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Biological indicators of Bulgarian and introduced Burley tobacco varieties

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Abstract

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The biological indicators of ten Bulgarian and introduced Burley tobacco varieties were analyzed. The analysis showed that the expression of the biological indicators is closely related to the genotype and is insignificantly influenced by the environmental conditions. The most favorable results for all morphological features and the length of the vegetation period was for the Burley 1344 variety, which can be used in the breeding programs as a donor to improve the biological parameters of Burley tobacco. In the other studied varieties of Burley tobacco, there was uniformity in morphological parameters. Pliska 2002 variety was not suitable for the Burley tobacco standard, because it presents with a small leaf width in the middle harvesting belt and too long vegetation period for the Burley tobacco varieties. Bulgarian varieties were more favorable biological indicators that those of the introduced varieties. From the introduced varieties with optimal biological parameters was characterized Burley 21 variety.

Keywords: Burley tobacco; biological indicators; biological assessment; varieties

Introduction

There were many indicators that determine the variety characteristics of tobacco (Risteski et al., 2010). The most important are: height, number of leaves, size and shape of the leaves, length of vegetation period (Korubin-Aleksoska, 2001; Masheva, 2009). All of them directly or indirectly determine the yield that is the main agronomic indicator (Hong and Jung, 1980; Chinchev, 1988). One of the most important varietal characteristics is the height of the stem (Tomov, 1972, 1985). As the height of stem grows, the number of leaves increases, which in turn leads to an increase in yield (Tomov, 1985; Smith and Whitley, 2004). The forms with small leaves are undesirable. However, the very large number of leaves usually reduces their size, which in turn reduces the percentage of classes. Increasing the number of leaves can be achieved either by increasing the height of the plant or by increasing the number of leaves per linear meter, which is preferable (Snell, 2006). The sizes of the leaves were of great importance for both yield and quality (Tomov, 1985; Docheva et al., 2015). According to Palmer et al. (2007), the sizes of the leaves were the main feature that determines the yield. Therefore, the increase in yield must be done primarily by increasing the size of the leaves, then by their number, thickness, etc.

The length of vegetation period is one of the main characteristics of all types of tobaccos as it has a direct relation to yield and quality (Chinchev, 1988). Bridges et al. (1994) report that the selection is undesirable both in the direction of reduction and in its extension of the vegetation period. In the first case, the yield of the plants was lower and in the second the harvesting of the tobacco harvest is delayed. The shortening of the vegetation period is a priority in the selection of Burley tobacco (Risteski et al., 2012).

The aim of the present study was to make a comparative assessment of the most important biological indicators of the

most widely used Burley tobacco varieties in Bulgaria, in order to use the obtained results in the selection and production of Burley tobacco.

Materials and Methods

In order to achieve the goal set for the period 2015-2017 in the experimental fields of TTPI – Markovo, ten varieties of Burley tobacco were tested. The varieties Burley 2115, Burley 1000, Burley 1317, Burley 420, Pliska 2002 and Burley 1344 are the work of the Bulgarian selection. Burley 21, Tennessee 86, Kentucky 14 and Kentucky 17 were introduced from USA. Until 2010, Burley 21 variety was used for standard for Burley tobacco, and after that – Pliska 2002. The subject of research and analysis were the most important biological indicators for Burley tobacco: plant height, number of leaves, length and width of 7-8 leaf which correspond to size of the leaves of the lower harvesting belt; length and width of 13-14 leaf, respectively, for middle harvesting belt. The length of the vegetation period was also been estimated. 120 plants from each variant were measured.

The same cultivation technologies are applied to all variants. The drying was performed in the heating base TTPI. Field experiments were determined according to the methodology of Zapryanov and Dimova (1995).

Daily average temperatures were almost identical over the three experimental years. Falling rainfall over the three years of the study was insufficient for the growth and development of tobacco, the amount of which was extremely unevenly distributed throughout the vegetation season. The driest was 2015.

The mathematical treatment of the data was done with the SPSS 20 products applied. Experimental data were processed by the ANOVA analysis method, and variance differences were established by Dunkan Multiple Range Test (1995).

