

Investigations of Combining Abilities in Diallel Set of Varieties Belonging to Several Tobacco Types

Ana KORUBIN - ALEKSOSKA (✉)

Jane ALEKSOSKI

Summary

General and specific combining abilities were investigated for the characters stalk height, leaf number, fresh mass and dry mass per stalk in four parental genotypes (Burley B-2/93, pink flower Suhum - S1, white flower Suhum - S2 and Prilep P-84) together with their six diallel F1 hybrids with the aim of improving the process of creation of new varieties. The trial was set up in 2007 at the Experimental field of Tobacco Institute-Prilep in randomized block design with four replications. For the analysis of the combining abilities, Griffing's Method 2 Model 1 was used.

The best general combiner for stalk height and fresh/dry yield mass per stalk was B-2/93, and for leaf number it was P-84. Hybrids S2 x P-84 and S1 x P-84 showed the best SCA for stalk height. The three varieties in these two combinations showed low GCA for the same character. The only combination with high SCA for leaf number per stalk was S1 x S2 (hybrid created from two lines of a same variety, differing only by their flowers color, which indicates an intravarietal hybridization, applied as a method for maintenance of varieties, in order to prevent degeneration and to increase the biological potential of the variety). Hybrids B-2/93 x S2, B-2/93 x P-84 and B-2/93 x S1 have high SCA for fresh/dry mass yield per stalk. In all three combinations, maternal variety B-2/93 was with high GCA values, and parental varieties with low GCA values.

Key words

tobacco (*Nicotiana tabacum* L.); quantitative traits; diallel crossings; inheritance; partial dominance; intermediate; heterosis; GCA - general combining abilities; SCA - specific combining abilities

University Sv. Kliment Ohridski - Bitola, Scientific Tobacco Institute - Prilep, Department of Genetics, Selection and Seed control, Kicevski par bb, Prilep, Republic of Macedonia

✉ e-mail: anakorubin@yahoo.com

Received: May 7, 2009 | Accepted: July 31, 2009

Introduction

Selection in its creativity offers various possibilities for development of new genotypes, superior to the existing ones. A proper selection of parental pairs, based on investigation of combining abilities will ease and fasten the process of creation of new varieties.

Combining abilities for various characters in tobacco have been studied by many authors. For characters investigated in this paper, different results were obtained for different genetic material. Thus, significantly higher GCA (general combining abilities) and lower SCA (specific combining abilities) values were reported by: Prasannasimha Rao et al. (1993) in a diallel cross among six flue-cured varieties of various geographic origin for yield; Ramanarao et al. (1993) in seven flue-cured varieties and 42 hybrids for yield; Krishnamurthy et al. (1994) in diallel cross among ten flue-cured varieties for height, leaf number and yield; Wilkinson et al. (1994) in 55 hybrids obtained from eleven Virginia varieties for the characters height and leaf number; Kara and Esendal (1995) in six oriental varieties and their fifteen F1 hybrids for leaf number and yield; Prasannasimha Rao (1995) in nine filler tobaccos and 36 F1 hybrids for leaf number and yield characters; Butorac et al. (2000a) in four Burley varieties (TN86, Saturn, Bs92 and Bols) and their six diallel F1 hybrids for the major agronomic and morphologic characters, and Butorac et al. (2000b) in four Burley varieties (TN86, BL1, Hy71 and Poseydon) and their diallel F1 hybrids for the major economic and agronomic characters. Both additive and dominant genes take part in the inheritance of these characters, but additive genes are prevailing.

Wilkinson et al. (1994) reported significant GCA and SCA values for the yield, with equal importance of both additive and non-additive gene effects in inheritance of this character.

Aim of the paper is to determine general combining abilities for major morphological characters in four different parental tobacco genotypes, to study the inheritance in F1 progeny, and to select, by determination of special combining abilities in diallel crosses, those combinations where the required characters will be fixated most rapidly.

Materials and methods

Investigations included four tobacco genotypes: Burley B-2/93 (Fig. 1), Suhum with pink flowers S1 (Fig. 2), Suhum with white flowers S2 (Fig. 3) and Prilep P-84 (Fig. 4). Six F1 hybrids were obtained with diallel crossings. The field experiment was set up in 2007 at Tobacco Institute - Prilep, using randomized block design with four replications. Fifty stalks from each replication or 200 stalks in the whole trial were measured, with an equal number of leaves from the middle primings. The area of each replication was 147.6 m². The useful area of the whole plot was 590.4 m² and, together with margins, the total area was about 838 m². Traditional cultural practices were applied during the growing period of tobacco.

Investigations were focused on the following morphological characters: stalk height, leaf number per stalk, green tobacco yield per stalk and dry mass yield per stalk. Determination of the mode of characters inheritance was based on the test-significance of mean values in F1 progeny. Combining ability analysis was done according to Method 2 and Model 1 by Griffing (1956).



