INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES
IJPAES
VOLUME-2, ISSUE-2 APRIL-JUNE-2012 ISSN 2231-4490

Coden : IJPAES www.ijpaes.com
Received: 12th April-2012 *Revised: 16th April-2012* *Accepted: 20th April-2012*
Research article

HETEROSIS AND RELATIVE HETEROSIS IN TOBACCO (*NICOTIANA TABACCUM* L.)

J.N. Patel[1], A.D. Patel[2], Sudeshna Chakraborty[1] and Sasidharan N[1].

[1]Department of Agricultural Botany, Anand Agricultural University, Anand 388110, Gujarat, India
[2]Bidi Tobacco research Station, Anand Agricultural University, Anand 388110, Gujarat, India
(sudi.bot@gmail.com)

ABSTRACT: Tobacco (*Nicotiana tabacum* L) is one of the world's principal cash crops of India. The present investigation significant and desirable heterosis and heterobeltiosis were observed for days to flower in cross III and IV, number of branches per plant in cross II and III, for khakhri yield per plant in cross II and III, for number of capsules per plant in cross II, for days to capsule maturity in cross I and III, for test weight in cross III, for seed yield per plant in cross I, which indicate the feasibility of utilizing hybrid vigour on commercial scale.
Key words Tobacco, heterosis, heterobeltiosis, inbreeding depression

INTRODUCTION

Tobacco (*Nicotiana tabacum* L.) 'The Golden Leaf' is one of the world's leading non food crop and is one of the important crops among the principal cash crops of India. It is consumed by the people of almost all countries of the world. The major tobacco producing countries in the world are U.S.A., China, Brazil, India, Turkey and Bulgaria. India ranks second in terms of area and third in production with a rate of 10% at 300 million kg in 2010-11. The crop is rich source of chemicals viz., nicotine, solanesol, malic acid and citric acid. Apart from these phytochemicals edible protein from green tobacco leaf and oil from the seeds are two areas where further research could justify cultivation of tobacco for alternate uses.

The nature of gene action governing the expression of various traits could be helpful in formulating an effective and sound breeding programme. The knowledge of heritability and genetic gain of the characters is necessary to determine the extent to which they can be transmitted from their parents to offsprings and the extent to which they can be improved through selection. Further, the response of selection is determined by the type of gene action involved in the expression of a trait.

MATERIAL AND METHODS

The experimental material for the present study comprised of seven lines viz., GT 7, Jayalakshmi, Anand 145, Kumkumathri, GT 9, Bhagyalakshmi and HDBRG LP 2, their F_1, F_2, Back crosses (B_1 and B_2) as detailed in Table 1 and 2. The seeds of F_1 and back crosses (B_1 and B_2) were prepared by hand pollination. For parents and F_2 self seeds were collected.

Table 1. Description of parents used in the study

Sr. No.	Parents	Special features
1	GT 7	Tall and high leaf potential, tolerant to drought
2	Jayalakshmi	White seeded
3	Anand 145	Suitable for lal chopadia, golden yellow colour of leaves, seed contain high oil per cent
4	Kumkumathri	Good aroma and taste and high nicotine
5	GT 9	Mosaic resistant and high yielding
6	Bhagyalakshmi	Chewing tobacco, the cured leaves posses white crystalline encrustation and medium pungent in taste
7	HDBRG LP 2	Good export potential, cured leaf has high filling value and higher nicotine and used for blending

Table 2. Experimental material studied during 2003-04.

Cross	Family	Generation	Material studied
I	GT 7 x Jayalakshmi	P_1	GT 7
		P_2	Jayalakshmi
		F_1	GT 7 x Jayalakshmi
		F_2	GT 7 x Jayalakshmi
		B_1	(GT 7 x Jayalakshmi) x GT 7
		B_2	(GT 7 x Jayalakshmi) x Jayalakshmi
II	Jayalakshmi x Anand145	P_1	Jayalakshmi
		P_2	Anand145
		F_1	Jayalakshmi x Anand145
		F_2	Jayalakshmi x Anand145
		B_1	(Jayalakshmi x Anand145) x Jayalakshmi
		B_2	(Jayalakshmi x Anand145) x Anand145
III	Kumkumathri x GT 9	P_1	Kumkumathri
		P_2	GT 9
		F_1	Kumkumathri x GT 9
		F_2	Kumkumathri x GT 9
		B_1	(Kumkumathri x GT 9) x Kumkumathri
		B_2	(Kumkumathri x GT 9) x GT 9
IV	Bhagyalakshmi x HDBRG LP2	P_1	Bhagyalakshmi
		P_2	HDBRG LP2
		F_1	Bhagyalakshmi x HDBRG LP2
		F_2	Bhagyalakshmi x HDBRG LP2
		B_1	(Bhagyalakshmi x HDBRG LP2) x Bhagyalakshmi
		B_2	(Bhagyalakshmi x HDBRG LP2) x HDBRG LP2

