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ESTIMATION OF THE HETEROTIC EFFECT IN F1 GENERATION OF VARIOUS TOBACCO GENOTYPES AND THEIR DIALLEL CROSSES

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ABSTRACT

Two-years trial (2007 - 2008) was set up in the field of Tobacco Institute-Prilep, to study the mode of inheritance and heterotic effect for the characters: height of the stalk with inflorescence, height of the stalk without inflorescence, leaf number, middle belt leaf area, green mass yield and dry mass yield per stalk. The investigations included four parental genotypes (the oriental pink flowered Suhum S1, white flowered Suhum S2 and red flowered Prilep-84, and the large-leaf variety Burley B-2/93 in CMS form) and their six diallel F1 hybrids. The trial was set up in randomized blocks with four replications and traditional cultural practices were applied in tobacco growing.

The analysis of variance revealed statistically justified differences between parents and their progenies for the characters investigated. Positive heterosis with poor heterotic effect was recorded in S1 x S2 hybrid for stalk height with and without inflorescence and for green/dry mass yields in S2 x P-84, while in S2 x P-84 only for height of the stalk without inflorescence. Negative heterosis with poor heterotic effect was recorded in hybrids S1 x P-84 for leaf number and for green/dry mass yields and S2 x P-84 for leaf number and green mass per stalk. The low heterotic effect indicates that application of heterosis is economically unjustified, but in the same time it points out to the eventual breeding activities for creation of new and more superior varieties.

Keywords: tobacco *Nicotiana tabacum* L., diallel cross, inheritance, heterosis, heterotic effect

There is great probability that new lines with preferred characters can be obtained from the varieties with high heterotic effect.

Introduction

Heterosis is the phenomenon where F1 progeny of genetically divergent lines and varieties is more vigorous than in parents. It is used in mass production especially of side-fertilizing cultures, in which it is difficult to obtain homogenous and stable varieties and where each subsequent reproduction differs from the previous ones due to the free fertilization.

Heterosis is not used in the production and breeding of oriental tobacco because it is considered as economically unjustified measure. However, genetic investigations on inheritance of characters in various crops have always been completed by determination of the heterotic effect in F1 hybrids. Genetic mechanism of the heterosis enables early prognosis of the breeding value of hybrid combinations.

Hybrid vigor of F1 hybrids in different tobacco varieties has been investigated in many papers, but we only present those in which oriental tobaccos are included. Marani and Sachs (6) obtained positive heterosis for height and leaf number in hybrids of oriental tobacco. Matzinger and Wernsman (7) recorded positive heterosis only for stalk height in flue-cured and oriental varieties. Tomov (9) found strong positive heterotic effect for stalk height in domestic varieties of oriental tobacco. Jung et al. (2), in diallel analysis of six oriental and fifteen F1 hybrids revealed positive heterosis for stalk height, leaf number and yield, with strong heterotic effects in hybrids Samsun x Izmir and Xanthi x Izmir). Terrill et al. (8) revealed positive heterosis for stalk height and yield in 12 varieties of sun-cured, flue-cured, dark-fired, Burley, Maryland and cigar tobacco and their diallel F1 hybrids. Lee & Chang (5) found positive heterosis

for leaf length and width and for leaf mass yield in their analysis of local and oriental Korean varieties and 28 F1 hybrids. Kara & Esendal (3) in six oriental varieties and their 15 F1 hybrids (excluding reciprocal crosses) revealed negative heterosis for leaf number and significant heterosis for yield (the average yield of the hybrids was 15.2% higher than the parents). Korubin-Aleksoska (4) in analysis of three oriental varieties and one semi-oriental and their diallel F1 progenies found positive heterosis for stalk height (YV 125/3 x FO), for middle belt leaf area and dry mass yield (P 12-2/1 x P-2 and P-2 x YV 125/3) and for green mass yield (P 12-2/1 x P-2). The cross P-2 x YV 125/3 showed negative heterosis for leaf number per stalk. The authors reported that application of heterosis in tobacco production is economically unjustified (except for hybrids resistant to some disease).

The aim of these investigations is to estimate the heterotic effect for major quantitative characters in F1 generation on various tobacco genotypes, making a contribution to genetic investigations of this crop, and also to predict the perspective of the new lines.

Materials and Methods

Investigations on major quantitative characters and heterotic effect in F1 progeny was performed with four tobacco varieties, three of which were oriental (Suchum S1 with pink flowers, Suchum S2 with white flowers and Prilep P-84 with red flowers) and one large-leaf variety (Burley B- 2/93 in CMS form).

The diallel crossings provided the maximum number of combinations that can be made between some parental genotypes.

