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HETEROSIS FOR SEED AND OTHER QUANTITATIVE CHARACTERS IN TOBACCO (*NICOTIANA TABACUM L.*)

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ABSTRACT

Thirty-six F_1s obtained from line x tester mating of six high oil content varieties as lines and six low oil content varieties as testers were evaluated for seed and other quantitative characters Low to moderate heterosis in both directions (-ve and +ve) was encountered for days to flower, plant height, number of curable leaves, leaf length, leaf width, 1000-seed weight and seed oil content The traits cured leaf yield, weight of crow foot capsule, crow foot capsule seed weight and seed yield recorded low to high heterosis in negative and positive directions Hybrid Sendarapatty Special x Chama exhibited maximum heterosis of 51.68% for seed yield Hybrids A 145 x Maragadham and A 145 x Chama with moderate heterosis (16.45% and 17.28% respectively) suggest limited possibility in production of seed oil content. Hybrids CM 12 x K 326 and CM 12 x A 119 expressed 100 and 95 per cent heterosis and 76 and 90 per cent heterobeltiosis respectively for cured leaf yield. These may be useful for extraction of phytochemicals and pharmaceutical products.

INTRODUCTION

Tobacco enjoys a unique status among commercial crops for its narcotic value of the leaf consumed in different forms. However, due to the alleged health hazards associated with its consumption, anti-smoking campaigns are gaining momentum. In the event of phasing out tobacco for its narcotic purpose for human consumption, it has to be exploited for other alternative uses. Tobacco seed oil is an important by-product of this crop, which is presently used in soaps, varnishes and paints industry. Refined tobacco seed oil has been under use as edible oil (Chari, 1995; Thakur *et al.*, 1998). Thus its economic importance is prominent Research information on heterosis for seed characters and seed oil content is not available Hence an investigation was undertaken and results are given in this paper.

MATERIAL AND METHODS

Thirty two recommended varieties of different tobacco types grown in different agro-climatic zones of India were examined for their 1000-seed weight and seed oil content (Lalitha Devi *et al.*, 2002). Varieties Sendarapatty Special (country cheroot), Pyruvithanam (Natu), VT 1158, Hema and CM 12 (Flue-cured Virginia) and A 145 (chewing) which exhibited high seed oil content were used as lines Another set of six varieties A 119 (Bidi), Olor (cigar), Maragadham, Podali and chama (chewing) and K 326 (Flue-cured Virginia) with low seed oil content were taken as testers Thirty six crosses were made during 1999-2000 at C T R I Farm, Katheru following line x tester model. The experiment was laid out in a replicated trial using a randomised block design with 12 parents and 36 F_1s. Each plot consisted of 28 plants. Recommended package of practices were followed. Five random plants in each plot were considered for recording data on days to flower, plant height, curable leaf number, leaf length, leaf width, cured leaf yield, crow foot capsule weight, crow foot capsule seed weight, seed yield per plant, 1000-seed weight and seed oil content The data were subjected to statistical analysis (Panse and Sukhatme, 1969).

Heterosis was estimated over mid parent (MP) and better parent (BP) using the following formulae:

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$$\text{Heterosis (H)} = \frac{[F_1 - MP] \times 100}{MP}$$

Where,

H is per cent heterosis;

F_1 is hybrid value;

MP is mid parental value i.e., mean of parent 1 and 2.

$$\text{Heterobeltiosis (HB)} = \frac{(F_1 - BP) \times 100}{BP}$$

Where,

HB is per cent heterobeltiosis;

F_1 is hybrid value;

BP is better parent value.

The test of significance was carried out following "t" test for H and HB.

RESULTS AND DISCUSSION

Mean values of parents (lines and testers) for different characters under study are given in Table 1. For brevity, percent Heterosis (H) and Heterobeltiosis (HB) estimates of promising hybrids for days to flower, plant height, curable leaf number, leaf length and leaf width were presented in Table 2. The H and HB estimates for cured leaf yield and seed traits are given in Table 3.

