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DEGREE OF INHERITANCE AND HERITABILITY OF YIELD IN PARENTAL GENOTYPES AND F_1 HYBRIDS OF TOBACCO

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Abstract: The mode and level of inheritance of green and dry mass yield per stalk were investigated in four parental genotypes (Burley - B 2/93, Suchum - S1, Suchum - S2 and Prilep - P-84) and in their six diallel F_1 hybrids. The trial was set up in 2007, 2008 and 2009 in the field of Tobacco Institute-Prilep in a randomized block design with four replications. The aim of the investigation was to estimate the heritability as an indicator of the inheritance of the yield as one of the most important quantitative characters of tobacco, in order to give suggestions for the selection of parental genotypes and directions for the creation of new varieties. The mode of inheritance was estimated according to the test - significance of the mean value of F_1 progeny compared to the parental average. Narrow-sense heritability was estimated after Allard (1960), while broad-sense heritability and genetic components were estimated after Mather and Jinks (1974). The mode of inheritance in the hybrids was different. Positive heterosis for green and dry mass yields per stalk was recorded in S1 x S2. Negative heterosis for green mass yields per stalk was recorded in S1 x P-84 and S2 x P-84, while for dry mass yield it was recorded in S1 x P-84. Inheritance of the characters during the three years of investigation was identical. The higher heritability index of both types was recorded for dry mass yield. As regards inheritance of the yield, the values of broad-sense heritability were higher than those of narrow-sense heritability.

Key words: tobacco, heredity, green and dry mass yield per stalk, heterosis, narrow-sense and broad-sense heritability (h^2).

Introduction

The indicator of inheritance known as heritability is genetic index for a prognosis of the selection results. Many authors made investigations into the inheritance of characters in various cultures, including tobacco. Povilaitis (1966) reported low heritability in a diallel set of eight flue-cured varieties for leaf number

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and yield per stalk, while for leaf area the highest heritability was recorded in top leaves. Espino and Capote (1976), in diallel of seven dark tobacco varieties, reported medium heritability for stalk height and leaf number and low heritability for yield per stalk. Ibrahim and Avratovscukova (1982), in five flue-cured varieties and ten diallel F_1 hybrids, recorded high to moderate broad-sense heritability for stalk height and yield, and moderate heritability for leaf number per stalk. Dobhal (1987) reported high heritability for leaf number in 25 genotypes of cigar wrapper tobacco. In 55 genotypes of *Nicotiana rustica* (hookah and chewing tobacco), Naumovski (1987) reported high heritability in a diallel of oriental tobacco for leaf number. Dobhal and Nageswara Rao (1988) reported moderate heritability for stalk height and yield. Legg (1989), in seven homozygous genotypes of dark and flue-cured tobacco and 21 F_1 hybrids, found heritability high enough to justify the process of selection. Chaubey et al. (1990) obtained high heritability for leaf number and yield per stalk in 72 genotypes of *Nicotiana rustica*. Butorac (1999) investigated four parental varieties of Burley tobacco and their diallel F_1, F_2, BC_1 and BC_2 progenies and reported that their broad-sense heritability was higher than the narrow-sense heritability. The highest heritability was estimated in inheritance of the leaf area and the sixth leaf weight. Korubin-Aleksoska and Aleksoski (2009) in three oriental and one semi-oriental variety and their F_1 and F_2 progenies obtained very high index for both types, with predominance of the broad-sense heritability.

The aim of the three-year investigation was to determine the mode and grade of inheritance of the yield per stalk of F_1 progeny in four varieties in order to improve our knowledge of the genetic nature and to give further directions in selection of tobacco.

Materials and Methods

Four tobacco genotypes were included in investigations: one large-leaf - Burley B2/93 (Figure 1) and three oriental - Suhum S1 and S2 (Figure 2 and Figure 3) and Prilep P-84 (Figure 4), together with their six diallel F_1 hybrids (Aleksoski, 2009). The trial with parental genotypes and their F_1 progenies was set up in 2007, 2008 and 2009 in the field of Scientific Tobacco Institute-Prilep in randomized blocks with four replications. The area of each replication was 150 m^2 and the area of the total trial was 600 m^2. All suitable cultural practices were applied during the growth period of tobacco.

In 2007, during tobacco growth in field (May-September), mean monthly temperature was 20.88^oC and the number of rainy days was 40, with 229.9 mm of the total amount of precipitation. In the same period in 2008, mean monthly temperature was 19.91^oC, the number of rainy days 39 and the total amount of precipitation 235.4 mm. In 2009, mean monthly temperature was 19.89^oC, the number of rainy days 42 and the total amount of precipitation 240.6 mm.