Results and Discussion

The dispersion analysis of Burley's tobacco samples tested showed a clear trend of the strong influence of genotype on all morphological characteristics (Table 1). The standard of proof of values was very high. The dominant influence of

Table 1. Analysis of variance for cured tobacco yield

	Sum of squares							df
Source of variation	Height of plants cm	Number of leaves	Length of 7-8 leaf, cm	Width of 7-8 leaf, cm	Length of 13-14 leaf, cm	Width of 13-14 leaf, cm	Length of vegetative period	
Variants	5103.5	410.9	5649.9	4928.2	6175.2	4760.5	25515.1	9
Years	35.8	1.3	9.3	1.07	0.3	6.66	26.13	2
Interactions	1171.8	8.71	165.4	25.4	53.8	242.02	422.02	18
Residual	29231.8	1604.3	3704.1	1340.4	2797.9	2093.45	4061	1170
Total	31544869	793637	4162197	1114484	389259	1143808	7895774	1200
				Mean square				
Variants	567.05	45.67	627.8	547.6	686.1	528.94	2835.01	
Years	17.89	0.65	4.7	0.5	0.174	3.33	13.06	
Interactions	65.09	0.48	9.2	1.4	2.98	13.45	23.45	
Residual	24.98	1.37	3.2	1.2	2.39	1.79	3.47	
				F				
Variants	22.7	33.3	198.3	477.9	286.9	259.61	816.8	
Years	0.7	0.48	1.5	0.46	0.07	1.86	3.8	
Interactions	2.6	0.35	2.9	1.23	1.25	7.51	6.8	
				Sig of F				
Variants	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
Years	0.489	0.621	0.23	0.628	0.93	0.156	0.023	
Interactions	0.000	0.994	0.000	0.227	0.21	0.000	0.000	
n%								
Variants	14.4	20.3	59.3	78.3	68.4	67	84.9	
Years	0.1	0.06	0.09	0.02	0.004	0.09	0.09	
Interactions	3.3	0.4	1.7	0.4	0.59	3.4	1.4	

genotype was reported for the length of the vegetation period (84.9%), the width of 7-8 leaf (78.3%), the length of 13-14 leaf (68.4%), the width of 13-14 leaf (67%) and the length of the 7-8 leaf (59.3%). These morphological features are of decisive importance in the formation of the yield (Tomov, 1985).

The impact of the year factor and the interaction between the two factors (year and variant) is comparatively low, often with a low degree of proof. For the three years of observation, the highest results for all morphological traits except for the length of the vegetation period were reported for Burley 1344 variety. The longest vegetation period for the three years of study was reported for Pliska 2002 variety.

For 2015, the lowest data for plant height, number of leaves and length of the 13-14 leaf were reported for Burley 1000 variety. Kentucky 14 variety had the lowest values in the width of the 7-8 leaf and the length of 13-14 leaf. With the lowest values for the width of 13-14 leaf was Pliska variety, and for the length of the vegetation period - Burley1317 variety (Table 2).

For 2016, the lowest plant height and size of 7-8 leaves were reported at B2115. The number of leaves and width of the 13-14 leaf were minimal for Kentucky 14 and the duration of the vegetation period is shorter for B1344 (Table 3). For 2017, the lowest values for plant height and the size of 7-8 leaf were observed for Kentucky 14 variety (Table 4).

For the three-years study period, the highest level of uniformity between the studied Burley tobacco varieties existed with respect to plants height. For the other indicators, Burley 1344 showed proved maximum values in terms of number and size of the leaves (Table 5).

Regarding to the number of leaves, a high degree of similarity occurred between Pliska 2002 and Burley 21 varieties, and between Tennessee 86 with Kentucky 17 and Burley 420 varieties, and Kentucky 14 with Burley 1000 varieties.

Table 2. Analysis of variance of the morphological indexes of the variants studied for 2015