For days to flower, the hybrids Pyruvithanam x Olor, VT 1158 x Olor, Hema x Olor, A 145 x Olor and CM 12 x Olor expressed highly significant positive heterosis Hybrids with Olor (a late flowering variety) showed low to medium per cent heterosis. The dominance nature of Olor for late flowering is seen in the hybrids To produce more thin to medium bodied, elastic and moderate size leaves late flowering is preferred. This is the case with Cigar wrapper, Oriental and White Burley varieties. Early flowering is desirable for undertaking early topping at button stage to improve leaf expanse and body and in turn yield. The early flowering genotypes, if untopped, may put forth more and more axillary suckers to get more flowers and thereby more seed.

For plant height, hybrids Hema x Chama, A 145 x Olor, CM 12 x Olor and CM 12 x Podali showed significant positive heterosis to the tune of 21 to 26 per cent while Hema x K 326 expressed significant negative heterosis of 26%.

Many authors observed significant and positive heterosis with low to medium magnitude for plant height A few reports (Matzinger, 1968, Lakshmmarayana, 1987; Ramana Rao and Krishna Murthy, 1987) indicated the occurrence of negative heterosis.

Curable leaf number exhibited an array of variation from significant to highly significant, negative to positive estimates of heterosis with low to moderate magnitude. It is due to the high genetic divergence prevailed among the varieties involved in the study.

Leaf length showed significant to highly significant positive heterosis of low to moderate magnitude. However, F_1s of A 145 x K 326 and CM 12 x K 326 expressed significant but -ve heterosis of low values.

Leaf width expressed low to moderate heterosis. The F_1s recorded significant to highly significant positive heterosis.

Cured leaf yield showed significant to highly significant and positive heterosis with the exception of A 145 x K 326 and A 145 x Podali tending to negative direction. Heterobeltiosis estimates expressed significant to highly significant values in both positive and negative directions.

Considering different types involved in the hybridisation programme, hybrid vigour for cured leaf yield can be assessed in three groups. In group 1 *viz.*, Country cheroot or Natu varieties crossed with other types revealed interesting aspects Between the two cheroot varieties, Pyruvithanam nicked well and gave substantial heterosis for cured leaf yield with

Table 1. Mean values of parents for different characters

Parents	Days to flower	Plant height (cm)	Curable leaf number	Leaf length (cm)	Leaf width (cm)	Cured leaf yield (kg/plot)	Crowfoot capsule weight (g)	Crowfoot capsule seed weight (g)	Seed yield/ plant (g)	1000- Seed weight (g)	Per cent seed oil content
Lines											
Sendarapatty special	78.40	180.77	22.87	58.07	21.75	3.47	0.5067	0.3238	30.6667	0.0894	34.32
Pyruvithanam	74.40	142.85	21.87	46.90	17.10	2.20	0.3000	0.2026	44.0000	0.0881	30.78
VT 1158	83.40	199.59	25.53	52.22	24.17	3.57	0.3422	0.2270	29.6667	0.0995	33.36
Hema	81.67	178.70	20.80	52.32	23.43	4.05	0.3949	0.2755	28.6667	0.0922	31.91
A 145	64.73	104.15	9.07	46.13	19.79	1.90	0.4006	0.2793	40.6667	0.0919	34.07
CM 12	84.40	156.17	21.33	54.89	25.94	1.47	0.3610	0.2314	29.6667	0.0989	31.71
Testers											
A 119	70.60	138.07	11.60	46.34	18.01	1.55	0.2625	0.1831	19.3133	0.0785	26.90
Olor	94.13	156.64	27.00	47.73	21.25	3.75	0.3976	0.2629	28.6667	0.0810	26.35
Maragadham	81.13	139.50	18.93	50.62	27.45	3.20	0.3523	0.2389	31.6667	0.0819	27.42
K326	89.80	140.47	21.47	53.55	23.54	1.96	0.2126	0.1535	26.6667	0.0864	27.78
Podali	70.67	139.67	14.80	42.00	21.39	2.68	0.2729	0.1898	31.0000	0.0646	26.85
Chama	71.27	150.81	19.40	28.17	24.40	2.13	0.3740	0.2376	30.0000	0.0783	24.79
S.Em	0.9149	8.6717	0.3705	0.9643	1.3192	0.2118	0.0066	0.0044	1.2263	0.0001	0.5594
CD 0.05	2.5361	24.0361	1.0270	2.6730	3.6566	0.5871	0.0183	0.0121	3.3990	0.0004	1.5507
C V %	2.09	9.29	3.15	3.25	9.61	10.56	3.12	3.10	6.25	0.28	3.19

