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STUDY OF THE EFFECT OF THE PERIOD OF REPLAINING ON THE MORBIDITY RATE IN VIRGINIA TOBACCO

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Abstract

*The present work studies the influence of the vegetation period in Virginia tobacco on the spread of the viruses PVY-Complex (%), TMV (%), TSWV (%), CMV (%). To establish this relation, a correlation analysis was applied and the proven effects were represented by linear regression models. In 2014, with an increase of the period from replanting, the incidence of PVY-Complex (0.997**), TMV (0.860*) and TSWV (0.830*) increased significantly. The effect of the replanting on plant morbidity rate is similar (0.808**) also in 2015. In 2016, the very strong impact of the days from replanting on CMV (0.962**) and TSWV (0.907 **) viruses was proven. In 2017 the increase in the period from replanting leads to an increase in the percentage of diseased plants from PVY-Complex (0.946**), CMV (0.940**) and TSWV (0.976**).*

Key words*: Virginia tobacco, viral diseases, correlation analysis.*

INTRODUCTION

Tobacco production is among the major branches of agriculture in Bulgaria. Tobacco is cultivated in more than 100 municipalities, and in a large part of them it is the main livelihood of the local population (Bozukov, 2014). Four varieties are cultivated in the country - Oriental tobacco - Basma and Caba Kulak and big-leaved tobacco - Flue-cured - Virginia and Air Cured-Burley, occupying an area of 9963 ha (MZH, 2016).

Tobacco cultivation should take into account the complicated interactions between the genotype and agro-ecological conditions as well as the presence of different phytopathogens (Bojinova & Djulgerski, 2006). Some of them are viral diseases and the damage to the crop is significant (Maiss, 2004).

One of the most common viruses causing serious economic losses is the genus Potyvirus. The three potyviruses PVY (Potato virus Y), TEV (Tobacco etch virus) and TVMV (Tobacco vein mottling virus) often occur as a tobacco viral complex (Greenwell, 2011; Dietrich & Maiss, 2003; Yonchev, 2014).

The disease that they cause in tobacco in Bulgaria is called Sipanitsa (Yonchev, 2014). Another economically important viruses are TMV (Tobacco mosaic virus) and TVMV (Tomato mosaic virus) of the genus Tobamovirus (Stoimenova, 1995).

They are spread in all the countries where tobacco is grown. The illness it causes is called a simple tobacco mosaic virus. CMV (Cucumber mosaic virus) is a virus also spread worldwide which causes considerable damage to tobacco production (Srivastava & Bhaskar, 1987).

In Africa it can be found in Zambia and Morocco (Thottapilly, 1992). The disease it causes with tobacco is called cucumber mosaic virus.

Tomato spotted wilt virus is a disease which is a serious problem for tobacco production in many countries around the world. In Bulgaria, the disease was first found in 1952 in Gotse Delchev and Sandanski tobacco regions, and in the first years of its occurrence it caused 30 to 50% losses, and in separate years, such as 1956, 1969, 1977, 1983 and 1984. The viral disease covers up to 70% of the areas with oriental tobacco and 80-100% with large-sized tobaccos (Gabrovska, 1984; Kovachevski et al., 1999).

The aim of the present study is to show the influence of the period from the replanting of Virginia tobacco on the spread of economically important viral diseases in this tobacco group in the region of Plovdiv.

MATERIALS AND METHODS

The areas are routinely studied, with virus spreading evaluated on the basis of the characteristic symptoms of the disease. Reports are made based on the percentage of attacked plants.

The subject of research in the present work is tobacco from Virginia variety group. The data on the basis of which the study was conducted were obtained during the period 2014-2017. The study has taken into account the degree of influence of the following viruses: PVY-Complex (%), TMV (%), TSWV (%), CMV (%) on Virginia tobacco in the period from 20th to 107th days after the replanting.