Crossings were made in the Experimental field of Tobacco Institute-Prilep during 2006-2007. The seed from six combinations for F1 generation was obtained by hand castration and pollination. The trial was set up during 2007-2008 in randomized blocks with four replications. Investigations included parental genotypes and progenies of the following F1 hybrids:

1. Burley B-2/93 x Suchum S1
2. Burley B-2/93 x Suchum S2
3. Burley B-2/93 x Prilep P-84
4. Suchum S1 x Suchum S2

5. Suchum S1 x Prilep P-84

6. Suchum S2 x Prilep P-84

Each replication was performed at an area of 147.6 m². The whole trial was set up at of 590.4 m² usable area, i.e. at 838 m² total area, together with the paths.

All suitable cultural practices were applied during the growing season.

Analysis was made on the following quantitative traits: stalk height with inflorescence, stalk height without inflorescence, leaf number per stalk, middle belt leaf area, green mass yield per stalk and dry mass yield per stalk.

The first three characters were investigated in the period of tobacco flowering, at the end of July and August. 50 stalks from each replication were measured, or a total of 200 stalks from the whole trial, with the same number of leaves from the middle primings.

Leaf area was calculated by multiplication of their length and width with the coefficient $k=0,6354$.

Green mass yield was measured after each harvest. Total weight of tobacco from each plot was added and the addition was divided with the number of stalks from which tobacco leaves were picked. The same method was used to calculate dry mass yield per stalk, i.e. tobacco was measured after manipulation and formulae for corrected yield were applied.

Processing of results

Data obtained from measurements of each character by combinations for parental genotypes and their F1 progeny were processed by the variational-statistical method.

Mode of inheritance was estimated according to the test-significance of the mean value of F1 progeny compared to the parental average (1). Significantly higher mean value of the hybrid obtained from parent with higher average value denotes the appearance of positive heterosis (+h), whereas significantly lower mean value of the hybrid obtained from parent with lower average value denotes negative heterosis (-h).

Heterosis (h) is a phenomenon in which the progeny of the first generation possesses more strongly expressed characters, both positive and negative, compared to the parents. Its effect is estimated as follows:

$$h = \overline{F1} - \overline{BP} ,$$

where:

$\overline{F1}$ - mean value of F1 generation

\overline{BP} - mean value of the better parent

Standard error of heterosis in relation to \overline{BP} is estimated by

$$\text{the formula: } Se(h) = \sqrt{\text{variance of } h}$$

The significance of F1 generation in relation to \overline{BP} is tested

$$\text{with t-test: } t = \frac{\overline{F1} - \overline{BP}}{SE(h)}$$

Meteorological data

Manifestation of quantitative characters greatly depends on the effect of environmental factors. In 2007, during tobacco growth in field (May-September), mean monthly temperature was 20.88°C and the number of rainy days was 41, with total amount of precipitation 229.9 mm. In the same period in 2008, mean monthly temperature was 19.91°C and the number of rainy days was 39, with total amount of precipitations 235.4 mm.

Values of the above parameters indicate optimum climate conditions for production of oriental tobaccos. They reveal approximately identical conditions in both investigating years.

Results and Discussion

Heterosis (h) is a consequence of heterozygosity of F1

progeny, in which some diallel and non-allelic genes in interaction affect certain character, exceeding the parents in positive or negative direction. Expression of the strength of this phenomenon is called heterotic effect. It is manifested only in F1 generation, while in the successive generations it disappears, due to impossibility of its fixation.

The reveal of heterosis is based on previous investigations on inheritance of the characters. In our two-year investigation, the highest among parents was the large-leaf variety B-2/93, and P-84 was the shortest. Among hybrids, B-2/93 x Suchum S1 was the highest, while S1 x P-84 and S2 x P-84 were the shortest. The highest leaf number among parental genotypes was observed in P-84 and the lowest in B-2/93, while among hybrids this character was highest in S1xS2 and lowest in crossings where B-2/93 was one of the parents. The largest leaves and highest yield of green and dry mass were observed in B-2/93, whereas the smallest leaf and lowest green and dry mass yields were found in P-84. Among hybrids, predominant for all three characters were those in which B-2/93 was one of the parents. The smallest leaf area and lowest green and dry mass yield was noticed in S1 x P-84 and S2 x P-84, in which negative heterosis appeared. Values for the quantitative characters in parents and F1 progeny are presented at **Table 1**.