Table 2. Per cent Heterosis (H) and Heterobeltiosis (HB) estimates of promising hybrids for five quantitative characters

Character	Promising hybrids	H	Promising hybrids	HB
Days to flower	Pyruvithanam x Olor	16.56**	Pyruvithanam x Olor	24.19**
	VT 1158 x Olor	11.26**	A 145 x Olor	22.56**
	Hema x Olor	12.02**	Hema x Olor	12.02**
Plant height	CM 12 x Olor	26.65**	CM 12 x Olor	26.47**
	Hema x Chama	22.58*	A 145xA 119	-25.94**
	A 145 x Olor	21.86*	Hema x K 326	-34.22**
Curable leaf number	A 145 x A 119	24.85**	A 145xA119	11.29*
	Pyruvithanam x Olor	20.58**	Hema x K 326	9.50**
	Hema x Podali	20.22**	Pyruvithanam x Olor	9.15**
Leaf length	A 145 x Chama	20.34**	Pyruvithanam x Maragadham	12.45**
	Pyruvithanam x Maragadham	16.73**	A 145 x Olor	11.78**
	A 145 x Olor	13.66**	A 145 x Chama	9.95**
Leaf width	Pyruvithanam x Maragadham	29.68**	Pyruvithanam x A 119	23.65**
	Pyruvithanam x A 1 19	26.82**	VT 1158 x Chama	18.71**
	A 145 x Maragadham	20.69**	Hema x Chama	14.90**

* Significant at 0.05 level of probability;
** Significant at 0.01 level of probability.

Pyruvithanam x Maragadham showing 73% followed by Pyruvithanam x A 119 giving 71% and in both cases HB also showed 46%. Similarly Pyruvithanam crossed with Chama showed higher H (40%) and HB (38%) than Sendarapatty Special crossed with Chama.

Hybrids in group II (FCV versus other types) expressed maximum heterosis Among the three Flue-cured Virginia varieties, crosses between CM 12 and other types excelled followed by VT 1158 versus other types and Hema versus others. Among inter-type crosses CM 12 x Olor and CM 12 x A 119 gave 95.4 and 95.36% heterosis of which the latter showed 90.32% HB also. Next in line is VT 1158 x Chama with 85.61% heterosis and 48.18% HB. The tester Chama nicked well with all the three FCV lines. Another chewing variety Maragadham also gave good amount of heterosis with the three FCV lines, the maximum expressed is CM 12 x Maragadham (75.64%) As regards intratype hybrids in this group, CM 12 x K 326 excelled in expressing 100% heterosis and 76% HB. While the other two are minimal for their H values, infact their HB values are on negative direction.

Coming to group III i.e., chewing versus other type varieties, only A 145 x A 119 (bidi) exhibited high heterosis of 74.5% and HB of 58.95% compared to others.

