in Table 1. It is seen that variances due to *gca* and *sca* were highly significant for all the traits studied. The ratio as proposed by Baker (1978), $2^2 g/(2^2 g+^2 S)$ revealed the importance of non-additive gene action in the inheritance of these traits. thus both additive and non additive types of gene action were observed for all the traits studied. Miller and Marani (1963): Singh and Gupta (1970); Bhandari (1978; Patil and Chopde (1983); also reported similar findings for seed cotton yield per plant and boll number. The estimates of general combining ability effects of the ten parents have been presented in Table 2. The estimates of general combining ability effects of the ten parents have been presented in Table 2. Among the parents ANL, 5, 9-1487, Frego, HG and HT for eggs/plant; ANL, HG, 9-1487 for larval count; AET 5, 9-1487, Okra for square damage; HT, JK 276-4 for green boll damage; AET 5, 9-1487 for open boll damage and open locule damage (in desired direction) AET 5, Okra, JK 276-4 for boll number, AET 5, Okra, HT 276-4 for seed cotton

Table 1. Estimates of variances for general and specific combining ability in *G. hirsutum* L.

Source of variation	df	No. of eggs/ plant	No. of larvae/ plant	Square damage/ plant	GBD/ plant	OBD/ plant	OLD/ plant	Boll number	Seed cotton yield/plant
GCA	9	0.210**	0.040**	22.18**	9.44**	35.69**	21.52**	32.33**	459.93**
SCA	45	0.170**	0.020**	18.80**	11.01**	38.22**	19.52**	30.87**	595.88**
Error	54	0.005	0.002	1.72	0.68	1.88	1.33	0.80	5.17
$\sigma^2 g$		0.010	0.002	1.70	0.73	2.81	1.68	2.70	37.89
$\sigma^2 s$		0.160	0.019	17.08	10.33	36.34	18.19	30.06	590.71
$2^2 g / 2\sigma^2 g + \sigma^2 s)$		0.170	0.230	0.16	0.12	0.13	0.15	0.15	0.11

yield per plant are detected as good general combiners. A comparison of *gca* effects of parents indicated that none of the parents was good in respect of all the characters. All these facts suggested that these parents have additive variance for respective traits.

The estimates of specific combining ability ffects of the top three performing crosses out of 5 crosses produced from 10 X 10 diallel cross for ll the traits have been presented in Table 3. The est cross combinations for seed cotton yield per lant were Frego X 9-1487, Okra X ANL; for egg ounts HT X JK 276-4 X B 1007; for square damage,)kra X 9-1487, Frego X 9-1487, Okra X ANL; for reen boll damage, Okra X 9-1487, Frego X 9-1487, IT X B 1007; for open locule damage, HT X B 007, Okra X 9-1487, Okra X Frego X 9-1487, HG X IT; for open locule damage, HT X B 1007, Okra X -1487, Okra X Frego and for boll number, Okra X NL, Okra X ANL, Okra X ANL, Okra X 9-1487, rego X 9-1487. It was apparent from the Table III at crosses involving parents with high X high *ca* did not yield good specific combination hereas crosses involving parents with low X low r high X low or low x high resulted in high positive *ca* effects. This may be due to mutual cancellation of the contribution by different yield components. Grafius (1956) suggested that there cannot be any one gene system for yield *per se* and that yield is an end product of multiplicative interaction between yield and yield components.

It is interesting to note that those crosses which showed highest sca effects for boll number exhibited highest sca effects for seed cotton yield per plant also. It is also suggestive that overall, crosses showing high sca effects for *Helicoverpa* in desired direction showed high sca effects for seed cotton yield. Most of the crosses that exhibited negative or positive sca effects had atleast one parent with positive gca effect. This further suggests the utility of heterosis breeding. The specific cross combination Okra x 9-1487 and Frego x 9-1487 which were found superior for seed cotton yield and bollworm damage will be subjected to multilocation test for further evaluation under minimum plant protection. In the light of gene action involved heterosis breeding seems to be very effective for improving the seed cotton yield. boll number and bollworm resistance by selecting genetically diverse parents (or) modified type recurrent selection which allows intermating, among the selects can be used for accumulation of favourable genes.