Variants	Height of plants cm	Number of leaves	Length of 7-8 leaf, cm	Width of 7-8 leaf, cm	Length of 13-14 leaf, cm	Width of 13-14 leaf, cm	Length of vegetative period
				2015			
B1317	164.975^{a}	26.55^{a}	59.48^{e}	30.15^{d}	60.345^{c}	31.035^{c}	75.7^{f}
B1000	158.075^{e}	24.975^{e}	56.5975^{e}	31.9675^{c}	58.385^{d}	31.61^{b}	80.05^{e}
B1344	165.325^{a}	26.925^{a}	62.2725^{a}	33.3675^{a}	66.0475^{a}	34.6525^{a}	71.625^{g}
B420	162.2^{bc}	25.725^{bcd}	60.47^{b}	31.605^{c}	61.775^{b}	32.01^{b}	80.2^{e}
B2115	161.7^{c}	24.975^{e}	56.125^{e}	28.19^{e}	58.88^{d}	29.485^{d}	80.3^{e}
Pliska 2002	161.875^{bc}	25.475^{bcde}	60.3525^{b}	31.7325^{c}	60.875^{c}	28.2225^{e}	87.4^{a}
B21	162.875^{abc}	25.425^{cde}	58.6125^{d}	28.35^{e}	58.8725^{d}	29.652^{d}	81.075^{d}
Tenesi 86	162^{bc}	25.8^{bc}	60.95^{b}	32.6175^{b}	61.6375^{b}	31.68^{b}	81.875^{c}
Kentaki 14	158.875^{d}	25.225^{de}	56.17^{e}	27.54^{f}	58.3775^{d}	29.27^{d}	84.6^{b}
Kentaki 17	164.275^{ab}	26^{b}	56.1725^{e}	27.9725^{ef}	58.7525^{d}	29.48^{d}	84.725^{b}
LSD5%	**11.17**	**2.42**	**3.99**	**2.25**	**3.2**	**2.34**	**3.73**

Table 3. Analysis of variance of the morphological indexes of the variants studied for 2016

Variants	Height of plants, cm	Number of leaves	Length of 7-8 leaf, cm	Width of 7-8 leaf, cm	Length of 13-14 leaf, cm	Width of 13-14 leaf, cm	Length of vegetative period
				2016			
B1317	161.975^{b}	26.325^{ab}	59.835^{d}	30.305^{c}	60.815^{b}	30.705^{d}	75.575g
B1000	158.525^{c}	25.175^{d}	58.04^{e}	32.5675^{a}	58.3825^{c}	31.5975c	79.425^{f}
B1344	166.025^{a}	26.8^{a}	63.075^{a}	33.02^{a}	66.8325^{a}	34.59a	70.55^{h}
B420	162.575^{b}	25.875^{bc}	61.13^{b}	31.535^{b}	61.505^{b}	31.3775c	79.225^{f}
B2115	158.05^{c}	25.075^{d}	55.55^{g}	28.3075^{d}	58.6925^{c}	29.4275e	80.275^{e}
Pliska 2002	161.7^{b}	25.5^{cd}	60.7175^{bc}	31.45^{b}	60.8^{b}	27.35f	87.875^{a}
B21	162.175^{b}	25.55^{cd}	57.74^{e}	28.315^{d}	58.8375^{c}	29.67e	81.5^{d}
Tenesi 86	162.875^{b}	25.825^{bc}	60.3025^{cd}	32.6825^{a}	61.0575^{b}	34.04b	84.75^{c}
Kentaki 14	158.125^{c}	25.1^{d}	56.4275^{f}	27.5325^{e}	58.5975^{c}	29.295e	85.25^{bc}
Kentaki 17	166.05^{a}	25.85^{bc}	56.5425^{f}	28.2525^{d}	58.675^{c}	29.3625e	85.975^{b}
LSD5%	**11.41**	**2.45**	**2.25**	**2.41**	**3.6**	**2.23**	**4.21**

Table 4. Analysis of variance of the morphological indexes of the variants studied for 2017

Variants	Height of plants, cm	Number of leaves	Length of 7-8 leaf, cm	Width of 7-8 leaf, cm	Length of 13-14 leaf, cm	Width of 13-14 leaf, cm	Length of vegetative period
			2017				
B1317	163.7^{ab}	26.7^{a}	59.065^{c}	30.2^{e}	60.9175^{c}	31.09^{c}	75.95^{g}
B1000	161.575^{bcd}	24.875^{d}	57.3825^{de}	32.485^{b}	58.6825^{d}	32.43^{b}	79.7^{f}
B1344	164.825^{a}	26.7^{a}	62.8675^{a}	33.3925^{a}	65.845^{a}	34.6525^{a}	71.05^{h}
B420	163.375^{ab}	25.75^{bc}	59.6525^{c}	31.1975^{d}	61.9825^{b}	30.735^{c}	79.75^{f}
B2115	160.975^{cd}	24.95^{d}	55.9125^{f}	28.0975^{fg}	58.745^{d}	29.37^{d}	81.825^{e}
Pliska 2002	162.75^{abc}	25.25^{cd}	60.5275^{b}	31.6975^{c}	60.705^{e}	27.4475^{e}	87.45^{a}
B21	160.3^{de}	25.45^{bcd}	58.0025^{d}	28.485^{f}	58.9175^{d}	29.7325^{d}	81.85^{e}
Tenesi 86	161.775^{bcd}	25.825^{bc}	61.0325^{b}	32.575^{b}	60.905^{c}	34.3975^{a}	82.725^{d}
Kentaki 14	158.625^{e}	25^{d}	56.5925^{ef}	27.97^{g}	58.61^{d}	29.4575^{d}	86.45^{b}
Kentaki 17	163.125^{abc}	25.875^{bc}	57.1975^{de}	28.11^{fg}	59.0525^{d}	29.5^{d}	84.15^{c}
LSD5%	**10.03**	**2.7**	**3.74**	**2.3**	**3.28**	**3.87**	**4.21**