A casual perusal of means of parents and hybrids reveals the probable genetic basis of heterosis. Hybrids Pyruvithanam x A 119, Sendarapatty Special x Maragadham and Pyruvithanam x Maragadham of group I, CM 12 x A 119,VT 1158 x Olor,CM 12 xOlor, VT 1158 x Maragadham, Hema x Maragadham, CM 12 x Maragadham, CM 12 x K 326, VT 1158 x Podali, CM 12 x Podali, VT 1158 x Chama and Hema x Chama of group II and A 145 x A 119 of group III depicted transgressive heterosis. The hybrids which exhibited dominance mode are Sendarapatty Special x Olor, Pyruvithanam x Olor, Sendarapatty Special x A 119, Sendarapatty Special x K 326, Pyruvithanam x K 326, Sendarapatty Special x Podali and Sendarapatty Special x Chama (group I),VT 1158 x A 119, Hema x Olor, VT 1158 x K 326 and Hema x Podali (group II) and A 145 x Olor, A 145 x Podali and A 145 x Chama (group III) Hybrids Hema x A 119 and Hema x

Table 3. Estimates of percent Heterosis (H) and Heterobeltiosis (HB) for cured leaf yield and seed traits

Hybrids	Cured leaf yield (kg/plot)		Weight of crowfoot capsule (g)		Weight of crowfoot capsule seed (g)		Seed yield/ plant (g)		1000-seed weight (g)		Per cent seed oil content	
	H	HB	H	HB	H	HB	H	HB	H	HB	H	HB
Sendarapatty Special x A 119	42.63**	3.17**	7.49**	-18.41**	4.77**	-17.97**	30.68**	6.52**	18.21**	11.07**	4.60**	-6.71**
Sendarapatty Special x Olor	11.63**	7.47**	-12.94**	-22.30**	-16.60**	-24.43**	6.78**	3.26*	16.67**	11.19**	12.07*	-0.93
Sendarapatty Special x Maragadham	40.72**	35.45**	6.15**	-10.03**	16.74**	1.45**	-15.50**	-16.86**	14.82**	10.06**	0.79	-9.34**
Sendarapatty Special x K 326	31.62**	3.17**	15.93**	-17.70**	13.57**	-16.28**	-12.77**	-18.49**	2.73**	1.01**	0.68	-8.91**
Sendarapatty Special x Podali	27.60**	13.26**	0.69**	-28.50**	-6.81**	-26.10**	-12.42**	-12.96**	-1.04**	-14.77**	0.69	-8.65**
Sendarapatty Special x Chama	15.0**	-7.21**	-11.76**	-23.31**	-10.55**	-22.45**	51.68**	-	16.57**	9.40**	3.75**	-10.65*
Pyruvithanam x A 119	71.81**	46.82**	31.71**	-23.5**	27.94**	21.82**	35.78**	-2.27	-8.52**	-13.51**	5.04**	-1.59*
Pyruvithanam x Olor	15.10**	-8.53**	-21.85**	-31.44**	-16.62**	-26.17**	26.62**	4.55*	-17.26**	-20.54**	-3.24**	-10.20**
Pyruvithanam x Maragadham	73.33**	46.25**	33.42**	23.53**	35.28**	25.03**	14.51**	-1.52	0.94**	-2.61**	2.02**	-3.56**
Pyruvithanam x K326	26.44**	19.55**	.26.73**	8.27**	13.59**	-0.15**	-6.62**	-25.0**	-7.33**	-8.17**	-5.55**	-10.16**
Pyruvithanam x Podali	25.00**	13.81**	28.89**	10.2**	2.91**	-0.35**	12.88**	-3.80*	-2.62**	-15.55**	-0.92	-7.24**
Pynrvithanam x Chama	40.55**	38.64**	15.16**	3.77**	20.72*-*	11.83**	9.0** *	-8.34**	-8.89**	-13.96**	- 6.42**	-3.94**