Genetic components of variance

The estimates of the genetic components of variation D,F, HI, H2 and h^2 along with their

Table 2. Estimates of *gca* effects of parents

Parents	No. of eggs/ plant	No. of larvae/ plant	Square damage/ plant	GBD/ plant	OBD/ plant	OLD/ plant	Boll number	Seed cotton yield/plant
Okra	0.014	0.013	-1.031**	-0.116	-0.603	-0.015	1.702**	7.952**
Frego	-0.100**	0.021	2.270**	0.114	0.171	-0.493	-1.934**	-5.211**
MET 5	0.006	-0.011	-2.253**	-0.413	-3.560**	-2.737**	3.033**	9.951**
HG	-0.080**	-0.062**	0.293	0.156	2.840**	2.168**	-1.878**	-8.081**
HT	-0.051**	-0.052**	0.053	-1.118**	0.960*	0.535	-0.477	2.722**
K 276-4	0.188*	0.068**	0.109	-1.209**	-0.655	-0.589	1.544**	3.602**
Glabrous	0.088**	0.034**	0.963**	1.422**	0.715	-0.037	-0.327	-1.423*
ANL	-0.160**	-0.064**	1.325**	1.426**	1.090**	1.262**	-1.684**	-7.446**
B 1007	0.233**	0.094**	-0.133	0.041	0.551	0.809*	-0.055	-3.295**
9-1487	-0.137**	-0.041**	-1.595**	-0.303	-1.511**	-0.903*	0.077	1.228
SE (g i)	0.018	0.012	0.359	0.226	0.375	0.316	0.245	0.622
SE (g i - g j)	0.028	0.018	0.535	0.336	0.559	0.471	0.365	0.928

GBD : green boll damage OBD : open boll damage OLD : open locule damage standard errors and proportions for eight traits studied have been presented in Table 4. The significance of t^2 values for seed cotton yield, boll number and egg count indicated epistasis. For other traits studied though the epistasis was not operative, significant specific combining ability variance as well as dominance components (H1 and H2) confirmed the involvement of dominance with the result that the presence if epistasis can be concluded for these traits. The mean degree of dominance measured by the ratio $(H1 / D)^{½}$ indicated over-dominance for all these characters

Table 3. Estimates of *sca* effects of some of the promising crosses

No.of eggs/plant		No.of larvae/plant	
Cross	*sca* effect	Cross	*sca* effect
HT x JK 276-4 (High x Low)	-0.595**	Okra x 9-1487 (Low x High)	-0.355**
Okra x 9-1487 (Low x High)	-0.514**	HT x JK 276-4 (High x Low)	-0.231**
Okra x Glabrous (Low x Low)	-0.375**	JK 276-4 x B 1007 (Low x High)	-0.193**
SE (Sij)	0.056	SE (Sij)	0.036
SE (Sij - Sik)	0.091	SE (Sij - Sik)	0.059

square damage		GBD/plant	
Cross	*sca* effect	Cross	*sca* effect
Okra x 9-1487 (High x High)	-8.240**	Okra x 9-1487 (Low x Low)	-6.068**
Frego x 9-1487 (Low x High)	-8.133**	Frego x 9-1487 (Low x Low)	-5.675**
Okra x ANL (High x Low)	-5.839**	HT x B 1007 (High x Low)	-5.117**
SE (Sij)	1.082	SE (Sij)	0.680
SE (Sij - Sik)	1.775	SE (Sij - Sik)	1.115

OBD/plant		OLD/plant	
Cross	*sca* effect	Cross	*sca* effect
Okra x 9-1487 (Low x High)	-9.715**	HT x B 1007 (Low x Low)	-6.391**
Frego x 9-1487 (Low x High)	-9.529**	Okra x 9-1487 (Low x High)	-6.298**
HG x HT (Low x Low)	-8.564**	Okra x Frego (Low x Low)	-6.293**
SE (Sij)	1.131	SE (Sij)	0.952
SE (Sij - Sik)	1.855	SE (sij - Sik)	1.562

