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MONITORING OF *POLISTIGMA RUBRUM, TRANZSCHELIA PRUNI SPINOSE, STIGMINA CARPOPHILA* IN PLUM ROOTSTOCK-CULTIVAR COMBINATIONS FOR THE TROYAN REGION

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Abstract

The study was conducted in the period 2017-2019 in an intensive plum plantation of the RIMSA Troyan. The susceptibility of the rootstock combinations to Polistigma rubrum (Persoon) De Candolle*, Tranzschelia pruni spinose* (Persoon) Dietel*, Stigmina carpophila* (Lev Ellis) *was studied. The infectious process of infection and development was monitored and the degree of attack of Polistigma rubrum* (Persoon) De Candolle*, Tranzschelia pruni spinose* (Persoon) Dietel*, Stigmina carpophila* (Lev Ellis)*, in plum rootstock combinations for the climatic conditions of the region of Troyan were reported. The climatic factors - temperature and precipitation during the infection and manifestation of the diseases have a significant influence on the degree of damage. Studies have found that in all treatments of the study, the highest values for the degree of attack of Polistigma rubrum* (Persoon) De Candolle*, Tranzschelia pruni spinose* (Persoon) Dietel*, Stigmina carpophila* (Lev Ellis) *were reported for 2019, due to the fact that the year is characterized by heavy and prolonged rainy periods, especially the month of June (234.6mm). During the 3 years of the study, the rootstock combinations with Wavit were characterized by a high attack index for the three diseases Polistigma rubrum* (Persoon) De Candolle*, Tranzschelia pruni spinose* (Persoon) Dietel*, Stigmina carpophila* (Lev Ellis)*. Stigmina carpophila occurs exclusively in the treatments with Brompton for the cultivars 'Hanita' and 'Stanley' and in the rootstock Wavit in 'Cacanska Lepotica' and 'Jojo'. The lowest degree of attack has the cultivar 'Hanita' (average 23%), and the highest is in 'Cacanska Lepotica' on Wavit (46.4%).*

Key words: *Plum, rootstock combinations, fungal diseases.*

INTRODUCTION

Fungal diseases, such as *Polistigma rubrum* (Persoon) De Candolle*, Tranzschelia pruni spinose* (Persoon) Dietel*, Stigmina carpophila* (Lev Ellis) occur annually in plum orchards in Bulgaria and everywhere in European countries (Alexandru et al., 2019; Molnár et al., 2018; Stoyanova et al., 2016; Miter et al., 2015b; Borovinova, 2002).

These are common diseases in the conditions of natural infection for the climatic conditions of a given area and cause significant losses.

Usually these diseases can be effectively managed by combining cultural technologies and growing resistant cultivars.

Proper disease management involves the selection and planting of genetically resistant cultivars. Iliev and Stoev (2011) show that *Polystigma rubrum* (Persoon) is one of the most common diseases on plums.

Vitanova et al. (2004) define 'Stanley' and 'Anna Spath' as tolerant to red leaf spots in the conditions of Bulgaria for the period 1996-2003.

There is an extremely strong manifestation of fungal diseases in years with high temperature, high humidity, heavy rainfall and intense clouds. Oroian et al. (2010) study, plantations from the Cluj region, Romania (2008 and 2009), on the emergence of specific pathogens in apples, pears and plums, taking as a main factor the average annual temperature, with the same phytosanitary measures in all variants.

As a result, it is reported that the attack and losses from fungal diseases increased in 2009, when it was warmer than in 2008 (the average temperature is 0.5°C higher), under the same conditions of maintenance and phytosanitary measures.

With additional studies to establish the correlation between climatic factors, represented mainly by temperature and the degree of attack of pathogens, appropriate strategies for integrated tree protection could be developed.

Polistigma rubrum (Persoon) De Candolle occurs annually and depends on the climatic conditions in the spring, when the infection occurs, causes greater or lesser damage to the plum leaves, which leads to a decrease in the quantity and quality of the plum crop and weakening of the plum trees.

