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COMBINING ABILITY ANALYSIS FOR CURED LEAF YIELD AND ITS COMPONENT TRAITS IN BIDI TOBACCO (*Nicotianatabacum*L.)

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Abstract: Combining ability analysis for ten characters was studied using half diallel analysis mating design involving set of 8 parents in bidi tobacco. Combining ability analysis revealed that *gca* variance were significant for cured leaf yield per plant, days to flowering, number of leaves per plant, plant height, leaf length, leaf width, leaf thickness, days to maturity and nicotine content whereas, *sca* variance were significant for all characters except cured leaf yield per plant and leaf thickness. However, the magnitude of combining ability variances revealed prime role of additive genetic variance for inheritance of cured leaf yield, days to flowering, plant height and leaf thickness. Whereas, preponderance of non-additive genetic variance was found for leaf length, leaf width, days to maturity, nicotine content and total reducing sugar. For number of leaves per plant both additive and non-additive components of genetic variance were important with an equal magnitude. Among the all parents ABD 101, ABD 111 and GT 7 were good general combiners for cured leaf yield and its related attributes. Parents GT 4, Red Russian and ABD 10 were found to be good general combiners for earliness. Based on sca effects, the hybrids GT 7 x ABD 10, ABD 101 x GT 7 and ABD 111 x Red Russian were found to be promising cross combinations for development of high yielding genotypes.
Keywords: Combining ability, bidi tobacco, curd leaf yield, nicotine content.

Introduction

Tobacco (*Nicotianatabacum* L.) “The Golden Leaf” is one of the important crops among the principal cash crops of India and has been known for centuries as a non-food narcotic cash crop. The chromosome number of genus *Nicotiana* varies from 2n=24 to 48. The most dominant and modern form of tobacco consumption in the world is through cigarette. *N.rustica* varieties are mainly used for chewing, hookah and snuff. Flue-cured and burley tobacco are the two major domestic types of tobacco used in cigarettes. Tobacco is not a homogeneous product. The flavor, mildness, texture, tar, nicotine, and sugar content vary considerably across varieties or types of tobacco. Defining characteristics of different tobacco types include the curing process (flue, air, sun-cured), leaf color (light or dark), size, and thickness. A given type of tobacco has a different quality depending on where it is grown, its

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position on the stalk (leaves near the bottom of the stalk are lower in quality) and weather conditions during growing and curing. Nicotine is an alkaloid found in the nightshade family of plants (Solanaceae) that constitutes approximately 0.6–3.0 per cent of the dry weight of tobacco with biosynthesis taking place in the roots and accumulation occurring in the leaves. Nowadays, with the advancement of biometrical genetics several techniques are available which permits quantitative genetics analysis and help in selection of promising parents and cross combination for further exploitation. Those parents who produce the good progenies on crossing are of immense values to the plant breeder. Combining ability analysis is a powerful tool to discriminate good as well as poor combiners and also helpful in choosing appropriate parental material for hybridization programme. At the same time they are also provides the information about the nature of gene action involved in the inheritance of a character. Combining ability analysis using half diallel mating design was carried out in the present study to obtain information on selection of batter parents and cross combinations for their further use in hybridization programme.

Materials and Methods

Eight parental lines viz., ABD -101, ABD- 111, ABT-10, GT-9, GT-7, GT-4 and ABD 10 were cross in half diallel mating design to obtain twenty eight hybrids during *kharif* season 2011-2012. The resultant 28 hybrids along with their parents were grown in randomized complete block design with three replications at Bidi Tobacco Research Station (BTRS), Anand Agricultural University, Anand, during *kharif* season 2012-2013. Each plot consisted of two rows with 10 plants; each row was sown at a distance of 90 cm between rows and 75 cm between plants. The guard rows were provided on all the sides of experimental blocks to eliminate border effects. All the recommended package of practices was followed for successfully raising the healthy crop. The observations were recorded on five randomly selected plants per plot in each replication for 10 characters viz., cured leaf yield per plant, days to flowering, number of leaves per plant, plant height, leaf length, leaf width, leaf thickness, days to maturity, nicotine content and total reducing sugar content. The combining ability analysis was performed with the data obtained for parents and hybrids according to Method-I and Method- II proposed by Griffing (1956).