Table 5. Analysis of variance of the morphological indexes of the variants studied for the three-year period (2015-2017)

Avarage for the period							
Variants	Height of plants, cm	Number of leaves	Length of 7-8 leaf, cm	Width of 7-8 leaf, cm	Length of 13-14 leaf, cm	Width of 13-14 leaf, cm	Length of vegetative period
B1317	163.55^{abc}	26.525^{b}	59.46^{c}	30.21^{d}	60.69^{d}	30.94^{c}	75.74167^{f}
B1000	159.3917^{g}	25.0083^{e}	57.34^{de}	32.34^{b}	58.48^{e}	31.87^{c}	79.725^{e}
B1344	165.3917^{a}	26.8083^{a}	62.73833^{a}	33.26^{a}	66.24^{a}	34.63^{a}	71.075^{g}
B420	162.7167^{bc}	25.7833^{c}	60.4175^{b}	31.44^{c}	61.75^{b}	31.37^{c}	79.725^{e}
B2115	160.2417^{de}	25^{e}	55.8625^{f}	28.19^{e}	58.77^{e}	29.42^{d}	80.8^{de}
Pliska 2002	162.1083^{cd}	25.4083^{d}	60.5325^{b}	31.6267^{c}	60.79^{cd}	27.67^{e}	87.575^{a}
B21	161.7833^{cd}	25.475^{d}	58.11833^{d}	28.38^{e}	58.87^{e}	29.68^{d}	81.475^{d}
Tenesi 86	162.2167^{cd}	25.8166^{c}	60.76167^{b}	32.625^{b}	61.2^{c}	33.37^{b}	83.11667^{c}
Kentaki 14	158.5417^{g}	25.1083^{e}	56.39667^{f}	27.68^{f}	58.52^{e}	29.34^{d}	85.43333^{b}
Kentaki 17	164.4833^{ab}	25.9083^{c}	56.6375^{ef}	28.11^{e}	58.82^{e}	29.44^{d}	84.95^{b}
LSD5%	**19.42**	**4.47**	**6.93**	**4.11**	**5.94**	**5.38**	**7.47**

With regard to the length of the 7-8 leaves, Tennessee 86 with Pliska 2002 and Burley 420 varieties were included in one group. Burley 21 variety was similar to both Burley 1000 and Kentucky 17 varieties. The last variety was in one group with Kentucky 14 and Burley 2115 varieties.

At the width of 7-8 leaves, there are three formed groups of similarity. Pliska 2002 and Burley 420 varieties are in the first group, Tennessee 86 and Burley 1000 varieties are in the second group, and Kentucky 17 with Burley 21 and Burley 2115 varieties are in the third group.

In the case of the size of the leaves of a medium harvest belt, the degree of uniformity between the lines is greater. In terms of length, Tennessee 86 with Pliska 2002 and Burley 1317 varieties were in one group, and Kentucky 17 with Kentucky 14, Burley 21, Burley 2115 and Burley 1000 varieties were in another gropu.

Formation of two large groups by degree of uniformity was also observed in relation to the width of the 13-14 leaves. The first group was: Kentucky 17 with Kentucky 14, Burley 21 and Burley 2115 varieties, and the second: B 420 with Burley 1000 and Burley 1317 varieties.

Burley 1344 variety was presented with the shortest and the most favorable length of the vegetation period. The longest period of vegetation was recorded in standard Pliska 2002.

For the length of the vegetation period, the two Kentucky varieties showed a high level of uniformity. Burley 2115 variety was similar as with Burley 21 and Burley 420 varieties and with Burley 1000 variety.