The green and dry mass yields per stalk were investigated in this paper. Data obtained for each character were analysed using the analysis of variance.

Mode of inheritance was determined by test-significance of the mean values in F_1 progeny and their comparison with parental averages (Borojević, 1981).

Heritability (h^2) is the ratio between the components of genetic and phenotypic variance. It can be presented in two ways and it is expressed in percentages.

Figure 1. Burley B 2/93.

Figure 2. Suchum S1.

Figure 3. Suchum S2.

Figure 4. Prilep P-84.

Narrow-sense heritability in some combinations was calculated as the ratio of the additive component of the genetic variance to the phenotypic variance according to the formula of Allard (1960):

$$h^2_{NS} = VA/VP \text{ or } h^2 = \frac{\sigma^2 F_2 - \frac{\sigma^2 P_1 + \sigma^2 P_2 + \sigma^2 F_1}{3}}{\sigma^2 F_2} \cdot 100$$

Broad-sense heritability for all combinations of F_1 progeny is the ratio of the total genetic variance (additive and dominant) to the phenotypic variance, and is calculated using the formula of Mather and Jinks (1974):

$$h^2_{BS} = (VA + VH)/VP \text{ or } h^2 = \frac{\frac{1}{2}D + \frac{1}{2}H_1 - \frac{1}{4}H_2 - \frac{1}{2}F}{\frac{1}{2}D + \frac{1}{2}H_1 - \frac{1}{4}H_2 - \frac{1}{2}F + E}$$

Estimation of the genetic components D, H_1, H_2 and F was made after Mather and Jinks (1974).

Results and Discussion

Our three-year investigation revealed different modes of inheritance. The inheritance of green mass yield per stalk in progenies with B 2/93 as one of the parents was partially dominant. Positive heterosis occurred in S1 x S2 and negative heterotic effect was recorded in the hybrids S1 x P-84 and S2 x P-84 (Table 1).

Table 1. Mode of inheritance for green mass yield per stalk (g) in F_1 progeny.

Parents and F_1 hybrids	2007	2008	2009	$\bar{x}$
	$\bar{x}$	$\bar{x}$	$\bar{x}$	
1. P1	1098.63	1016.90	1100.24	1071.92
2. P2	267.27	209.64	283.18	253.36
3. P3	260.45	207.65	275.41	247.84
4. P4	159.73	157.88	169.35	162.32
5. P1 x P2	812.77 pd	800.19 pd	812.93 pd	808.63 pd
6. P1 x P3	811.58 pd	808.36 pd	824.11 pd	814.68 pd
7. P1 x P4	795.45 pd	790.55 pd	832.39 pd	806.13 pd
8. P2 x P3	269.44 +h	210.50 +h	294.27 +h	258.07 +h
9. P2 x P4	133.24 -h	130.26 -h	146.32 -h	136.61 -h
10. P3 x P4	135.11 -h	133.27 -h	148.24 -h	138.87 -h

P1 - Burley B - 2/93; P2 - Suchum S1; P3 - Suchum S2; P4 - Prilep P - 84; i - Intermediate; pd - Partial dominance; d - Dominance (positive and negative); h - Heterosis (positive and negative).

Modes of inheritance and average values for dry mass yield per stalk in the investigating period are presented in Table 2. Positive heterosis was observed in S1 x S2 and negative heterosis in S1 x P-84.

Inheritance of the characters during the three years of investigation was identical.

Table 2. Mode of inheritance for dry mass yield per stalk (g) in F_1 progeny.

Parents and F_1 hybrids	2007	2008	2009	$\bar{x}$
	$\bar{x}$	$\bar{x}$	$\bar{x}$	
1. P1	185.43	177.85	190.55	184.61
2. P2	25.99	24.73	26.04	25.59
3. P3	26.03	25.03	26.17	25.74
4. P4	24.01	23.68	24.49	24.06
5. P1 x P2	132.15 pd	129.88 pd	130.42 pd	130.82 pd
6. P1 x P3	133.24 pd	130.04 pd	145.95 pd	136.41 pd
7. P1 x P4	122.15 i	117.33 i	116.31 i	118.60 i
8. P2 x P3	26.40 +h	25.29 +h	26.88 +h	26.19 +h
9. P2 x P4	23.14 -h	22.74 -h	23.79 -h	23.22 -h
10. P3 x P4	24.05 -d	23.75 -d	24.29 -d	24.03 -d

P1 - Burley B - 2/93; P2 - Suchum S1; P3 - Suchum S2; P4 - Prilep P - 84; i - Intermediate; pd - Partial dominance; d - Dominance (positive and negative); h - Heterosis (positive and negative).