Anthesis occurs between 7 a.m. to 10 a.m. Hence, flower buds likely to open next morning were retained on the segment of the inflorescence selected for crossing and remaining buds, flowers and capsules (if any) were removed. The stigma of freshly emasculated flower was immediately dusted with pollen grains from the freshly plucked flowers of the appropriate male parent and the gynoecium was covered by slipping gently a piece of soda straw tube over the stigma and beaded its upper tip. The crossed buds were duly labeled and capsules were harvested at maturity. Few closed buds of parents and F_1 plants were selfed. All the crosses alongwith their parents were grown in Compact Family Block Design with four replications. Mean values obtained from the observation recorded on representative plants and samples for all the characters for each of the entry in each family main and sub plots were used for statistical computation of all the characters studied. The statistical analysis was conducted for Estimation of heterosis and Estimation of inbreeding depression.

Heterosis expressed as per cent increase or decrease of F_1 hybrid over its mid- parent (heterosis) as well as better or superior parent (heterobeltiosis) was computed as follows:

$$Heterosis\ \ (H_1\%) = \frac{\overline{F_1} - \overline{MP}}{\overline{MP}} x100$$

$$Heterobelt\ iosis\ (H_2\%) = \frac{\overline{F_1} - \overline{BP}}{\overline{BP}} x100$$

Where,

$\overline{F_1}$ = mean performance of the F_1 hybrid

$\overline{MP}$ = mean value of the parents (P_1 and P_2) of a hybrid

$\overline{BP}$ = mean value of better parent

The standard errors and 't' value for test of significance for heterosis and heterobeltiosis were calculated as under :

Standard error for heterosis : $$S.E.(\overline{F_1} - \overline{MP}) = \sqrt{\frac{3Me}{2r}}$$

Standard error for *Heterobeltiosis*: $$S.E.(\overline{F_1} - \overline{BP}) = \sqrt{\frac{2Me}{r}}$$

Where,

Me = error mean squares

r = number of replications

$$\text{'t' test : } t\ (H_1) = \frac{(\overline{F_1} - \overline{MP})}{S.E.(\overline{F_1} - \overline{MP})}$$

$$t\ (H_2) = \frac{(\overline{F_1} - \overline{BP})}{S.E.(\overline{F_1} - \overline{BP})}$$

The test of significance of heterosis and heterobeltiosis was carried out by comparing the calculated value of 't' with the tabulated value of 't' at 5 % (1.96) and 1% (2.57) levels of significance.

Estimation of inbreeding depression

The following formulae were used to estimate the inbreeding depression.

$$\textit{Inbreeding depression(\%)} = \frac{\overline{F_1} - \overline{F_2}}{\overline{F_1}} x 100$$

$$S.E.(\overline{F_1} - \overline{F_2}) = \sqrt{\frac{[V(F_1)(n_1 - 1)] + [V(F_2)(n_2 - 1)]}{n_1 + n_2 - 2}}$$

't' test for inbreeding depression

$$\text{'t'} = \frac{(\overline{F_1} - \overline{F_2})}{S.E.(\overline{F_1} - \overline{F_2})}$$

Where,

F_1 = mean value of the F_1 hybrid
F_2 = mean value of the F_2 generation
$V(F_1)$ = variance of the F_1 generation
$V(F_2)$ = variance of the F_2 generation
n_1 = number of observations in F_1 generation
n_2 = number of observations in F_2 generation

The significance of the inbreeding depression was tested by comparing the calculated 't' value with the table 't' value at 5% (1.96) and 1% (2.57) levels of significance.