Boll number		Seed cotton yield/plant	
Cross	*sca* effect	Cross	*sca* effect
Okra x ANL (High x Low)	13.307**	Frego x 9-1487 (Low x Low)	63.534**
Okra x 9-1487 (High x Low)	13.251**	Okra x 9-1487 (High x Low)	53.036**
Frego x 9-1487 (Low x Low)	10.451**	Okra x ANL (High x Low)	44.696**
SE (Sij)	0.739	SE (Sij)	1.876
SE (Sij - Sik)	1.212	SE (Sij - Sik)	3.077

This must not be considered as an unbiased estimate for atleast seed cotton yield, boll number and egg count. Exploitation of over-dominance in its form would warrant the production of only hybrids since selection would be ineffective in its presence to develop a line better than the parents.

Dominance effect as algebric sum over all loci(h^2) in heterozygous phase in all crosses was significant for egg, larval count, open boll damage, open locule damage, boll number and seed cotton yield per plant indicating that dominance to be unidirectional in the inheritance of these traits while it was non-significant for square damage and green boll damage. In the present material, the direction of dominance was not clear. The proportion of total number of dominant and recessive genes (KD/KR) among the parents determines the extent of genetic advance that can be achieved in a particulars direction. If the alleles present in the population are predominant and gene action. It is therefore essential to assess the proportion of dominant and recessive genes in the population for selecting the genotype for desirable improvement. In the present study the proportion of dominant genes was higher than recessive genes for all the traits except seed cotton yield per plant where both types of genes were almost equal in proportion. The statistic K(F) failed to detect the number of effective factors controlling the traits, egg, larvae, square damage, green boll damage. This may be attributed partly due to complementary gene action and partly due to ambidirectional distribution of genes with plus and minus effects (Mather and Jinks, 1971). For other traits viz., open boll damage, open locule damage, boll number, yield atleast two groups controlled the inheritance and showed dominance. Duhoon *et al.*, (1983) also reported similar findings on bollworm damage. The ratio H_2 / 4 H1 indicated somewhat symmetrical distribution for egg, larval count, green boll damage, boll number and seed cotton yield per plant where as sharp asymmetrical gene distribution was observed for rest of the traits studied. Statistically non-significant values of correlation (r) of either positive or negative sign,

Table 4. Estimates of components of variation

Components of variations	No.of eggs/ plant	No.of larvae/ plant	Square damage/ plant	GBD/ plant	OBD/ plant	OLD/ plant	Boll number	Seed cotton Yield/plant
D	0.080	0.023**	28.334**	5.141	46.666**	23.807**	5.824	48.037
	(0.053)	(0.007)	(9.682)	(3.350)	(0.013)	(3.260)	(10.226)	(186.689)
H_1	0.704**	0.084**	87.561**	47.552**	161.796**	76.817**	114.461**	2152.993**
	(0.011)	(0.016)	(20.608)	(7.131)	(			
H_2	0.652**	0.074**	62.865**	39.446**	117.528**	59.309**	102.523**	2021.686**
	(0.097)	(0.014)	(7.155)	(6.061)	(16.305)	(5.898)	(18.499)	(337.734)
h^2	0.161**	0.023*	0.684	3.675	151.466**	94.895**	148.707**	3030.975**
	(0.065)	(0.009)	(11.724)	(4.075)	(10.914)	(3.948)	(12.383)	(226.066)
F	0.054	0.022	46.187**	9.326	79.224**	39.941**	3.871	-15.528
E	0.005	0.002	1.750	0.667	2.297	1.458	0.850	5.171
	(0.016)	(0.002)	(2.919)	(1.010)	(2.718)	(0.983)	(3.083)	(56 289)
$(H_1/D)1/2$	2.971	1.915	1.758	3.041	1.862	1.796	4.433	6.695
$H_2/4H_1$	0.232	0.219	0.179	0.207	0.182	0.193	0.224	0.235
KD/KR	1.258	1.661	2.728	1.850	2.676	2.381	1.162	0.953
K(F)	0.246	0.316	0.011	0.093	1.289	1.600	1.450	1.499
ryr. wr + vr	-0.409	-0.155	0.067	0.486	0.585	0.551	-0.538	-0.404
Heritability (NS)	18.700	21.900	16.400	15.700	15.600	16.400	20.800	16.00
t^2	3.765*	3.468	0.339	1.909	0.692	0.177	15.511**	32.080**

