

# Studies on the inheritance of agronomic traits in hybrids of different types of tobacco

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## Abstract

The aim of the paper is to study the inheritance of: green and dry leaf and seed yield per plant, as well as to detect heterosis in four F<sub>1</sub> hybrids obtained by crossing five varieties, four of which are Oriental in the role of mother and a Burley as a father, in 2019 and 2020. The most common mode of inheritance is the intermediate, and then the partial-dominant. There is no heterosis in the inheritance of green and dry leaves yield per plant, while for the yield of seeds in all combinations there is positive heterosis. The highest heterotic effect has MS 8/1 x B-9/91.

The mode of inheriting the agronomic traits per plant indicates a shorter and more reliable successive selection when creating superior varieties. The paper indicates further research into hybrids with strong heterosis for seed yield, in line with new trends in alternative tobacco use.

**Keywords:** tobacco (*Nicotiana tabacum* L), leaf-yield, seed-yield, inheritance, heterosis.

## Introduction

Tobacco is a plant used by humans for centuries in various ways, most often for smoking. Today there is a strong propaganda about its harmful effect on human health. Therefore, efforts are being made for alternative use of this crop in the direction of seed production, extraction of oil from it and providing renewable sources of biomass and biofuel. However, there is a huge number of smokers who, despite the anti-advertising, do not give up the pleasure offered by this ancient culture.

The aim of this investigations is to study the mode of inheritance and to discover a possible heterotic effect on the yield of green and dry leaf mass and seed yield per plant in the F<sub>1</sub> generation obtained by crossing varieties from different types, which will give important guidelines for future selection programs for tobacco breeding in the direction of increasing leaf yield and seed yield.

## Material and methods

For genetic studies on inheritance of green and dry leaf mass yield and seed yield, five varieties of tobacco were selected, four of which in the role of mother: three of the type Prilep (P-23, P 18-50/4 and P 76/86), one of the Basmak type (MS 8/1), and the Burley variety B-9/91 in the role of a father.

In 2018, in field conditions, with manual castration and pollination, four crosses were made: P-23 x B-9/91, P 18-50/4 x B-9/91, P 76/86 x B-9/91 and MS 8/1 x B-9/91.

In 2019, at the Experimental Field at the Scientific Tobacco Institute - Prilep, we set up an experiment with nine genotypes (five parents and four F<sub>1</sub> hybrids), according to a Randomized block system in four replications. Oriental genotypes are planted at 45 x 15 cm, large-leaf variety B-9/91 at 80 x 50 cm, while F<sub>1</sub> hybrids at 60 x 30 cm. In the same

year we collected seeds for the second generation and again made the same crosses from which we collected seeds for the first generation.

In 2020, an experiment was set up using the same method, in which the same set of nine genotypes was planted. The paper presents two-year results from the first generation.

The yield of green leaf mass was measured after each harvest, the weight of all harvests from each plot was valued and divided by the number of plants from which the tobacco was harvested, giving us the weight of the green leaf per plant. Dry leaf yield was measured and calculated after tobacco manipulation. Seed yield is an average of 10 plants per repetition or 40 plants out of four repetitions. The obtained results are processed statistically. The mode of inheritance of traits is determined on the basis of test significance from the mean value of the F<sub>1</sub> generation relative to the average of both parents, according to Borojevic (1981).

### **Results and discussion**

Yield is a priority and its increase is an eternal aspiration for every breeder. Usually yield and quality do not go in the same direction. Therefore, the duty of the breeder is to increase the yield in his creations, without compromising the quality. This paper covers genetic studies on the inheritance of leaf and seed yields in tobacco.

The highest yield of green leaf mass per plant among the parent genotypes in 2019 and 2020 is the large-leaf aer-cured variety B-9/91, and among the oriental parents the variety P 76/86. The most productive F<sub>1</sub> hybrid is P 76/86 x B-9/91, and the least productive is P-23 x B-9/91.

The same rank is obtained for the yield of dry leaf mass per plant in the two years of investigations, because it is in same genome of heredity.

MS 8/1 is characterized by the highest yield of seed per plant, and with the lowest P 18-50/4. Among the F<sub>1</sub> hybrids MS 8/1 x B-9/91 has the highest and P-23 x B-9/91 the lowest seed yield per plant.