RESULTS AND DISCUSSION

In the present investigation the extent of heterotic effects heterosis i.e. relative heterosis and heterobeltiosis as well as inbreeding depression were estimated. The relative heterosis was estimated over mid-parent and heterobeltiosis over better parent in F_1 hybrids value and inbreeding depression in F_2 generation for various characters in four crosses of tobacco are presented in Table 1.

During the present study the magnitudes of various heterotic effects and inbreeding depression were recorded very low to moderate during days to flower. The estimates of relative heterosis (RH) in four crosses ranged from -12.77 percent to 0.55 per cent where negative significant relative to heterosis was recorded in Cross III positive heterosis in Cross I [1],[2], [3]. The results of relative heterosis and heterobeltosis were contradicted with those obtained by several workers [4], [5], [6], [7], [8].

The number of leaves per plant showed, the minimum and maximum values of relative heterosis of -10.39 (cross II) and 2.62 (cross III) per cent. The cross IV only depicted positive heterobeltiosis. The estimates of relative heterosis were significant and negative. Negative to positive range of heterosis was reported in tobacco [9] whereas several other reported negative and positive heterobeltiosis, with which the present observations are in partial agreement [10]. The variation might due to the variation in the genotypes studied.

The plant height (cm) showed very low to moderate heterotic effects. Heterosis over mid parental value varied from -2.13 (cross III) to 4.52 (cross II) per cent. The cross III (-2.13%) and cross I (-0.85%) exhibited significant negative heterotic effect, which is desired for dwarf plant stature, where seed yield is main objective. Whereas, the cross II (4.52%) exhibited significant positive heterotic effect [11]. During the present study the magnitude of relative heterosis was recorded moderate with positive estimates in number of branches per plant. The minimum and maximum value of relative heterosis recorded was 3.77 (cross IV) to 19.80 (cross II) per cent, respectively. The crosses, II (19.80%) and III (16.09%) registered significant positive relative heterosis which is desirable for the important yield contributing character. The estimates of heterosis over better parent ranged from -11.73 (cross IV) to 14.77 (cross III) per cent and only these two crosses depicted significant estimates. While the estimates of relatives heterosis varied from -6.11 (cross IV) to 24.86 (cross II) per cent in Khakhri yield per plant (g). Significant positive relative heterosis was observed with crosses II (24.86%), III (16.53%) and I (15.01%), whereas, the cross IV (-6.11%) had significant negative estimate relative heterosis. During the study of number of capsules per plant various heterotic effects were observed high in both the directions. The minimum and maximum estimate of relative heterosis were -9.75 (cross IV) and 14.35 (cross I) per cent, respectively. Significant positive relative heterosis was observed with crosses I (14.35%), III (9.70%) and II (7.30%), which suggested considerable increase in number of capsules per plant with hybrids. Whereas, the cross IV (-9.75%) had significant negative value of relative heterosis. The days of capsule maturity showed magnitudes of various heterotic effects which were low to moderate for the trait. The estimates of relative heterosis ranged from -6.65 (cross III) to 1.02 (cross IV) per cent. For early maturity, crosses III (-6.65%) and I (-1.47%) exhibited the significant negative heterosis in desired direction. The test weight (mg) showed magnitude of various heterotic effects which were high in both directions.

The minimum and maximum estimates of relative heterosis were -35.77 (cross IV) and 25.18 (cross III) per cent, respectively. The seed yield per plant (g) showed significant positive relative heterosis with crosses I (28.62%) and II (7.07%) whereas the cross IV (-6.81%) only depicted significant negative relative heterosis. The seed oil percent revealed significant reduction in a seed oil per cent of hybrid in comparison to parental mean values as none of the crosses exhibited significant positive relative heterosis. During the study of seed oil yield per plant (g) significant positive relative heterosis was observed with the crosses I (24.09%) and II (8.52%).Whereas, the cross IV (-7.0%) had depicted significant negative relative heterosis.

Table 3: Heterosis (MP %), hetrobeltiosis (BP %) and inbreeding depression for various characters in four crosses in tobacco.

