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Phytopathological assessment of reaction of genotypes from variety group burley tobacco to economically important viral diseases

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Abstract

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During the period 2008-2018 is carried out an immunological study of the response to PVYn (necrotic strain) and TMV-TGM strain of nine inducted and five Bulgarian varieties Burley tobacco variety group, which are the parent of twenty-three prospective consolidated tobacco lines of the same variety group included in the study. Reported is the development of economically important viral diseases sipanitza and ordinary tobacco mosaic at the tested genotypes of tobacco placed under natural conditions of infection. The phytopathological evaluation of fourteen Burley tobacco varieties showed that resistant of strain TMV-TGM are the predominant part of genotypes, with only two of them react with sensitivity. Seven samples are responding to PVYn as resistant, and seven are sensitive. It is established difference in the results obtained for reaction of Tennessee 86 varieties to strain TMV-TGM and the data reported in the literature. Differences in the results are obtained and the literatures exist also for two Bulgarian varieties: Burley 2115 variety and Burley 1000 variety. Of tested twenty-three lines Burley tobacco, eighteen of them have complex resistance to the two viruses with which it is working. The remaining lines are showed sensitivity to one of the two viruses.

Keywords: Burley tobacco; phytopathological assessment; PVY; TMV

Introduction

Plant viruses are one of the most important pathogens causing viral disease of major economic importance in many of the major agricultural crops including tobacco, such as reduced yield and quality (Maiss, 2004; Kim et al., 2018). Plants attacked by viruses activate complex defense pathways that operate at different levels, often at considerable energy costs that lead to losses. (Syller & Grupa, 2016). Tobacco is a natural host for more than 20 viruses, among which the most important economic and significant damage to tobacco is TMV (Tobaccco mosaic virus); TSWV (Tomato spotted wilt virus); CMV (Cucumber mosaic virus); PVY (Potato Virus Y); AMV (Alfalfa mosaic virus); TRSV (Tobacco ringspot virus); TEV (Tobacco etch virus) and TVMV (Tobacco vein mottling virus), (Dukić, et al., 2006; Dimitrov & Bozukov, 2004).

The most commonly used methods of controlling disease-causing agents include chemical agents which, in viral diseases, have no direct effect on the causative agent. This control of viral diseases requires extended specifically use of pesticides to effectively influence the vectors and natural storage depots of plant viruses. The application of chemical means carries a risk to human health and the environment. In order to minimize these risks, it is necessary to use alternative methods to fight viruses.

The selection method, which is the creation and implementation of sustainable varieties, is still the cheapest and the most radical one method for reducing crop losses by producing environmentally friendly production without environmental hazard (Stoimenova, 2009; Drumeva – Yoncheva, 2007; Keranova, 2018; Mihaylova, 2016; Kumar et al., 2017).

For the creation of resistant tobacco varieties, it is necessary to know the reaction of the initial selection material to the crop-specific economically important pathogens (Bozukov, 2012). In a more advanced selection of genotypes, it is advisable to try to produce two backgrounds – natural infection background for the study of commercial qualities and artificial contamination for plant selection for further selection work (Gabrovska, 1982). Of particular interest are genotypes that carry genes for resistance to a number of diseases – tobacco mosaic with a TMV agent, sipanitza of causative agents: PVY, TEV and TVMV, which are complex or self-contained (Greenwell, 2011; Kennedy, 2011; Yonchev et al., 2018). Pyramiding sources of resistance is essential for achieving broad – spectrum and durable resistance and for protection crops from commonly occurring mixed virus infections (Fuchs, 2017). The creation of varieties with durable resistance is a complex and lengthy and complex process that requires extensive, diverse and preceding selection immunity studies (Yonchev, 2014).