VT 1158 x A 119	58.20**	13.45**	8.33**	-4.27**	3.80**	-6.21**	25.18**	3.37	4.72**	-6.33**	13.25**	2.28**
VT 1158 x Olor	42.9**	39.47**	-40.98**	-45.10**	-21.55**	-26.89**	14.26**	5.59**	9.75**	-0.40**	12.50**	0.69
VT 1158 x Maragadham	51.03**	43.42**	7.17**	5.65**	4.29**	1.72**	24.98**	21.03**	10.36**	0.60*	-2.96**	-11.60**
VT1158 x K326	21.66**	-5.61**	52.67**	23.76**	59.43**	33.66**	14.77**	8.97**	-13.66**	-19.30**	-4.73**	-12.70**
VT 1158 x Podali	58.79**	39.21**	13.00**	-8.33**	6.86**	-1.89**	32.93**	30.10**	-0.61*	-17.99**	-12.60*	-21.12**
VT 1158 x Chama	85.61**	48.18**	7.82**	3.24**	2.37**	4.76**	9.48**	8.90**	-15.07**	-24.12**	2.10**	-11.01**
Hema x A 119	11.07**	-23:21**	21.72**	1.32**	5.49**	-12.20**	16.67**	-2.34	-6.67**	-13.56**	6.44**	-1.92*
Hema x Olor	25.64**	20.99**	-13.32**	-13.61**	-11.44**	-9.32**	51.13**	51.13**	-18.01**	-22.99**	-6.01**	-14.19**
Hema x Maragadham	50.69**	35.06**	-44.39**	5.22**	18.51**	10.64**	20.42**	14.71**	-6.66**	-11.82**	6.78**	-0.74
Hema x K 326	8.97**	-19.01**	47.00**	13.09**	34.45**	4.68**	-	3.61*	-3.70**	-6.72	9.25**	2.18**
Hema x Podali	43.92**	19.75**	28.43**	-1.16**	-2.79**	-17.89**	21.75**	17.19**	-9.69**	-23.21**	5.09**	-3.24**
Hema x Chama	63.43**	24.69**	4.14**	1.39**	7.21**	-0.15**	21.57**	18.9**	7.39**	-0.66**	-4.85**	-15.46*
A 145 x A 119	74.57**	58.95**	5.64**	-12.56**	-0.87**	-17.94**	14.43**	-15.59**	16.43**	7.94**	3.84**	-7.09**
A 145 x Olor	16.25**	-12.27**	-19.19**	-19.50**	-20.25**	-22.59**	17.31**	-	-0.58*	-6.42**	6.53**	-5.53**
A 145 x Maragadham	10.98**	-11.56**	24.89**	17.37**	38.25**	28.25**	15.21**	2.46	7.13**	1.31**	16.45**	5.08**
A 145 x K 326	-9.33**	-10.71**	12.98**	-13.53**	19.92**	-7.09**	21.77**	0.81	-9.87**	-12.51**	9.69**	-0.44
A 1 45 x Podali	-19.21**	-30.97**	20.14**	-7.99**	7.54**	-9.67**	2.25	-0.84	9.96**	-6.31**	-0.54**	-11.07**
A 145 x Chama	9.90**	-4.23**	-0.08**	-3.39**	4.99**	-2.83**	14.12**	-0.84	8.23**	0.22	17.28**	1.30
CM 12 x A 119	95.36**	90.32**	16.55**	0.66**	17.56**	5.32**	8.86**	-10.11**	8.00**	-3.13**	7.10**	-1.08
CM 12 x Olor	95.40**	36.00**	-10.41**	-14.54**	-5.26**	-10.92**	12.0**	-10.11**	10.56**	0.61*	8.13**	-0.99
CM 12 x Maragadham	75.64**	28.44**	9.20**	7.89**	16.62**	14.82**	-	-3.16	-5.31**	-13.45**	8.47**	1.13
CM 12 x K 326	100.58**	76.02**	3.31**	-17.92**	0.83**	-16.12**	2.95	-2.26	7.23**	0.51**	-1.37*	-8.94**
CM 12 x Podali	65.38**	28.36**	7.42**	-14.60**	-5.94**	-14.39**	14.27**	11.84**	1.22**	-16.28**	-9.01**	-15.97**
CM 12 x Chama	63.89**	38.50**	-3.73	-5.40**	-3.03**	-5.85**	15.05**	14.43**	-4.51**	-14.46**	-1.65*	-12.37**

* Significant at 0.05 level of probability; ** Significant at 0.01 level of probability.