GBD : green boll damage OBD : open boll damage OLD : open locule damage suggested that dominant as well as recessive genes controlled the high or low mean performance (Mather and Jinks, 1971). The magnitude of narrow sense heritabilities were low for all the traits studied, suggesting the importance of non-additive gene effect. Bhatade (1981); Duhoon et al., (1983), Amalraj and Gawande (1985) also reported similar findings for boll number, seed cotton yield per plant and bollworm damage.

Both the procedures revealed the prevalence of additive as well as non-additive gene effects for all the traits except egg, green boll damage, boll number and seed cotton yield. But the Jinks - Hayman's approach failed to reveal the existence of additive components for these characters. Since epistasis was also detected for some of the traits in addition to the concentration of genes with additive effects a part of non-allelic interactions may also be fixed to isolate transgressive segregants. Any from of recurrent selection which allows intermating among the selects may be more effective to fix favourable recessive alleles which are hidden in the heterozygous condition.

REFERENCE

AMALRAJ, S.F.A. and GAWANDE, M.C., (1985) Genetics of yield and ginning characters in intervarietal hybrids of *G. hirsutum* L. **J. Indian Soc. Cott. improv., 10**: 100-106

BAKER, R.J., (1978). The theory and analysis of diallel crosses. **Genetics., 39**: 789-809.

BHANDARI, D.R., (1978). Line x tester analysis of combining ability and its interaction with environment in American cotton (*G. hirsutum L.*) **Madras Agric. J., 65** : 218-225.

BHATADE, S.S., (1981) Genetic analysis for yield and fibre characters in (*G. arboreum L.*) **Indian J. Agric. Sci., 51** : 160 - 162.

DUHOON, S.S., VIJAIRAGHAVAN, K.M. and RAO, M.H. (1983). Genetic analysis of yield and fibre characters in desi cotton (*G. arboreum L.*) **J. Indian Soc. Cott. Improv., 8** : 70 - 73.

GRAFIUS, J.E., (1956) Components of yield in Oats - A geometric interpretation. **Agronomy J., 48** : 419-423.

GRIFFING, B., (1956). A generalised treatment of the use of diallel crosses in quantitative inheritance. **Heredity., 10** : 31-50

HAYMAN, B.I., (1954) The theory and analysis of diallel crosses. Genetics., 39: 789-809.

MATHER, K. and JINKS, J.L., (1971) Biometrical Genetic 2nd Edition. Chapman and Hall Ltd., London E.C. 4.

MILLER, P.A., and MARANI, A., (1963) Heterosis and combining ability in diallel crosses of upland cotton (*G. hirsutum* L.) **Crop Sci., 3** : 341 -344.

PATIL, R.A. and CHOPDE, P.R., 1983. Diallel cross analysis for combining ability in upland cotton (*G. hirsutum L.*). **J. Indian Soc. Improv., 8** : 54 - 60.

SINGH, R.B. and GUPTA, M.P., M.P., 1970. combining ability for yield characters in upland cotton. **Indian J. Genet. 30** : 608-618.

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TRANFORMATION OF SULPHUR IN SOILS OF NORTH KARNATAKA AS INFLUENCED BY SOURCES AND LEVELS OF SULPHUR

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ABSTRACT

A Laboratory incubation experiment was conducted in Vertisol and an Inceptisol of North Karnataka to know the effect of different sources and levels of sulphur and time of incubation on transformation of available S in soils. Among the different sources of sulphur, ammonium sulphate recorded the highest release of S due to its more soluble nature compared to other sources. The available S content was more in inceptisol. There was a rapid release of S during the first fifteen days of incubation followed by a slower linear release.

KEY WORDS: S transformation, Vertisol, Inceptisol, Incubation, Sources and levels of S

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