

Comparative Study on the Effect of the Climatic Conditions on Biological, Economic and Chemical Characteristics of Large-Leaved Tobacco Samples of Burley and Virginia Groups

Tzenka I. Radoukova^{1}, Yovko K. Dyulgierski²*

1 - Agricultural University – Plovdiv, 2 Mendeleev Boul., 4000 Plovdiv, BULGARIA

2 - Tobacco and Tobacco Products Institute (TTPI), Markovo, Plovdiv, BULGARIA

*Corresponding author: kiprei@abv.bg

Abstract. Correlations between the climatic characteristics: average daily temperature and precipitation sum, on the one hand, and, the biological, economic and chemical characteristics of ten large-leaved Burley and Virginia tobacco samples, on the other, were studied and compared. Except for the vegetation period length, for which a positive correlation was reported, the effect of the climatic conditions on the biological characteristics was insignificant. In both tobacco types the amount of precipitation showed positive correlation with the yield and negative one with the nicotine content ($p < 0.05$). Out of all the studied large-leaved tobacco samples, the climatic conditions had a stronger effect on the biological, economic and chemical characteristics of Burley tobacco, i.e. that tobacco type was influenced to a larger degree by the environmental conditions.

Keywords: Burley tobacco, Virginia tobacco, Biological, Economic and Chemical Characteristics biological indicators, Climatic Conditions, correlation analysis, dependencies.

Introduction

Many researchers emphasized the importance of the genotype-environment interrelations. NGUYEN *et al.* (1980) considered that the relative performance of different genotypes often varied depending on the environment. That caused some difficulties in plant breeding activities (HOTAYLEVA & TARUTINA, 2002). According to GRAVOIS *et al.* (1991), breeding should be based on good knowledge of the genetic structure of the breeding material and the effect of genotype-environment interaction. Due to the great plasticity of tobacco and its dependence on the environment (climate, soils and agrotechniques), there should be a good knowledge about the constancy of the separate morphological traits and the limits of varietal variation. When making technological decisions, it is very important to

know well the variation amplitude of the phenotypic expression of the major economic and technological characteristics (NAUMOVSKI, 1985; DIMANOV & ZAPRYANOVA, 2002; VELICHKOVA *et al.*, 2012).

Temperature and precipitation are the major factors affecting the rate of growth and development of tobacco plants, the productivity and the chemical content of the raw material (DIMITROVA, 2005). It was established that the morphological traits of tobacco plants depend mainly on the variety and the climate and soils have less effect. Studies of MOHAMAD (1969) and TOMOV (1990) showed that climatic conditions affected significantly plant height and had less effect on the number of leaves.

The chemical composition of the leaves depends on the varietal and biological

characteristics of the plants but the effect of the climate and soil is the most significant. The content of nicotine and soluble carbohydrates is in a positive correlation with temperature and in a negative one with rainfalls (TOMOV, 1989).

The aim of the present study was to compare the response of local and introduced Burley and Virginia varieties and variety groups to the changes of temperature and rainfalls in five consequent years characterized by quite different climatic conditions and to evaluate their susceptibility to the environment.

Material and Methods

The experiment was carried out in the period 2006-2010, following the plot design. Ten varieties and lines of each of Burley (Burley 21, Burley 1322, Burley 1344, Line 1354, Line 1362, Line 1386, Line 1393, Line 1400, Line 1458, Line 1466) and Virginia (Virginia 0454, Virginia 0514, Virginia 330, Virginia 250, Line 543, Line 586, Line 607, Line 642, Line 842, Line 843) variety groups, both local and introduced, were the object of the study. Tobacco growing, harvesting and curing followed the adopted technology for those varietal groups. The interdependencies between the climatic characteristics: average daily temperature and precipitation sum, on the one hand, and the most

important biological, economic and chemical characteristics, on the other, were established. The climatic data were measured in the period from 1 June to 31 August (for each studied year, respectively), i.e. the period of tobacco growing in the fields. The following characteristics were studied: plant height; number of leaves; length and width of the 7th, 14th and 21st leaf, representative for the lower, medium and top harvesting layer of leaves, respectively; vegetation period length; yield and percentage of the first-, second- and third-class of cured tobacco; percentage of nicotine content, sugars, total nitrogen and proteins.