Table 1. Genotypes of variety group Burley tobacco

Variety	Years of testing	
	Naturall infection	Artificial infection
Kentucky 908 – USA	2011	2011
Tennessee 90 – USA	2011	2011
Tennessee 86 – USA	2010-2011	2010-2011
Kentucky 907 – USA	2011	2011
Banket 102 – USA	2011	2011
Burley NSZ – USA	2011	2011
Burley 21 – USA	2010-2011	2010-2011
Burley 64 -USA	2011	2011
Burley 2115 – Bulgaria	2011	2011
Burley № 1 – Bulgaria	2011	2011
Burley 1317 – Bulgaria	2010-2011	2010-2011
Burley 1344 – Bulgaria	2010-2011	2010-2011
Burley 1000 – Bulgaria	2010-2011	2010-2011
Kentucky 8959 – USA	2018	2018
Line 1354-[(Burley 64 x Burley 21) x Burley 1000]	2008-2011	2008-2009
Line 1349-(Burley 1000 x Burley №1)	2008-2011	2009-2010
Line 1409-[(Burley 21 x (Banket 102 x Tn 86)]	2008-2011	2009-2010
Line 1231-[Burley 21 x (Burley 21 x Burley 2115)]	2008-2011	2008-2009
Line 1435-(Line 1334 x Tennessee 86)	2008-2011	2008-2009
Line 1478-(Burley 1317 x Tennessee 90)	2008-2011	2008-2009
Line 1393-(Burley 1317 x Burley 21)	2008-2011	2009-2010
Line 1322-(Banket 102 x Tennessee 86)	2011-2013	2011
Line 1390-(Burley 21 x Burley 2115)	2011-2013	2008-2011
Line 1334-[(Tn 86 x Burley 21) x (B 21 x B 2115)]	2011-2013	2011
Line 1383-[(Burley 64 x B 21) x (Tn 86 x BNSZ)]	2011-2013	2011
Line 1145-(Burley 64 x Burley 21)	2011-2013	2011
Line 1499-(Ky 908 x Line 1383)	2010, 2011, 2012, 2016	2010, 2011, 2012, 2016
Line 1466-(Burley 1317 x Kentucky 8959)	2015-2017	215
Line 1527-(Burley 1317 x Kentucky 907)	2015-2018	2015
Line 1495- (Burley 1317 x BurleyNSZ)	2015-2016	2015
Line 1416-(Tennessee 86 x Line 1322)	2015-2018	2015
Line 1540-(Line1322 x Kentucky 908)	2015-2018	2015
Line 1531-(Burley 1344 x Line 1334)	2015-2016	2015
Line 1468-(Burley 1317 x Burley 1344)	2015-2016	2015, 2016
Line 1533-(Burley 1344 x Kentucky 8959)	2015, 2016	2015, 2016
Line 1362-(Line1145 x Tennessee 86)	2015-2018	2015, 2018
Line 1543-(Burley1000 x Line 1527)	2015-2018	2015, 2018

The purpose of this study is to make a phytopathological assessment of the reaction of varieties and promising lines of Burley tobacco varieties to strain TMV-TGM and PVYn and trace under natural conditions the spread of disease ordinary tobacco mosaic and sipanitza when the tested genotypes.

Material and Methods

During the period 2008-2018, is accomplished immunological examination of the reaction to PVY^n (necrotic strain) and TMV-TGM strain of nine introduced and five Bulgarian varieties Burley tobacco, appearing starting parents surveyed twenty tree promising and consolidated lines tobacco is of the same variety group. Under the particular conditions of the test field TTPI natural infection background defined development of economically important viral diseases sipanitza and ordinary tobacco mosaic at the tested genotypes of tobacco (Table 1).

The following viral strains are used for artificial infestation: TMV-TGM (Stoimenova, 1995) and PVY №53 (necrosis strain), registered in NBIMCC respectively under №3294 and №3577.

The identification of the diseases and common tobacco mosaic on the tested genotypes of tobacco under a natural infectious background is performed visually by route survey of the areas, based on the symptoms characteristic of each of the viruses. The indicator method is used to prove the complex of potiviruses attributed to the disease sipanitza and the tobamoviruses causing the ordinary tobacco mosaic under field conditions (Kovachevski et al., 1999).