Results and Discussion

The mean squares due to general combining ability (*gca*) and specific combining ability (*sca*) for different traits are presented in Table 1. The highly significant values of mean squares for general and specific combining ability indicated possibility of involvement of both additive and non additive gene actions for expression of most of the characters. Analysis of variance for combining ability (table 1) revealed that general combing ability (*gca*) variances were highly significant for all the characters indicating the role of additive gene action in the inheritance of these characters except total reducing sugars, for which it was significant and negative. While, the variances due to specific combing ability (*sca*) were highly significant for all characters except cured leaf yield per plant and leaf thickness indicating the role of non-additive gene action for the expression of those characters. The estimates of the potance ratio and predictability ratio indicated and conforming predominant role of additive gene action in the expression of cured leaf yield per plant, days to flowering, plant height and leaf thickness. Whereas, non-additive gene action was predominant for leaf length, leaf width, days to maturity, nicotine content and total reducing sugar. For number of leaves per plant both additive and non-additive components of genetic variance were important with an equal magnitude. Similar results were reported by Dave (2012) for number of leaves per plant, leaf width, nicotine content and total reducing sugar. Likewise, Jadeja *et al.* (1984) and Makwana (2006) recorded similar results for leaf thickness and leaf length, respectively. The characters, cured leaf yield per plant, plant height, days to flowering and days to maturity were estimated same results by Patel and Kingaonkar (2006).

Estimates of *gca* effects showed that it was difficult to pick up a good combiner for all the characters together as the combing ability effects were not consistent for all the yield components (Table 2). It was possibly because of the negative association of the traits. In the present investigation, the parents ABD-101, ABD-111 and GT-7 possessed significant *gca* effects for cured leaf yield per plant. In addition to cured leaf yield per plant, parents ABD-101 was good general combiner for number of leaves per plant, leaf length and leaf width. While, ABD-111 was also observed to be good general combiner for traits like number of leaves per plant and plant height. The parents GT 4, Red Russian and ABD 10 were responsible as good general combiners for early flowering and maturity. Among these, GT 4 was also good combiner for leaf thickness. Only parent ABT 10 was good combiner for nicotine content. These parents could be largely utilized in future breeding programme to develop high yielding hybrids. The *gca* variance for reducing sugar was negative, therefore, *gca* effects of the parent for character total reducing sugar was not workout.

The estimates of *sca* effects (Table 3) revealed that none of the hybrid was found consistently superior for all the traits. The *sca* effects of hybrids for the character cured leaf yield and leaf thickness were not estimated as their values of *sca* variances were non-significant. The highest significant *sca* effects in desired direction for various characters were exhibited by different hybrids *viz.,* ABD 101 × Red Russian, ABD 10 × Red Russian, ABD 111 × GT 7 and other ten hybrids were showed early flowering; ABD 101 × ABD 111, GT 9 × GT 7,ABD 101 × ABT 10, ABD 101 x GT 9 and GT 7 x Red Russian for number of leaves per plant; GT 9 × GT 4, GT 9 × GT 7 and ABT 10 × ABD 10 for plant height; ABD 101 × GT 9, GT 7 × ABD 10 and ABT 10 × GT 7 and other nine hybrids for leaf length; ABD 101 × GT 7, ABD 111 × GT 4, GT 7 × Red Russian,ABD-111 × Red Russian, ABT-10 × ABD-10, GT-7 ×ABD-10, GT-9 × GT-4for leaf width; GT 7 × ABD 10, ABD 111 × Red Russian, GT 9 ×Red Russian and ABD-101 × GT-9 for days to maturity; GT 7 × ABD 10 had the highest significant and positive *sca* effect followed by ABD 111 × ABT 10for nicotin content; GT 7 × ABD 10followed by GT 9 × ABD 10 and ABD 101 × GT 7for total reducing sugar.