Inheritance of green leaf mass yield per plant in 2019 and 2020 in F<sub>1</sub> offspring is intermediate. Only P-23 x B-9/91 has partial dominance. The mode of inheritance points to fast and reliable selection in the process of creating new superior varieties.

An identical inheritance occurs for the dry leaf mass yield per plant in the two years of investigation.

The same mode of inheriting in leaf yield was obtained by: Gixhari & Sulovari (2010), in their three-year research on two sites in a genetically diverse population of eight oriental tobaccos and their one-way diallel hybrids, and found heterosis; Aleksoski & Korubin – Aleksoska (2011), in a three-year study of a one-way diallel of three oriental and one large-leaf variety and their six F<sub>1</sub> crosses, found both positive and negative heterosis; Imtiaz et al. (2014), in an experiment conducted in Khan Gari, Mardan, Pakistan, with seven Virginia flue-cured genotypes and their 42 two-way diallel crosses, found heterosis with a high heterotic effect and the possibility of its utilization; Kinay & Yilmaz (2016), in experiments with hybrids obtained by semi-diallel crosses between varieties: Xanthi-2A, Nail, Gümüřhacıköy, Tařova, Katerini, Canik and Erbaa, in the province of Tokat in Turkey, found an average heterosis of 28.4%. The heterotic effect on dry mass yield was 4%; Ganachari et al. (2018), in six flue-cured tobaccos and their 30 crosses, at ZAHRS (Zonal Agricultural and Horticultural Research Station), College of Agriculture - Shivamogga, Karnataka - India, and identified five hybrids that showed a highly significant heterotic effect; Aleksoski (2019), in a one-way diallel of four small-leaf aromatic and one large-leaf flue-cured variety, and their 10 F<sub>1</sub> crosses and found positive heterosis; Dyulgierski (2019), in eight Burley newly created hybrid combinations of the first generation and assessed that they are all better than the standard variety Pliska 2002, which

indicates the possibility of using heterosis in tobacco of the Burley type; Qaizar et al. (2019), in seven flue-cured varieties and lines and their complete diallel crosses, in the Mardan and Mansehra regions of Pakistan, found both positive and negative heterosis (best hybrids with a favorable significant heterotic effect for yield were: KHG24 x Spt G 28, KHG21 x NC606 and Spt G 126 x KHG24); Kinay et al. (2020), in a semi-diallel of seven genotypes (Xanthi-2A, Nail, Gümüşhacıköy, Taşova, Katerini, Canik, Erbaa) and 21 F<sub>1</sub> hybrids, tested in two locations (Erbaa and Bafra), in the Black Sea region of Turkey and obtained positive heterosis for the yield, which had no economic justification.

The biennial analysis of inheritance in seed yield per plant in all crosses informs of positive heterosis. This knowledge gives an opportunity for further studies in the field of hybridization and evaluation of the heterotic effect.

For seed yield researched: Bucciarelli et al. (2012), in two genotypes and found that Line 1917 gave a seed yield of 1.8 t/ha and a dry leaf yield of 1.93 t/ha, while the G105 variety gave a seed yield of 1.47 t/ha and dry leaf yield of 1.51 t/ha. The weight of 1000 seeds in Line 1917 is 73 mg, and in G105 69 mg; Grisa et al. (2016), in the Solaris variety for alternative tobacco production in Italy, carried by the idea that tobacco could indeed become a new industrial crop that offers opportunities for its use to obtain biomass and biofuel, recorded 31 to 34g of seeds per plant, or 1.1-1.8 t/ha from one harvest, with oil yield up to 0.59 t/ha. From two seed harvests they determined a total seed yield of 4.5 t/ha, from which 1.48 t of oil / ha can be obtained.

Table 1. shows the mean values for the yield of green leaf mass, dry leaf mass and seed per plant in the parent genotypes and their diallel F<sub>1</sub> offspring, as well as the mode of inheritance for the traits in 2019 and 2020.