Hierarchical cluster analysis of morphological traits showed a clear grouping of the studied varieties in two large groups. In the first group, Burley 2115 and Kentucky 14 varieties were with the highest degree of similarity. It included Burley 21 and Kentucky 17 varieties. Burley 1000 variety occupies a middle position by joining this group. In the second group, B420 and Tennessee 86 varieties were of the

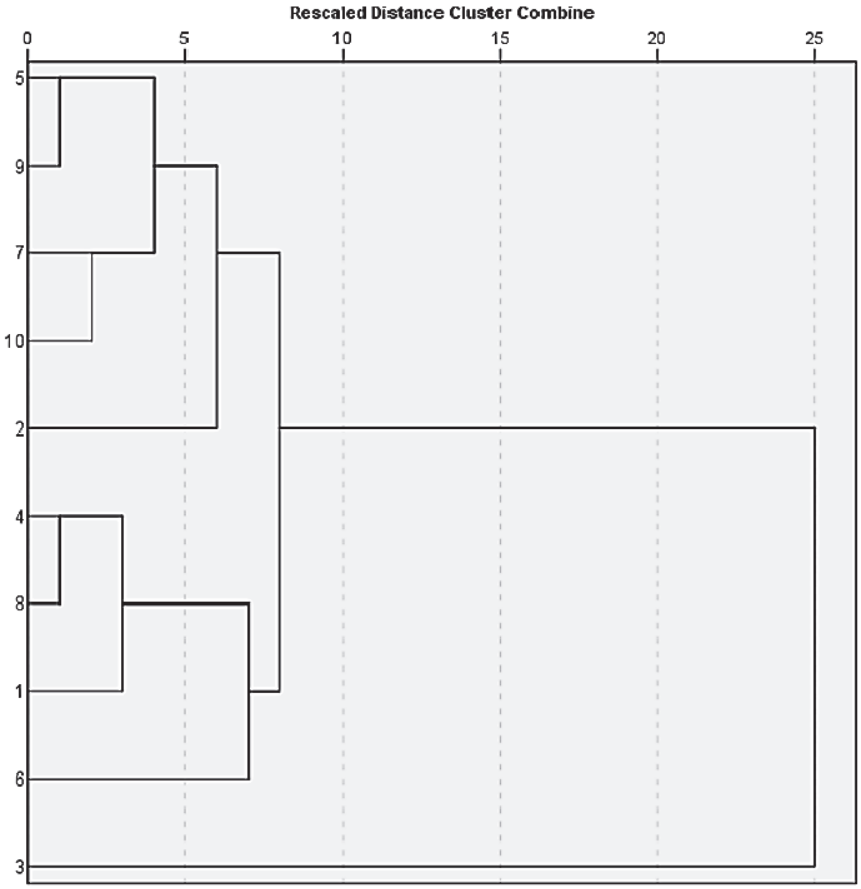

Fig . 1. Cluster analysis of the morphological indexes of the varieties studied
Legend: 1 - B1317; 2 – B1000; 3 – B1344; 4 – B420; 5 – B2115; 6 – Pliska; 7 – B21; 8 – Tenesi 86; 9 – Kentaki 14; 10 – Kentaki 17

similar values. Burley 1317 and Pliska 2002 varieties are in this group. The highest values reported were for B1344, and this variety forms a single cluster.

The summary results for all indicators lead to the conclusion that the most favorable biological indicator is Burley 1344 variety. This variety can be used in breeding programs to increase the number and size of leaves, as well as to shorten the length of the vegetation period.

Burley 1317 variety slightly outperforms the Burley 1000 and Burley 420 varieties, which in turn had similar characteristics. Pliska 2002 variety is not suitable for Burley tobacco standard because it presents itself with a very low leaves width in the middle harvesting belt. In addition, moreover, it was characterized by excessive long for Burley tobacco length of the vegetation period. The results obtained show that Burley 1344 and Burley 1317 were the most suitable for Burley's standard use. The biological parameters of the indigenous varieties were more favorable than those of the introduced varieties. The Burley 21 variety was outperforms in biological indicators to the other introduced varieties.

Conclusions

The results from the analysis of Burley tobacco varieties showed that the morphological appearance of the signs is closely related to the genotype and it was insignificantly affected by the environmental conditions.

The most favorable results for all morphological features and the length of the vegetation period were reported for Burley 1344 variety. Pliska 2002 variety was not suitable for the Burley tobacco standard, because of the very small leaf width in the middle harvesting belt and too long length of the vegetative period for the Burley tobacco varieties. In the other tested varieties there was a relatively good uniformity in morphological features.

The values of the biological indicators determine the Bulgarian varieties of Burley tobacco as more suitable for cultivation in the conditions of Bulgaria than the introduced ones.

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