Our investigation into the green and dry mass yield per stalk of tobacco showed high values for both types of heritability, which indicates the presence of a very high genetic variability and insignificant environmental variability. For these reasons, the investigated characters appeared to be highly heritable, i.e. their manifestation can be easily predicted and their faster stabilization can be obtained.

Table 3. Heritability of the yield in F_1 progeny.

Heritability (%)	2007		2008		2009	
	Green mass yield per stalk	Dry mass yield per stalk	Green mass yield per stalk	Dry mass yield per stalk	Green mass yield per stalk	Dry mass yield per stalk
Narrow-sense (h^2_{NS})	0.9578	0.9714	0.9418	0.9687	0.9492	0.9788
Broad-sense (h^2_{BS})	0.9965	0.9954	0.9983	0.9988	0.9972	0.9989
Difference	0.0387	0.0240	0.0565	0.0301	0.0480	0.0201

The highest heritability for both heritability types (Table 3) was recorded for dry mass yield per stalk in 2009 (h^2_{NS} = 0.9788, h^2_{BS} = 0.9989). The lowest values

for narrow-sense heritability was recorded for green mass yield per stalk in 2008 (h^2_{NS} = 0.9418). The lowest value for broad-sense heritability for the same character was recorded in 2007 (h^2_{BS} = 0.9965).

High heritability values for the yield were also reported by the following authors: Ibrahim and Avratovscukova (1982) in five flue-cured varieties and ten F_1 hybrids, Chaubey et al. (1990) in 72 genotypes of *Nicotiana rustica*, Butorac (1999) in a diallel of four Burley varieties, Korubin-Aleksoska and Aleksoski (2009) in a diallel of three oriental and one semi-oriental variety.

The mentioned authors reported higher broad-sense heritability compared to the narrow-sense heritability, which coincides with the results presented in this paper.

Conclusion

Parental genotypes B 2/93, S1, S2 and P-84 and their F_1 progenies are uniform. The most frequently inherited for the yield was partial dominance. Positive heterosis for green mass yield and dry mass yield per stalk was observed in S1 x S2. Negative heterotic effect for green mass yield was observed in S1 x P-84 and S2 x P-84, while for dry mass yield in S1 x P-84. The mode of inheritance of quantitative characters was identical in all three years of investigation.

A higher value of both heritability types was recorded for dry mass yield. In average, the values for broad-sense heritability were 0.036% higher than those for narrow-sense heritability.

Based on the percentual value of the narrow- and broad-sense heritability, it can be concluded that high genetic variance is present in expression of the characters, which indicates their fast fixation and stabilization in further generations.

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STEPEN NASLEĐIVANJA I HERITABILNOST PRINOSA KOD RODITELJSKIH GENOTIPOVA I F_1 HIBRIDA DUVANA

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R e z i m e

Način i nivo nasleđivanja prinosa zelene i suve mase po stabljici je istraživan kod četiri roditeljska genotipa (Burley - B 2/93, Suchum - S1, Suchum - S2 i Prilep - P-84) i njihovih šest dialelnih F_1 hibrida. Ogled je postavljen 2007, 2008 i 2009 na poljskom imanju Instituta za duvan-Prilep po principu slučajnog blok sistema u četiri ponavljanja. Cilj ovog istraživanja je bio da se proceni heritabilnost kao pokazatelj nasleđivanja prinosa kao jedan od najvažnijih kvantitativnih karakteristika duvana, kako bi se mogle dati sugestije za selekciju roditeljskih genotipova i uputstva za stvaranje novih sorti. Način nasleđivanja je procenjen prema testu značaja srednje vrednosti F_1 potomstva u poređenju sa roditeljskom srednjom vrednošću. Vrednosti heritabilnosti u užem smislu su procenjene prema Allardu (1960), dok su vrednosti heritabilnosti u širem smislu i genetičke komponente procenjene prema Matheru i Jinksu (1974). Način nasleđivanja kod hibrida je različit. Pozitivan heterozis za prinose zelene i suve mase po stabljici je zabeležen kod S1 x S2. Negativan heterozis za prinos zelene mase po stabljici je zabeležen kod S1 x P-84 i S2 x P-84, dok je za prinos suve mase zabeležen kod S1 x P-84. Nasleđivanje karakteristika tokom tri godine istraživanja je identično. Veći indeks heritabilnosti kod oba tipa je bio zabeležen za prinos suve mase. Kod nasleđivanja prinosa, vrednosti heritabilnosti u širem smislu su bile više nego vrednosti heritabilnosti u užem smislu.

Ključne reči: duvan, naslednost, prinos zelene i suve mase po stabljici, heterozis, heritabilnost u užem i širem smislu (h^2).

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