As test plants to characterize potiviruses are used the following types and varieties: *Petunya hybrida; Chenopodium amaranticolor, Phisalis floridana, Capsicum frutescens* cv. Tobacco, *Datura stramonium, Solanum nigrum, Nicotiana tabacum* L., Nevrocop 1146, *Nicotiana glutinosa.* For diagnosing tobamovirusesus plants *N. tabacum* cv. Samsun NN, Nevrocop 1146 and *Nicotiana glutinosa,* which respond with a hypersensitivity reaction to a tobamoviruses infection and a mosaic of CMV? Strain TMV-TGM is propagated in *N. tabacum* cv. Samsun N'N 'in order to prevent the contamination of TMV with ToMV (Stoimenova & Yordanova, 2005).

Results and Discussion

In Table 2 are presented the results of screening of fourteen Burley tobacco varieties with PVY^n and TMV-TGM. Half of the varieties (Tennessee 86, Tennessee 90, Kentucky 908, Kentucky 907, Kentucky 8959, Burley 1344 and Burley 1317) are resistant to the necrotic strain of PVY. In our study the Bulgarian varieties Burley 2115 and Burley 1000 developed systemic symptoms during the course of the experiment and designated as susceptible, thus confirming the results of an earlier investigation of Stoykova et al. (2000) for Burley 1000. However, Pamukov (1982), Stoyanov & Apostolova (2000), Tchinchev (1988) and Dyulgerski (2011) describe both accessions as resistant to PVY, which is in contrast with the data obtained in current study.

All of the tested tobacco varieties except two (Burey NSZ and Kentucky 8959) are resistant to TMV-TGM strain. This results are similar to those obtained by Miller (1987) except

Table 2. Immunological assessment of varieties Burley tobacco on natural infectious background (sipaniza and ordinary tobacco mosaic) and artificial contamination with PVYn and TMV-TGM

Variety	PVYn			TMV-TGM		
	Naturall infection	Artificial infection	Literary data	Naturall Infection	Artificial Infection	Literary data
Kentucky 908	0	R	R	0	R	R
Tennessee 90	0	R	R	0	R	R
Tennessee 86	0	R	R	0	R	S
Kentucky 907	0	R	R	0	R	R
Banket 102	10	S	S	0	R	–
Burey NSZ	0	S	–	0	S	–
Burley 21	0	S	S	0	R	R
Burley 64	0	S	S	0	R	R
Burley 2115	–	S	R	–	R	–
Burley № 1	–	S	–	–	R	–
Burley 1317	0	R	R	0	R	–
Burley 1344	0	R	-	0	R	–
Burley 1000	13	S	R	0	R	MR/R
Kentucky 8959	0	R	R	0	S	S

R – resistant, MR – moderate resistant, S – sensitive

Table 3. Immunological assessment of promissing lines of tobacco of variety group Burley tobacco on natural infectious background (sipaniza and ordinary tobacco mosaic) and artificial contamination with PVYn and TMV-TGM

Variety	PVYn		TMV-TGM	
	Naturall infection	Artificial infection	Naturall infection	Artificial infection
Line 1354-[(Burley 64 x Burley 21) x Burley 1000]	7.Jan	S	0	R
Line 1349-(Burley 1000 x Burley №1)	0	R	0	R
Line 1409-[(Burley 21 x (Banket 102 x Tn 86)]	0	R	0	R
Line 1231-[Burley 21 x (Burley 21 x Burley 2115)]	0	R	0	R
Line 1435-(Line 1334 x Tennessee 86)	0	R	0	R
Line 1478-(Burley 1317 x Tennessee 90)	0	R	0	R
Line 1393-(Burley 1317 x Burley 21)	0	R	0	R
Line 1322-(Banket 102 x Tennessee 86)	0	R	0	R
Line 1390-(Burley 21 x Burley 2115)	0	R	0	R
Line 1334-[(Tn 86 x Burley 21) x (B 21 x B 2115)]	0	R	0	R
Line 1383-[(Burley 64 x B 21) x (Tn 86 x BNSZ)]	0	R	3.May	S
Line 1145-(Burley 64 x Burley 21)	4%	S	0	R
Line 1499-(Ky 908 x Line 1383)	0	R	0	R
Line 1466-(Burley 1317 x Kentucky 8959)	0	R	2%	S
Line 1527-(Burley 1317 x Kentucky 907)	0	R	0	R
Line 1495- (Burley 1317 x BurleyNSZ)	0	R	2%	S
Line 1416-(Tennessee 86 x Line 1322)	0	R	0	R
Line 1540-(Line1322 x Kentucky 908)	0	R	0	R
Line 1531-(Burley 1344 x Line 1334)	0	R	0	R
Line 1468-(Burley 1317 x Burley 1344)	0	R	0	R
Line 1533-(Burley 1344 x Kentucky 8959)	0	R	0	R
Line 1362-(Line1145 x Tennessee 86)	0	R	0	R
Line 1543-(Burley1000 x Line 1527)	0	R	0	R