The correlation analysis of data was made by SPSS statistical package. The linear correlation coefficient was used for measuring the strength of the relation between the studied characteristics.

Results and Discussion

The results of the correlation analysis between the climatic and biological characteristics of Burley tobacco were presented in Table 2. A significant positive correlation between plant height and the precipitation amount was established. There was no significant correlation between the plant height and the temperature sum.

Table 1. Meteorological data obtained at Plovdiv station, 2006 – 2010

Meteorological index	2006	2007	2008	2009	2010
Daily average temperature °C June - August	23.1	24.6	22.3	23.5	23.9
Sum of rainfalls, l m ⁻²	170.8	289	105.5	129.2	204.6

Table 2. Correlations coefficients of the relationships between climatic conditions and biological characteristics for Burley tobacco

Meteorological index	Biological characteristics for Burley tobacco								
	Length of plants	Number of leaves	Length of 7-th leaf	Width of 7-th leaf	Length of 14-th leaf	Width of 14-th leaf	Length of 21-st leaf	Width of 21-st leaf	Length of vegetative period
Sum of rainfalls	0.368(*)	0.189	0.195	0.148	0.158	0.254	0.335(*)	0.251	0.678(**)
Sum of temperature	0.048	0.122	-0.133	-0.121	-0.041	-0.085	0.256	0.204	-0.442(*)

Legend: **p<600; *p<300

Data from the correlation analysis showed that the precipitation sum had an insignificant effect on the leaf size of the bottom harvesting leaf layer in Burley tobacco. The correlation between precipitation and the leaf size of the middle layer had higher values, although statistically insignificant again. The correlation coefficient of the leaves of the top harvesting layer increased, reaching to +0.34 for the leaf length, i.e. the value was statistically significant.

The effect of the temperature sum on the leaf size of the three leaf layers in Burley tobacco changed from negative for the leaf width of the bottom and middle layers to slightly positive for the leaf width of the top harvesting layer.

The correlation between the climatic factors and the vegetation period length in Burley tobacco was considerably stronger compared to the biometric indices. An average positive correlation was established between the vegetation period length and the precipitation amount (+0.68, $p < 600$), (Table 2). The correlation with temperature was slightly expressed and it was negative, the value being significant again (- 0.44, $p < 300$).

The results of the correlation analysis between the climatic and biological characteristics of Virginia tobacco were presented in Table 3. As a whole, they were slightly different from those of Burley tobacco.

Out of all the reported biometrical characteristics, a significant correlation (+0.31, $p < 300$) was found only between the amount of precipitation and the plant height. For all the other characteristics, no correlation was established, and the calculated coefficients were lower compared to the Burley tobacco ones.

A moderate positive correlation was found between the vegetation period length and the amount of precipitation (+0.58, $p < 600$), (Table 3). The temperature sum had a negative effect on that characteristic (-0.34, $p < 300$).

The results of the correlation analysis between the climatic and economic characteristics of Burley tobacco were

presented in Table 4. Positive correlation was established between the yield and the amount of precipitation (+0.47, $p < 300$). Lower, but also significant positive relation was found between the amount of precipitation and the percentage of the first-class tobacco leaves (+0.32, $p < 300$). The amount of precipitation had a negative effect on the percentage of third-class leaves, but the correlation between them was insignificant.

The temperature sum did not exert an effect on the yield and the percentage of the different classes of leaves in the studied samples of Burley tobacco.

The results of the correlation analysis of the climatic and economic characteristics of Virginia tobacco were presented in Table 5. Values obtained were close to those for Burley tobacco. In that case, the correlation between the yield and the amount of precipitation was statistically significant and positive (+0.43, $p < 0.05$) again), but the value was lower compared to Burley tobacco. The tendency towards a positive effect on the percentage of first- and second-class leaves and a negative effect on the percentage of third-class leaves was preserved but the reported correlation coefficients were statistically insignificant.

The temperature sum did not exert any effect on the yield and the percentage of the leaf classes of the studied samples of Virginia tobacco.