Table 1. Mode of inheritance for the yield of green leaves, dry leaves and seeds per plant of F<sub>1</sub> hybrids in 2019 and 2020

No.	Genotypes and F <sub>1</sub> hybrids		Yield per plant (g)			Yield per plant (g)		
			2019			2020		
			Green leaves	Dry leaves	Seeds	Green leaves	Dry leaves	Seeds
			$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$	$\bar{x}$
1.	P-23	P1 (♀)	113.14	19.13	11.32	127.66	20.86	10.55
2.	P 18-50/4	P1 (♀)	123.11	20.14	10.41	125.59	20.48	10.30
3.	P 76/86	P1 (♀)	142.10	22.17	10.88	144.82	22.20	11.00
4.	MS 8/1	P1 (♀)	102.71	16.52	11.36	104.19	16.39	11.38
5.	B-9/91	P2 (♂)	1296.53	179.69	10.78	1302.07	184.29	10.98
6.	P-23 x B-9/91	F <sub>1</sub>	502.82 <sup>pd</sup>	75.18 <sup>pd</sup>	16.27 <sup>+h</sup>	513.82 <sup>pd</sup>	75.58 <sup>pd</sup>	16.55 <sup>+h</sup>
7.	P 18-50/4 x B-9/91	F <sub>1</sub>	594.56 <sup>1</sup>	88.82 <sup>1</sup>	16.48 <sup>+h</sup>	603.07 <sup>1</sup>	89.41 <sup>1</sup>	17.11 <sup>+h</sup>
8.	P 76/86 x B-9/91	F <sub>1</sub>	726.84 <sup>1</sup>	103.86 <sup>1</sup>	17.05 <sup>+h</sup>	737.15 <sup>1</sup>	106.04 <sup>1</sup>	16.86 <sup>+h</sup>
9.	MS 8/1 x B-9/91	F <sub>1</sub>	558.53 <sup>1</sup>	82.93 <sup>1</sup>	23.24 <sup>+h</sup>	555.75 <sup>1</sup>	80.53 <sup>1</sup>	23.52 <sup>+h</sup>
LSD <sub>0.05</sub> =			33.66	8.39	1.65	25.75	5.59	0.74
0.01 =			60.58	15.11	2.97	46.34	10.07	1.32

## Conclusions

- Inheritance of green leaf mass yield per plant in F<sub>1</sub> hybrids in 2019 and 2020 is intermediate, with the exception of P-23 x B-9/91 where there is partial dominance. Exposed mode of inheritance indicates rapid and reliable successive selection in the process of creating new superior varieties.

- A completely identical mode of inheritance occurs for the yield of dry leaf mass per plant, because it is in same genome, carrier of the inheritance of the trait.
- The biennial analysis of the inheritance of seed per plant in all crosses informs about positive heterosis. This knowledge provides an opportunity for further studies in the field of hybridization and evaluation of heterotic effect.
- The inheritance of the yield is identical in the both years of investigations, which means that the traits are varietal characteristics, and on which environmental factors have a limited impact, but also that there is a professional approach to the overall work.
- The results of this paper are an excellent original source material for further successive selection activity in the direction of obtaining varieties with higher yield of leaf mass, and varieties with higher seed yield.
- The paper reveals the possibility of seed production and oil extraction from it, in line with new trends for alternative use of tobacco in providing renewable sources of biomass and biofuel.

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## **Studije o naslijeđivanju agronomskih svojstava kod hibrida različitih tipova duhana**

### **Sažetak**

Cilj rada je proučavanje naslijeđivanja prinosa zelenog i suhog lista i sjemena po stabljici, kao i otkrivanje heterozisa kod četiri F1 hibrida dobivena križanjem pet sorti, od kojih su četiri orijentalne u ulozi majke i jedna berlejska u ulozi oca, 2019 i 2020 godine.

Najčešći način naslijeđivanja svojstava je intermedijarni, zatim parcijalno-dominantni. Ne postoji heterozis u naslijeđivanju prinosa zelenog i suhog lišća po stabljici, dok postoji za prinos sjemena u svim kombinacijama. Najveći heterotični učinak ima MS 8/1 x B-9/91.

Način naslijeđivanja agronomskih svojstava po stabljici ukazuje na kraću i pouzdaniju sukcesivnu selekciju pri stvaranju superiornih sorti. U radu se ukazuje na daljnja istraživanja hibrida s jakim heterozisom za prinos sjemena, u skladu s novim trendovima u alternativnoj upotrebi duhana.

**Cljučne riječi:** duhan (*Nicotiana tabacum* L), prinos lista, prinos sjemena, naslijeđe, heterozis