The correlation analysis makes it possible to determine the degree and direction of impact of a given indicator on another by determining the value of the corresponding correlation coefficient. In the present study the Pearson-Brave coefficient was calculated. It is calculated according to the formula:

$$r = \frac{\sum_{i=1}^{n}(Y_i - \overline{Y})(X_i - \overline{X})}{\sqrt{\sum_{i=1}^{n}(Y_i - \overline{Y})^2 \sum_{i=1}^{n}(X_i - \overline{X})^2}}.$$

The determination coefficient gives information about how much of the change in a given indicator is due to the change of another indicator.

The regression analysis is a mathematical method that renders an established relation between two or more variables in an analytical form. To implement it, it is necessary for the dependent variables to have a near-normal distribution, the experimental data have to be random, the observations have to be independent. The reliability of the compiled regression models is verified by various methods. In this study, the coefficient of significance of each model was calculated; F-test was also carried out.

The mathematical processing of the experimental data in the present study was accomplished through the tools provided by the MS Excel operating system and the IBM Statistics SPSS 25 (Meyers et al., 2013; Hilton & McMurray, 2017; McCormick, 2017).

RESULTS AND DISCUSSIONS

The results of the performed correlation and regression analyzes are given in Table 1. It was previously proved that the experimental data meet the conditions for the application of these analyzes mentioned above in the report.

In Virginia tobacco, the infection of PVY-Complex (0.997**), TMV (0.860*), TSWV (0.830*) in 2014 significantly increased with an increase in the period from replanting. The effect of the replanting on the plant infection is similar (0.808**) in 2015. In 2016, the period from replanting had very strong impact on the virus CMV (0.962**), TSWV (0.907**). For 2017, it has been shown that the percentage of diseased plants by PVY-Complex (0.946**), CMV (0.940**) and TSWV (0.976**) increased with the increasing of the period from replanting.

The regression models presenting in an analytical form the described effects of the period from replanting on the morbidity rate of the plant are given in Table 1. All compiled models are statistically significant at a significance level equal to 0.05.

Table 1. Correlation coefficients and regression models presenting the effect of the period from replanting on the spread of some viral infections in tobacco

Year	Virus Name	Correlation Coefficient	Regression Model	F-test	Sign. of model
2014	PVY-Complex (%)	0.997**	y=0.272x-3.394	930.386	0.000
	TMV (%)	0.860*	y=0.005x-0.186	14.245	0.013
	TSWV (%)	0.830*	y=0.014x+2.219	11.068	0.021
2015	Infection (%)	0.808**	y=1.614x+0.883	13.193	0.008
2016	CMV (%)	0.962**	y=0.069x-1.388	61.395	0.001
	TSWV (%)	0.907**	y=0.038x-0.599	23.160	0.005
2017	PVY-Complex (%)	0.946**	y=0.344x-5.027	33.845	0.004
	CMV (%)	0.940**	y=0.035x-0.98	30.103	0.005
	TSWV (%)	0.976**	y=0.044x-0.664	79.722	0.001

**Correlation is significant at the 0.01 level; *Correlation is significant at the 0.05 level.

The graphs shown in Figures 1-4 visualize the effect of the period from replanting on the morbidity rate of the plant of viral infections.
The determination coefficients are given on each of the graphical images. Considering these, it can be claimed that the period of replanting has a very strong impact on the morbidity rate of the plant of the corresponding viral infections. In 2014, it has the strongest influence on PVY-Complex (99%), and the trend is continuous growth of the percentage of diseased plants. The other two viruses have comparative stability.
The analysis of the experimental data for 2015 showed the strong impact of the period only on the morbidity rate of CMV/PVY-Complex (65%) (Figure 2). The curve demonstrates strong growth of the diseased plants during 30th-40th days as well as during 60th-70th days. In the remaining period, there is no dynamic in the spread of the diseases.