R – resistant, S – sensitive

for the American Tennessee 86 variety claimed as sensitive. In comparison to our experiment Tennessee 86 reacted with hypersensitivity after inoculation with TMV-TGM. Necrotic lesions are observed on inoculated leaves of all individuals without systemic spread of the virus (Yonchev, 2014).

The results of the present study showed that Tennessee 86, Tennessee 90, Kentucky 908, Kentucky 907, Kentucky 8959, Burley 1344 and Burley 1317 are with complex resistance to PVY^n and TMV-TGM.

In Table 3 are presented the results of the artificial inoculation of twenty-three promising Burley tobacco lines with PVY^n and TMV-TGM. Only three (L 1383, L 1466 and L 1495) and two (L 1354 and L 1145) lines are sensitive to PVY^n and TMV-TGM respectively. All other 18 Burley tobacco accessions showed complex resistance to both viral strains.

In order to trace the development of the economically important diseases sipanitza and ordinary tobacco mosaic, the promising tobacco lines are tested under natural field conditions. Figure 1 presents data about the prevalence of the deseases sipanitza and ordinary tobacco mosaic over the years of the study. The monitoring covers over one hundred and twenty introduced varieties, perspective lines and hybrids of Virginia and Burley tobacco, grown in the experimental fields of TTPI on a total area of 3.5 ha. (Yonchev, 2014).

Observation in Burley tobacco group established the highest values of diseased plants at the end of the growing season of 2011, 2013, 2014 and 2015 in a period of eight

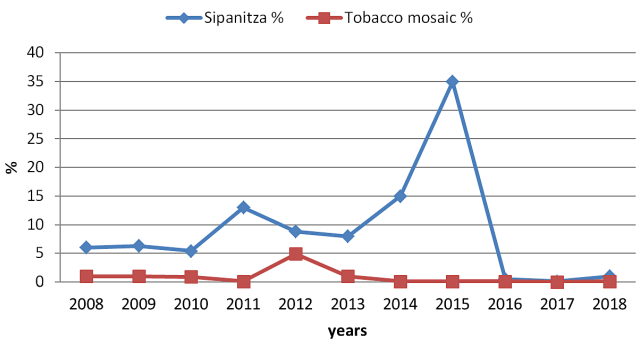

Fig. 1. Monitoring of the spread of sipaniza and tobacco mosaic in samples of variety group Burley tobacco

years. The highest potyvirus infection rate (35%) is recorded in the year 2015. In the remaining years of the study, infection with sipanitza is less than 10%. The lowest percentage of infected plants, about 1%, is reported for the period 2016-2018. Ordinary tobacco mosaic is very poorly represented during the investigated period – less than 1%, except 2012, when signs of the disease reached 4.9%.

Under the concrete ecological conditions and the available infectious background during the individual years of the examination, infection with potiviruses is found only in Line 1354 and Line 1145. Infection with ordinary tobacco mosaic is reported for Line1383, Line 1466 and Line 1495.

Conclusion

Seven of investigated Burley tobacco cultivars are resistant to PVY^n.

Twelve Burley tobacco cultivars react with hypersensitivity after inoculation with TMV-TGM**.**

Eighteen out of twenty-three lines possess complex resistance to PVY^n and TMV-TGM. The remaining five exhibited resistance to only one of both viruses.

Resistant lines could be used in breeding programs for creation of Burley tobacco cultivars and hybrids with complex resistance to PVY^n and TMV-TGM

Common tobacco mosaic is under the threshold of potential treat not exceeding 1% for investigated period, except for 2012, where a burst of 5% is detected showing the significance of the disease.

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