The present study revealed that even though none of the parents were good general combiners for all the traits. The parents ABD 101, ABD 111 and GT 7 that were good general combiners for most of the yield contributing characters, which could be used in future breeding programme in tobacco for obtaining desirable segregants. The cross combination with high degree of *sca* effects involving both the parents having good *gca* effects would be ideal for deriving desirable genotypes in advance generation. From this point the combinations GT 7 x ABD 10, ABD 101 x GT 7 and ABD 111 x Red Russian would ideal one which may serve as a better source population for deriving superior progeny in advance generation.

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Table 1. Analysis of combining ability and variance components for different characters in tobacco

Source of variation	d.f.	Cured leaf yield/plant	Days to flowering	Number of leaves /plant	Plant height	Leaf length	Leaf width	Leaf thickness	Days to maturity	Nicotine content	Total Reducing sugar
GCA	7	4940.11**	227.12**	16.00**	905.35**	26.74**	19.00**	1.41**	197.12**	0.60**	0.17**
SCA	28	303.73	15.95**	2.25**	74.99**	7.74**	6.97**	0.23	62.18**	0.53**	0.27**
Error	72	208.43	0.95	0.31	31.02	1.26	1.60	0.27	1.44	0.15	0.01
σ^2gca		463.63**	21.11**	1.37**	83.03**	1.90**	1.20**	0.11**	13.49**	0.007**	-0.010**
σ^2sca		95.29	14.99**	1.93**	43.96**	6.47**	5.36**	0.01	60.74**	0.37**	0.25**
Potance Ratio		-	5.64	2.86	7.55	1.17	0.89	-	0.88	0.075	-
Predictibility Ratio		-	0.73	0.58	0.79	0.37	0.31	-	0.30	0.03	-

***, ** indicate levels of significance at 5% and 1%, respectively**

d.f.=Digree of freedom

Table 2. Estimates of general combining ability effects of parents for various characters

Parents	Cured leaf yield /plant	Days to flowering	Number of leaves / plant	Plant height	Leaf length	Leaf width	Leaf thickness	Days to maturity	Nicotine content	Total reducing sugar
ABD -101	28.72**	9.24**	2.42**	-0.86	2.04**	1.61**	-0.03	5.64**	0.17	-
ABD- 111	22.09**	2.44**	1.06**	9.10**	-0.28	-0.09	-0.26	5.21**	-0.09	-
ABT-10	-4.58	2.77**	-0.09	9.84**	0.34	-0.97*	0.22	0.78*	0.41**	-
GT-9	1.84	-1.41**	-0.48**	3.10	1.02**	-0.30	0.19	2.01**	0.22	-
GT-7	10.96*	-1.49**	-0.12	2.65	0.75*	-0.91*	-0.17	-0.06	-0.06	-
GT-4	-22.02**	-4.38**	-1.03**	-18.51**	-1.01**	-1.09**	0.74**	-7.42**	-0.21	-
ABD 10	1.90	-1.26**	-0.05	3.68*	0.52	-0.86*	-0.23	-2.66**	-0.14	-
RED RUSSIAN	-38.89**	-5.92**	-1.71**	-8.98**	-3.39**	2.62**	-0.46**	-3.49**	-0.31**	-
S.E. (g_i)	4.27	0.29	0.17	1.65	0.33	0.37	0.16	0.36	0.12	
Range										
Min.	-38.89	-5.92	-1.71	-18.51	-3.39	-1.01	-0.46	-7.42	-0.31	-
Max.	28.72	9.24	2.42	9.84	2.04	2.62	0.74	5.64	0.41	-

*, ** indicate levels of significance at 0.05 and 0.01 probability, respectively

Table 3. Estimates of specific combining ability effects associated for various characters