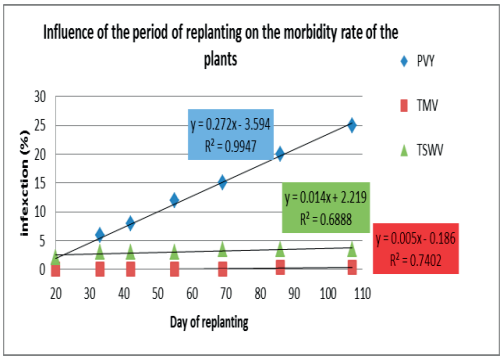

Figure 1. Influence of period of replanting in Virginia tobacco on morbidity rate in 2014

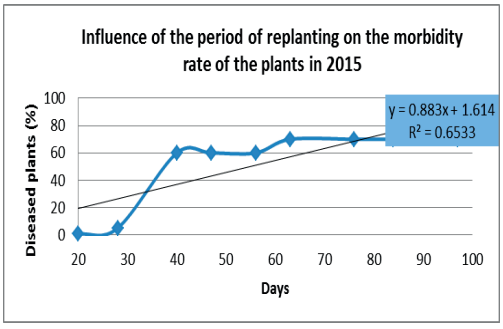

Figure 2. Influence of the replanting period in Virginia tobacco on the morbidity rate in 2015

In 2016, the strong impact of the replanting period on the spread of CMV (92%) and TSWV (82%) was demonstrated. Both viruses show a strong increase in the percentage of diseased plants between 35th and 55th days. In CMV, however, this trend continued after 60th day and no significant changes were observed in TSWV (Figure 3).

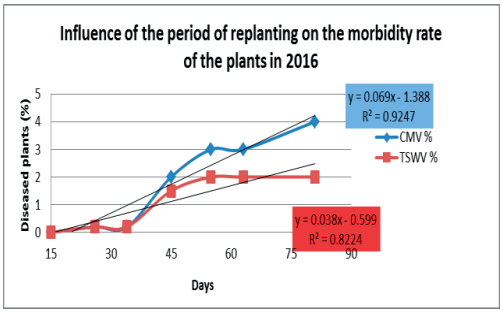

Figure 3. Influence of the replanting period in Virginia tobacco on the morbidity rate in 2016

In 2017 the strong impact of the number of days after planting on PVY-Complex (89%), CMV (88%) and TSWV (95%) was demonstrated (Figure 4). The most dynamic is the change in the percentage of diseased plants from PVY-Complex in the 20th-60th day period. After this period, relative stability in the spread of the disease is observed. The other two viruses did not show peaks or falls in the percentage of diseased plants.

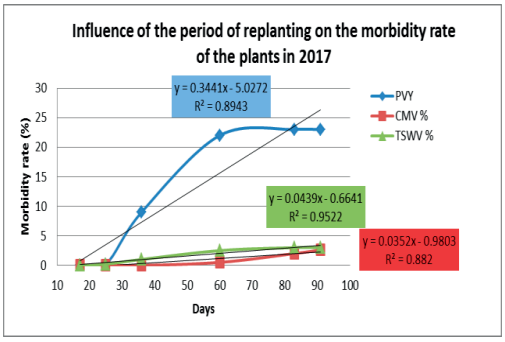

Figure 4. Influence of the replanting period in Virginia tobacco on the morbidity rate in 2017

CONCLUSIONS

The period of replanting has a very strong impact on the morbidity rate of the plants of the relevant viral infections.
In 2014, there is a continuous growth in the percentage of plants with symptoms of

Sipanitsa. There is comparative stability in the spread of the other two diseases.

In 2015, there was a strong dynamics in the development of the cucumber mosaic virus and Sipanitsa, in the period of 30th-40th days and 60th-70th days from replanting. In the remaining period there is no dynamics in the spread of the diseases.

In 2016, the invasion of CMV and TSWV is in dynamics, particularly strong in the cucumber mosaic virus.

In 2017, the greatest dynamics was observed in the spread of the potiviruses. The other two CMV and TSWV viruses did not show peaks or drops in the percentage of diseased plants.

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