TABLE 1

Inheritance of some quantitative characters from parents of the F1 progeny and occurrence of heterosis

Parents and F1 hybrids	Quantitative characters											
	Stalk height with inflorescence (cm)		Stalk height without inflorescence (cm)		Leaf number/stalk		Middle belt leaf area (cm ²)		Green mass yield / stalk (g)		Dry mass yield / stalk (g)	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
1. Burley B-2/93	170	153	147	142	36	34	1264	1138	1099	1017	185	178
2. Suchum S1	79	77	70	68	47	45	230	205	267	210	26	25
3. Suchum S2	88	77	69	67	47	45	239	220	260	208	26	25
4. Prilep P-84	65	64	58	57,	53	52	146	138	160	158	24	24

5. B-2/93 x S1	120	118	105	103	35	34	1063	1016	813	800	132	130
6. B-2/93 x S2	118	116	102	102	36	34	1074	988	811	808	133	130
7. B-2/93 x P-84	111	108	100	91	37	35	903	832	795	790	122	117
8. S1 x S2	80 +h	78 +h	70 +h	69 +h	47	45	233	210	269 +h	210 +h	26 +h	25 +h
9. S1 x P-84	78	77	71	69	43 -h	42 -h	185	173	133 -h	130 -h	23 -h	23 -h
10. S2 x P-84	78	77	72 +h	70 +h	45 -h	43 -h	174	158	135 -h	133 -h	24	24

Positive significant heterotic effect for stalk height both with and without inflorescence appeared in S1 x S2, and only for stalk height without inflorescence in the S2 x P-84. Positive heterotic effect for this character was also reported (2, 4, 6, 7, 8 and 9).

Negative heterotic effect for leaf number was observed in S1 x P-84 and S2 x P-84. The same effect for this character was also reported (3 and 4).

Positive heterotic effect for green and dry mass yields in our investigations was observed in S1 x S2. The same effect for this character was also reported (2, 3, 4, 5 and 8). Negative heterotic effect for green and dry mass yields was found in S1 x P-84, and only for green mass yield in S2 x P-84.

Heterotic effect of the characters that were subject of our investigation is presented in **Table 2**.

TABLE 2

Heterotic effect of quantitative characters in F1 hybrids

F1 hybrids	Quantitative characters											
	Stalk height with inflorescence (cm)		Stalk height without inflorescence (cm)		Leaf number/stalk		Middle belt leaf area (cm ²)		Green mass yield / stalk (g)		Dry mass yield / stalk (g)	
	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008	2007	2008
B- 2/93 x S1												
B- 2/93 x S2												
B-2/93 x P-84												
S1 x S2	+ 0.25	+ 1.14	+ 0.22	+ 1.02					+ 2.17	+ 0.86	+ 0.37	+ 0.26

S1 x P - 84					- 4.91	- 2.41			- 26.49	- 27.62	- 0.87	- 0.94
S2 x P - 84			+ 2.26	+ 2.03	- 4.91	- 1.99			- 24.62	- 24.61		

Conclusions

On the basis of presented data and analysis, the following conclusions can be drawn:

- a) Selected parents (Burley B-2/93, Suchum S1, Suchum S2 and P-84) are genetically homogeneous and significantly different;
- b) Application of the method of diallel crossing provides the maximum number of combinations which can be realized among parental genotypes;
- c) Positive heterotic effects for stalk height both with and without inflorescence, as well as for green and dry mass yields, were observed in hybrid S1 x S2, and only for the stalk without inflorescence in S2 -P-84. Negative heterotic effect for leaf number per stalk and for green and dry mass was found in hybrid S1 x P-84, whereas for leaf number and green mass yield it was observed in S2 x P-84;
- d) F1 hybrids in which heterotic effect was determined present a good basis for new perspective lines with better characters than their parents, which will be selected and stabilized in successive generations.

REFERENCES

1. **Borojević S.** (1981) Principi i metode oplemenjivanja bilja, Čirpanov, Novi Sad.
2. **Jung S.H., Hwang J.K. and Son S.H.** (1982) J. Korean Soc. Tob. Sci., **4-1**, 7-13.
3. **Kara S.M. and Esendal E.** (1995) Tob. Res., **21-1/2**, 16-22.
4. **Korubin - Aleksoska A.** (2008) Tutun, **5-6**, 113-119.
5. **Lee J.D. and Chang K.Y.** (1984) J. Korean Soc. Tob. Sci., **6** (1), 3-11.
6. **Marani A. and Sachs Y.** (1966) Crop. Sci., **6**, 19-22.
7. **Matzinger D.F. and Wernsman E.A.** (1968) Tob. Sci., **12**, 177-180.
8. **Terrill T.R., Aycock M.K., Link L.A. and Conner D.L.** (1982) In: Bul. Spec. CORESTA, Symposium Winston - Salem, p.80.
9. **Tomov N.** (1975) Nauk. Trud. Inst. Tjutjuna tjut. Izdel. Plovdiv, **5**, 39-56.