Hybrids	Cured leaf yield/plant	Days to flowering	Number of leaves / plant	Plant height	Leaf length	Leaf width	Leaf thickness	Days to maturity	Nicotine content	Total reducing sugar
ABD-101 × ABD-111	-	1.67*	2.71**	0.81	1.80*	0.65	-	-0.40	-0.73*	-0.01
ABD-101 × ABT-10	-	3.01**	1.59**	-3.27	-0.17	-0.01	-	-1.63	-0.01	0.01
ABD-101 × GT-9	-	5.39**	1.31**	3.60	4.31**	1.60	-	-2.86**	0.26	0.06
ABD-101 × GT-7	-	-3.13**	-2.11**	6.72	1.96*	7.16**	-	-1.13	-0.62	0.72**
ABD-101 × GT-4	-	-0.70	-1.74**	-4.32	1.47	0.24	-	10.24**	0.47	-0.66**
ABD-101 × ABD-10	-	-1.96*	-1.78**	4.23	-0.01	0.55	-	-0.53	-0.27	-0.60**
ABD-101 × RED RUSSIAN	-	-6.04**	-1.86**	2.29	1.87*	-0.10	-	3.30**	0.17	-0.14
ABD-111 × ABT-10	-	-1.8*	-0.11	1.97	1.17	-0.07	-	3.14**	1.15**	0.20*
ABD-111 × GT-9	-	2.12**	0.74	-5.89	1.51	0.39	-	-2.43*	-0.38	-0.18*
ABD-111 × GT-7	-	-5.47**	-1.35**	-8.31	0.51	0.91	-	-1.70	0.44	-0.51**
ABD-111 × GT-4	-	0.62	-1.58**	6.45	2.55**	3.26**	-	1.34	-0.35	0.14
ABD-111 × ABD-10	-	0.44	-0.15	2.47	-1.88*	-2.59*	-	2.57**	0.25	0.64**
ABD-111 × RED RUSSIAN	-	-1.58*	-0.63	-3.81	1.81*	2.60*	-	-9.93**	0.56	-0.86**
ABT-10 × GT-9	-	0.39	0.09	4.63	0.08	1.33	-	-1.00	0.34	0.04
ABT-10 × GT-7	-	-1.06	-0.27	-7.25	2.59**	-1.08	-	-0.60	0.35	-0.25**
ABT-10 × GT-4	-	-1.57*	-0.69	3.91	-0.56	0.53	-	6.77**	-0.31	0.25**
ABT-10 × ABD-10	-	0.51	0.73	9.39*	2.47**	2.17*	-	1.00	-1.60**	-0.17*

ABT-10 × RED RUSSIAN		-	-4.17**	-0.48	-2.81	1.35	-0.07	-	5.17**	0.33	0.29**
GT-9 × GT-7		-	-0.68	1.99**	12.35**	1.92*	-2.41*	-	6.50**	-1.22**	-1.08**
GT-9 × GT-4		-	-1.12	-0.37	18.38**	0.24	2.09*	-	4.87**	0.02	-0.35**
GT-9 × ABD-10		-	-4.58**	-0.15	-9.27*	-2.86**	0.74	-	5.77**	0.21	0.88**
GT-9 × RED RUSSIAN		-	-3.32**	-0.43	5.99	-2.0*	-0.93	-	-6.40**	-0.83*	0.05
GT-7 × GT-4		-	2.82**	-0.6	-3.97	-0.47	-0.85	-	11.60**	0.29	0.30**
GT-7 × ABD-10		-	-2.9**	-1.37**	-19.29**	3.23**	2.05*	-	-24.16**	1.71**	1.02**
GT-7 × RED RUSSIAN		-	3.49**	1.41**	6.51	2.25*	3.02**	-	5.00**	0.13	0.09
GT-4 × ABD-10		-	-0.34	-1.40**	-9.06*	0.74	-1.43	-	1.20	-0.44	0.09
GT-4 × RED RUSSIAN		-	-3.15**	-0.21	2.60	-0.47	1.48	-	3.37**	-0.66*	-0.10
ABD-10 × RED RUSSIAN		-	-5.87**	0.48	2.68	2.29*	1.03	-	4.60**	-0.74*	-0.24**
S.E.(Sij) ±		-	0.77	0.45	4.39	0.88	0.99	-	0.94	0.31	0.08
Range	Min.	-	-6.04	-2.11	-19.29	-2.92	-2.59	-	-24.16	-1.08	-1.08
	Max.	-	5.39	2.71	18.38	4.31	7.16	-	11.60	1.02	1.02
No. of Significant crosses		-	19	13	6	15	9	-	18	8	18
Positive		-	6	5	3	12	7	-	13	2	8
Negative		-	13	8	3	3	2	-	5	6	10

***, ** indicate levels of significance at 0.05 and 0.01 probability, respectively.**