Figure 1. Burley - 2/93

Figure 2. Sochoumi S1



Figure 3. Sochoumi S2

Figure 4. Prilep P-84

Results and discussion

Among parental genotypes and their F1 hybrids the highest was the large-leaf variety Burley B-2/93 where $\bar{x} = 167.62$ cm, and the shortest was the small-leaf aromatic variety P-84 where $\bar{x} = 65.06$ (Table 1). The highest leaf number was attained in P-84 ($\bar{x} = 55.77$), while the lowest among parents in B-2/93 ($\bar{x} = 35.80$) and among hybrids in B-2/93 x S2 ($\bar{x} = 31.50$). The highest yield was observed in B-2/93 ($\bar{x} = 1031.90$ g/stalk green tobacco; 167.20 g/stalk dry mass). The lowest yield among parents was attained in P-84 ($\bar{x} = 158.73$ g/stalk green tobacco; 24.43 g/stalk dry tobacco) and among hybrids in S2 x P-84 ($\bar{x} = 103.27$ g/stalk green tobacco; 20.15 g/stalk dry tobacco).

No positive heterosis occurred in the inheritance of investigated characters and negative heterosis was observed for leaf number per stalk and green/dry tobacco per stalk.

Variances for general and specific combining abilities are highly significant, which is confirmed by the F - test (Table 2). In all the examples, the GCA value was higher compared to that of SCA, indicating that inheritance of investigated characters is dominated by additive genes.

Table 1. Mean values of parents and their diallel F1 hybrids for morphological characters

Genotypes and F1 hybrids	Stalk height (cm)	Leaf number per stalk	Green tobacco yield (g/stalk)	Dry tobacco yield (g/stalk)
1. Burley B-2/93	167.62	35.80	1031.90	167.20
2. Suhum S1	80.19	47.22	204.77	24.98
3. Suhum S2	77.50	47.40	187.70	26.03
4. Prilep P-84	65.06	55.77	158.73	24.43
5. B-2/93 x S1	121.50	34.30	802.87	129.88
6. B-2/93 x S2	117.00	31.50	810.49	133.04
7. B-2/93 x P-84	109.50	33.90	786.05	111.11
8. S1 x S2	79.50	45.15	126.28	22.26
9. S1 x P-84	78.30	44.65	132.20	23.24
10. S2 x P-84	78.50	42.65	103.27	20.15
LSD _{0.05}	5.480	1.931	115.417	18.398
LSD _{0.01}	7.880	2.776	165.976	26.457

Table 2. Analysis of variance for combining abilities

Characters	Sources of variance	Degrees of freedom DF	Sum square SS	Mean square MS	Fe	Ft	
						0.05	0.01
1. Stalk height	1. GCA	3	8701.09	2900.36	986.63**	3.16	5.09
	2. SCA	6	122.30	20.38	6.93**	2.66	4.01
2. Leaf number per stalk	1. GCA	3	350.41	116.80	320.07**	3.16	5.09
	2. SCA	6	186.49	31.08	85.17**	2.66	4.01
3. Green tobacco yield per stalk	1. GCA	3	1167917.00	389305.00	298.54**	3.16	5.09
	2. SCA	6	75455.12	12575.85	9.64**	2.66	4.01
4. Dry tobacco yield per stalk	1. GCA	3	30033.61	10011.20	302.13**	3.16	5.09
	2. SCA	6	1619.21	269.87	8.14**	2.66	4.01

Table 3. GCA effects of parental lines for morphological characters

Genotypes	Stalk height		Leaf number per stalk		Green tobacco yield per stalk		Dry tobacco yield per stalk	
	GCA	Rank	GCA	Rank	GCA	Rank	GCA	Rank
1. Burley B-2/93	32.65	1	- 6.31	4	381,85	1	61,21	1
2. Suhum S1	- 7.94	2	1.56	2	- 116,87	2	- 19,30	3
3. Suhum S2	- 9.56	3	0.82	3	- 126,11	3	- 18,94	2
4. Prilep P-84	- 15.15	4	3.93	1	- 138,86	4	- 22,97	4
LSD _{0.05}	2.079		0.732		43.783		6.979	
LSD _{0.01}	2.851		1.004		60.045		9.571	

Table 4. SCA effects for morphological characters

F1 hybrids	Stalk height		Leaf number per stalk		Green tobacco yield per stalk		Dry tobacco yield per stalk	
	SCA	Rank	SCA	Rank	SCA	Rank	SCA	Rank
1. B-2/93 x S1	- 0.68	4	- 2.78	3	103.47*	3	19.74**	2
2. B-2/93 x S2	- 3.56	5	- 4.86	5	120.33**	1	22.54**	1
3. B-2/93 x P-84	- 5.47	6	- 5.55	6	108.64*	2	4.63	3
4. S1 x S2	- 0.46	3	0.93	1	- 65,16	4	- 7,73	6
5. S1 x P-84	3.93	2	- 2.68	2	- 46,49	5	- 2,72	4
6. S2 x P-84	5.74**	1	- 3.93	4	- 66,18	6	- 6,18	5
LSD _{0.05}	4.157		1.465		87.566		13.958	
LSD _{0.01}	5.702		2.009		120.091		19.143	