K 326 of group II and A 145 x Maragadham and A 145 x K 326 of group III reveal possible additive nature. Hybrids Pyruvithanam x Podali and Pyruvithanam x Chama of group I and CM 12 x Chama of group III exhibit likely interaction of additive type.

Moll *et al.* (1965) observed that increase in heterosis is seen with increased divergence within a restricted range of divergence, but extremely divergent crosses resulted in a decrease in heterosis. Results of the present study also prove this point. The restricted divergence existed between lines of group I (cheroot type) and among lines of group II (FCV type) clearly show the nicking ability of Pyruvithanam (group I) and CM 12 and VT 1158 (group II) in giving higher amounts of heterosis and HB with other type varieties. Similarly maximum H of 100% was observed between CM 12 x K 326 i.e., FCV x FCV cross Here again the divergence of varieties for plant habit, stature and leaf size might have lead to increase in heterosis.

By and large exploitation of heterosis for yield in tobacco has not received much response. This is mainly because in many instances, the quantum of heterosis observed has been low to medium (due to the self-pollinated nature of tobacco with predominant additive gene action) which does not give commensurate returns. Though distant parents of divergent origin give substantial heterosis for yield, the quality of F_1 hybrid leaf does not confirm to consumer preferences for narcotic purpose. Hence commercial exploitation of heterosis in tobacco remained in back seat.

However, with the anti-tobacco campaign gaining importance, alternative uses of tobacco are to be exploited In this direction, for instance to get more nicotine, solanesol or tobacco leaf protein(of feed and fodder value) the present results are of high relevance.

Weight of crow-foot capsule exhibited significant to highly significant heterosis and heterobeltiosis in both the directions Considering heterosis magnitude from 20% and above, 10 hybrids showed their mark with VT 1158 x K 326 topping the list(52 67% H and 23 76% HB) followed by Hema x K 326 (47.00 H and 13.09% HB) and Pyruvithanam x Maragadham (33.42% H and 23.53% HB) The other hybrids in descending order of percent heterosis are Pyruvithanam x A 119 (31.7), Pyruvithanam x Podali (28.89), Hema x Podali (28.43), Pyruvithanam x K 326 (26.73), A 145 x Maragadham (24.89), Hema x A 119 (21.72) and A 145 x Podali (20.14).

Hybrids VT 1158 x K 326, Hema x K 326, Pyruvithanam x Maragadam and A 145 x Maragadam tend to show transgressive vigour while others depict dominance nature towards their (line) parents.

Significant to highly significant and positive to negative H and HB were exhibited by the hybrids for the trait crow-foot capsule seed weight. Hybrids VT x K 326 (H 59.43, HB 33.66), A145 x Maragadham (H 38.25, HB 28.25), Pyruvithanam x Maragadham (H 35.28, HB 25.03), Hema x K 326 (H 34.45, HB 4.68), Pyruvithanam x A 119 (H 27.94, HB 21.82) and Pyruvithanam x Chama (H 20.72, HB 11.83) depicted substantial heterosis and heterobeltiosis. Of these F_1s, VT 1158 x K 326 appears to posess transgressive vigour, A 145 x Maragadham and Pyruvithanam x Maragadham indicate additive mode of interaction while others tend towards dominance of either line or tester parent.

Hybrids exhibited an array of variation for magnitude and direction of heterosis and heterobeltiosis falling under significant groups for the trait seed yield per plant. Hybrid Hema x Olor topped the list by expressing 51% heterosis and got the distinction of showing the same value of H and HB. Three hybrids *viz.*, Pyruvithanam x A 119, VT 1158 x Podali and Sendarapatty Special x A 119 showed above 30% heterosis.