Cross	Per cent heterosis over		ID (%)	Per cent heterosis over		ID (%)
	MP	BP		MP	BP	
	Days to flower			Number of leaves per plant		
I	0.55	2.20	2.28	2.30	-9.64**	0.87
II	-10.51**	11.20**	11.63**	-10.39**	4.18**	-10.16**
III	-12.77**	-7.54**	-4.24**	2.62	-1.86	8.80**
IV	-10.46**	-10.00**	-5.67**	-5.70**	-18.23**	-036
	Plant height (cm)			Number of branches per plant		
I	-0.85*	-2.88**	5.47*	8.77	1.63	12.47*
II	4.52**	-17.08**	10.53**	19.80**	2.79	21.09**
III	-2.13**	-2.46**	2.73**	16.09**	14.77**	5.84
IV	0.64	-0.43	7.46**	3.77	-11.73**	2.98
	Khakhari yield per plant(g)			Number of capsules per plant		
I	15.01**	-8.92	22.53**	14.35**	-7.89**	22.43**
II	24.86**	10.41**	20.59**	7.30**	1.90**	17.31**
III	16.53**	1.30**	15.93**	9.70**	-2.00	13.05**
IV	-6.11**	-18.51**	2.84	-9.75**	-18.70**	-6.03
	Days to capsules maturity			Test weight (mg)		
I	-1.47**	2.85**	-0.34	-24.65**	-29.29**	-49.02**
II	0.10	0.33	-4.46**	16.53**	-3.073**	-5.03**
III	-6.65*	-1.05**	-11.30**	25.18**	22.52**	17.94**
IV	1.02**	2.33**	-2.26	-35.77**	-43.01**	-42.89
	Seed yield per plant (g)			Seed oil per cent		
I	28.62**	16.08**	30.44**	-5.23**	-9.34**	-3.38**
II	7.07**	-0.52	17.58**	-5.32**	-5.86**	-0.92
III	1.36	-5.69**	16.53**	-0.19	-1.22**	-1.70**
IV	-6.81**	14.26**	13.75**	-5.76**	-8.41**	-5.22**
	Seed oil yield per plant (g)					
I	24.09**	17.18**	28.44**			
II	8.52**	3.48	17.14**			
III	-0.06	-1.59	10.13			
IV	-7.00**	-10.52**	7.48			

N.B.: *, ** significant at 5 % and 1 % level of significance, respectively.

REFERENCES

[1] Rao SV and Moses J S L. 1984. Genetic analysis of combining ability in cigarette tobacco. *Indian J. Agric. Sci.* 54: 911-916.

[2] Saiyad M R. 1999. Genetics of physico-chemical characters and root-knot resistance in tobacco (Nicotiana tabacum L.). Unpublished Ph.D. thesis submitted to Gujarat Agricultural University, Sardarkrushinagar.

[4] Butorac J, Belio M, Vasili D and Kozumplik V.1999. Quantitative parameters of some burley tobacco traits. Rostlinna Vvroba. 45 (4): 149-156.

[5] Patel D A. 1994. Genetic studies in rustica tobacco (Nicotiana rustica L.) Unpublished M.Sc. (Agri.) thesis submitted to Gujarat Agricultural University, Sardarkrushinagar.

[6] Patel J B. 1995. Heterosis and combing ability studies in tobacco (N. tabacum L.). Unpublished M.Sc. (Agri.) thesis submitted to Gujarat Agricultural University, Sardarkrushinagar.

[7] Kher H R. 1997. Heterosis and combining ability studies in bidi tobacco (Nicotiana tabacum L.) over diverse cytoplasm. Ph.D. thesis submitted to the Gujarat Agricultural University, Sardarkrushinagar.

[8] Patel J A, Patel B K and Chakraborty M K. 1998. Production potential and quality aspects of tobacco seed oil. Tob. Res. 24:44-48.

[9] Bhatt M M. 2000. Heterosis and combining ability in bidi tobacco (Nicotiana tabacum L.) over environment. Unpublished Ph.D. thesis submitted to Gujarat Agricultural University, Sardarkrushinagar.

[10] Kher H R, Pathak H C and Patel A D. 2001a. Heterosis for yield components in bidi tobacco (Nicotiana tabacum L.) over diverse cytoplasms. Tob. Res. 27 (2): 98-102.

[11] Patel J B. 1995. Heterosis and combing ability studies in tobacco (N. tabacum L.). Unpublished M.Sc. (Agri.) thesis submitted to Gujarat Agricultural University, Sardarkrushinagar.

[12] Kher H R, Pathak H C, Makwana M G and Patel J N. 2001b. Combining ability studies for yield and yield components in bidi tobacco (Nicotiana tabacum L.) over diverse cytoplasms. Tob. Res. 27 (2): 134-9.