Identical results on stalk height inheritance in diallel crosses from different parental genotypes were reported by Krishnamurthy et al. (1994), Wilkinson et al. (1994), and Butorac et al. (2000); for leaf number Krishnamurthy et al. (1994), Wilkinson et al. (1994), Kara i Esendal (1995), Prasannasimha Rao (1995), and Butorac et al. (2000), and for yield as the most

important economic character Prasannasimha Rao et al. (1993), Ramanarao et al. (1993), Krishnamurthy et al. (1994), Kara i Esendal (1995), Prasannasimha Rao (1995) and Butorac et al. (2000).

GCA values for the combining abilities reveal that the best general combiner for stalk height and green/dry tobacco per stalk was B-2/93, and for number of leaves per stalk P-84 (Table 3).

The SCA values (Table 4) reveal high significance of the variety S2 x P-84 for the character stalk height. No significance was observed for number of leaves per stalk, but positive SCA was observed in the variety S1 x S2 (obtained from two lines of a same variety that differ only in flowers color, indicating intravarietal hybridization applied as a method to preserve the variety in order to prevent its degeneration and to increase its biological potential) Highly significant value for green tobacco yield per stalk was attained in B-2/93 x S2, and significant value in B-2/93 x P-84 and B-2/93 x S1, whereas for dry tobacco yield per stalk in B-2/93 x S2 and B-2/93 x S1. This denotes that above mentioned hybrids are good combiners for investigated characters and in them fixation of the latter will be realized the most rapidly.

Conclusions

Analysis of variance for combining abilities of the varieties Burley B-2/93, Suhum S1, Suhum S2 and Prilep P-84 and their diallel crosses for the characters: stalk height, leaf number per stalk, green and dry tobacco yield per stalk revealed that general combining abilities (GCA) and specific combining abilities (SCA) have highly significant values and that GCA is drastically higher than SCA, indicating that dominant and recessive genes are included in inheritance of the above mentioned characters, but the additive component is in advantage. GCA values reveal that the best combiner for stalk height and green/dry tobacco yield per stalk was the large leaf variety B-2/93, and for number of leaves per stalk the oriental aromatic variety P-84. Analysis of SCA reveals that the best combiner for stalk height is hybrid S2 x P-84, and for green/dry tobacco yield per stalk the best combiners are those where maternal variety is B-2/93 (B-2/93 x S2,

B-2/93 x P-84 and B-2/93 x S1). In these hybrids fixation of the characters will be realized in a shortest period of time. None of the hybrids attained significant SCA value for leaf number per stalk. The only combination with positive SCA for this character is S1 x S2.

References

- Butorac J., Beljo J., Brozović D., Mustapić Z. (2000a). Combining abilities of Agronomic and morphological traits in Burley tobacco. *Agriculturae Conspectus Scientificus*, 65 (3): 153-159
- Butorac J., Vasilj Đ., Kozumplik V., Beljo J. (2000b). Inheritance of certain economic and agronomic traits in Burley tobacco. *Die Bodenkultur*, 51 (3): 151-156
- Griffing B. (1956). Concept of general and specific combining ability in relation to diallel crossing system. *Aust. J. Biol. Sci.* 9: 463-493
- Kara S.M., Esendal E. (1995). Heterosis and combining ability analysis of some quantitative characters in Turkish tobacco *Tob. Res.* 21 (1/2): 16-22
- Krishnamurthy A.S., Murthy K.S.N., Hanumantharao A. & al. (1994). Combining ability studies for yield, yield components and total alkaloids in flue-cured tobacco. *Tob. Res.* 20 (1): 43-46
- Prasannasimha Rao G.S.B., Lakshminarayana R., Rao R.V.S. (1993). Combining ability in diallel crosses of divergent flue-cured cultivars from different geographical regions *Tob. Res.* 19(2): 73-76
- Prasannasimha Rao G.S.B. (1995). Heterosis and combining ability in cigar filler tobacco (*N. tabacum* L.) *Tob. Res.* 21 (1/2): 28-36
- Ramanarao V.V., Prasannasimha Rao G.S.B., Krishnamurthy A.S. et al. (1993). Standard heterosis and combining ability in flue-cured tobacco (*Nicotiana tabacum* L.). *Tob. Res.* 19(1): 29-36
- Wilkinson C.A., Jones J.L., Tilson W. M. (1994). Diallel analysis of crosses among Virginia flue-cured tobacco. *Tob. Sci.* 38: 21-24