Hybrids Pyruvithanam x Olor, VT 1158 x A 119, VT 1158 x Maragadham, A 145 x K 326, Hema x Podali, Hema x Chama and Hema x Maragadham exhibited more than 20 per cent heterosis. The F_1s VT 1158 x Podali, VT 1158 x Maragadham, Hema x Podali and Hema x Maragadam indicated similar magnitude for H and HB.

The hybrids Hema x Olor, VT 1158 x Podali, VT 1158 x Maragadam, Hema x Podali, Hema x Chama and Hema x Maragadam tend to show transgressive vigour while others follow dominance towards their (line) parents.

A perusal of literature on other oil seed crops reveals low to high to very high heterosis and HB in sesame, groundnut, sunflower, castor and yellow sarson for seed yield. However, negative H and HB were also encountered in sesame (Shinde *et al.*,1993; Mishra and Yadav, 1996; Ragiba and Raja Reddy, 2000) and in sunflower (Ashok Kumar *et al.*,1999 and Jayalakshmi *et al.*, 2000). The present results indicate the same trend but a maximum heterosis of 51% only was encountered which suggest the possibility of exploiting heterosis for seed production with assorted hybrids.

For the character 1000-seed weight hybrids in general, exhibited low magnitude of heterosis in both the directions falling under significant and highly significant groups. Maximum H (18%) and HB (11%) are observed in the hybrid Sendarapatty Special x A 119. Other hybrids which expressed >10% H are Sendarapatty Special x Olor, Sendarapatty Special x chama, A 145 x A 119, Sendarapatty Special x Maragadam, CM 12 x Olor and VT 1158 x Maragadham. These F_1s (except the last two) showed similar magnitude of HB also. It is interesting to note that the above hybrids show that their

i) lines possess high 1000-seed weight
ii) testers have low 1000-seed weight and
iii) the F_1s depict dominance towards the high seed weight lines.

References on other oil seed crops indicate significant to highly significant, low to high values of H and HB in both +ve and -ve directions (Verma *et al.,* 1989 in yellow sarson; Mishra and Yadav, 1996 in sesame, Ashok Kumar *et al.*, 1999 in sunflower, Manivel *et al.,* 1999 in castor and Ragiba and Raja Reddy, 2000 in sesame). Results of this investigation are at a variance in encountering low magnitude of H and HB compared to the above reports on other crops, which may be due to the very minute size of seed in tobacco. However, these results suggest limited scope for improvement of this trait. For per cent seed oil content, hybrids expressed significant and highly significant yet low heterosis values of +ve and -ve nature Only five F_1s *viz.*, A 145 x Chama, A 145 x Maragadham, VT 1158 x A 119, VT 1158 x Olor and Sendarapatty Special x Olor exhibited > 12 per cent heterosis The HB values are not appreciable The first two hybrids gave 17 and 16 per cent H.

As in 1000-seed weight character, the hybrids depicted dominance towards their high seed oil lines, while the testers remained low for oil content.

For seed oil content, Swamy Rao (1970) observed in brown sarson a range of -12.5 to 52.93 per cent heterosis and -200.0 to 34.0 per cent heterobeltiosis while Verma *et al.* (1989) recorded very low values of -1.65 to 3.70% heterosis and 1.08 to 2.08% heterobeltiosis in yellow sarson Kowsalya *et al.* (1999) in upland cotton found -0.70 to 39.33% heterosis and -0.86 to 38.86% heterobeltiosis. Ashok Kumar *et al.* (1999) observed in sunflower -23.11 to 16.13% standard heterosis and -15.56 to 29.41% heterobeltiosis. The present study encountered -12.60 to 17.28% heterosis and -21.12 to 5.08% heterobeltiosis, thus it varies for the magnitude of heterosis and heterobeltiosis with the above oil seeds.

The heterosis estimates encountered in this study suggest limited possibility of increase in production of seed oil content.

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