Table 6 shows the relationship between the climatic and chemical characteristics of Burley tobacco. The correlation between the nicotine content and the amount of precipitation was significantly negative ($p < 0.05$). Concerning the content of soluble sugars, the correlation was lower expressed, negative and significant ($p < 0.05$). The total nitrogen content correlated negatively with the amount of precipitation and positively with temperature, but it was significant only concerning the temperature sum. The climatic factors did not have an effect on the percentage of protein content.

The results of the correlation analysis of the climatic and chemical characteristics of Virginia tobacco were presented in Table 7. In that case, again the differences to Burley

tobacco were small. A negative significant correlation between the nicotine content and the amount of precipitation was found ($p < 0.05$). Referring to the content of soluble

sugars, total nitrogen and proteins, the correlation coefficients had negative values and no statistical significant relationships.

Table 3. Correlations coefficients of the relationships between climatic conditions and biological characteristics for Virginia tobacco

Meteorological index	Biological Characteristics for Virginia tobacco								
	Length of plants	Number of leaves	Length of 7-th leaf	Width of 7-th leaf	Length of 14-th leaf	Width of 14-th leaf	Length of 21-st leaf	Width of 21-st leaf	Length of vegetative period
Sum of rainfalls,	0.317(*)	0.125	0.124	0.112	0.140	0.188	0.273	0.206	0.583(**)
Sum of temperature	0.026	0.074	0.108	0.067	0.011	-0.019	0.121	0.115	-0.344(*)

Legend: ** $p < 600$; * $p < 300$

Table 4. Correlations coefficients of the relationships between climatic conditions and economic characteristics for Burley tobacco ($p < 0.05$)

Meteorological index	Economic Characteristics for Burley tobacco			
	Yield	% of I class	% II class	% III class
Sum of rainfalls	0.475(*)	0.328 (*)	0.146	-0.220
Sum of temperature	0.101	-0.059	0.082	0.129

Legend: ** $p < 600$; * $p < 300$

Table 5. Correlations coefficients of the relationships between climatic conditions and economic characteristics for Virginia tobacco

Meteorological index	Economic Characteristics for Virginia tobacco			
	Yield	% of I class	% II class	% III class
Sum of rainfalls	0.432(*)	0.247	0.111	-0.132
Sum of temperature	0.033	0.024	0.009	0.049

Legend: ** $p < 600$; * $p < 300$

Table 6. Correlations coefficients of the relationships between climatic conditions and chemical characteristics for Burley tobacco

Meteorological index	Chemical characteristics for Burley tobacco			
	% nicotine	% sugar	% total nitrogen	% proteins
Sum of rainfalls	-0.424 (*)	-0.378(*)	-0.357 (*)	0.163
Sum of temperature	0.265	0.262	0.232	-0.107

Legend: ** $p < 600$; * $p < 300$

Table 7. Correlations coefficients of the relationships between climatic conditions and chemical characteristics for Virginia tobacco

Meteorological index	Chemical Characteristics for Virginia tobacco			
	% nicotine	% sugar	% total nitrogen	% proteins
Sum of rainfalls	-0.337(*)	-0.157	-0.243	- 0.192
Sum of temperature	0.186	0.184	0.150	0.248

While the effect of the temperature sum on the percentage of proteins was negative and the effect of precipitation was positive in Burley tobacco, in Virginia tobacco the tendency was just the opposite, but the values were statistically insignificant.

The temperature sum did not have a considerable effect on the chemical composition of the studied Virginia tobacco samples. In that case, again the correlation with the two studied climatic factors was also lower in Virginia tobacco than in Burley.

Conclusions

The effect of the climatic conditions on the biological characteristics was insignificant, except for the vegetation period length. The precipitation sum had a stronger effect compared to the temperature sum.

Moderate positive correlation was found between the yield and the amount of precipitation in both tobacco types. The temperature sum did not have an effect on the yield and the percentage of classes in the studied samples of Burley and Virginia tobacco.

The amount of precipitation had a positive effect on the yield and quality of both tobacco types, the effect being stronger in Burley tobacco.

A significant negative correlation was registered between the nicotine content and the amount of precipitation in Burley and Virginia tobaccos. Concerning the content of soluble sugars, the relation was lower, negative and significant only in Burley tobacco.

Out the studied samples of large-leaved tobaccos, the climatic conditions had a

stronger effect on the biological, economic and chemical characteristics of Burley tobacco.

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