According to Mitre (2015a), 'Anna Späth', 'Vinete romanesti', 'Vinete de Italia' and 'Tuleu timpuriu' had a high degree of attack by *Polystigma rubrum* (Persoon). These varieties have been shown to be very susceptible to *Polistigma rubrum* natural conditions of infection. The lowest attack rates of *Polystigma rubrum* were found in Top End, Jojo, Tophit, Toptaste, and Topfirst. The same cultivars are weakly attacked by *Stigmina carpophila* (Lev Ellis) (5.3-7.3% attack rate). These low levels of infection recommend the mentioned cultivars as possible donors in plum breeding programs, to create new genotypes with a good response to disease attack.

In another study by the same authors, Mitre et al. (2015b) under conditions of natural infection *Tranzschelia pruni-spinosae* (Persoon) Dietel studied the response of 13 plum cultivars to certain fungal diseases in Transylvania. With the best results, ie. low levels of rust infection were found in Jojo, Tophit, Topend, Anna Späth,

In UK orchards, O'brien and Berrie (2019) also studied plum rust caused by the fungus *Tranzschelia discolor*, which attacks plants of the genus *Prunus*. The first symptoms of rust are usually seen in July, although in years with hotter summers this can be delayed until August. Fungal spores are able to survive the winter in twigs or leaves, which means that this disease can continue for several growing seasons if sufficient control measures are not taken. Plum rust infections are most detrimental to yields when they appear at the beginning of the growing season from infected leaves. They greatly reduce their photosynthetic capacity and defoliate early, thus reducing the carbohydrate capacity of the tree, which causes lower fruit production the following year.

Soylu et al. (2003) observed rust in the eastern Mediterranean region of Turkey, where they encountered defoliation of plum trees (*Prunus cerasifera*) as a result of rust infections. The disease is observed in almost all orchards in the region on the leaves, but not on the fruits or twigs. The early symptoms of the disease are observed in late May, as distinct angular bright yellow lesions on the upper part of the leaves. By early September, the leaf lesions become dark brown.

Molnar et al. (2018), in a two-year study, determined the susceptibility of four plum cultivars to two fungal pathogens of plum (*Stigmina carpophila* (Lev Ellis) and *Polystigma rubrum* (Persoon) in two planting schemes (4 x 1.5 and 6 x 3). The results show that cvs 'Bluefre' and 'Stanley' were not affected in August 2016. In 'Čačanska Lepotica', the incidence was over 50% in both variants 2016. There is no significant difference between the two density systems.

Due to the significance of plum production for the Republic of Bulgaria and the damage caused by fungal diseases, it is important to determine the strength of their attack on plums during years with different climatic conditions. The obtained results can be used to determine the optimal period for application of pesticides in order to prevent the presence of diseases and to control them.

The objective of the present study was to trace the infection process and development and to register the degree of attack of *Polistigma rubrum* (Persoon) De Candolle*, Tranzschelia pruni spinose* (Persoon) Dietel*, Stigmina carpophila* (Lev Ellis), in plum cultivar rootstock combinations for the climatic conditions of the region of Troyan.

MATERIALS AND METHODS

The study was conducted in the period 2017-2019, in soil and climatic conditions of the region of Troyan. The altitude is 380 m, the exposure is west, with a slope of about 5-8°. The plantation was established in 2005 under the 4 x 1.7 m scheme, by planting in trenches trees of cultivars, such as 'Stanley', 'Čačanska Lepotica', 'Hanita' and 'Jojo', grafted on rootstocks, such as Brompton, GF 655-2, SJ A, Wavit, Wangenheims and *P. cerasifera* (control).

The crowns are free-growing and are maintained with annual winter pruning, the soil surface is covered with turf. The experimental plants are grown under non-irrigated

conditions, which are typical for the cultivation of plums in mountain areas.

Data on temperatures and precipitation, which are essential for the development of diseases, were gathered by the Meteorological Station of the Research Institute in Troyan.

The visual observation method was used to identify the diseases based on signs and symptoms shown by infected plants. The pathogens *Polistigma rubrum* (Persoon) De Candolle, *Tranzschelia pruni spinose* (Persoon) Dietel, *Stigmina carpophila* (Lev Ellis) were followed in this study. Each cultivar-rootstock combination is a treatment. The samples were taken 200 leaves from the middle floor by the 4 directions form 4 trees (replications).

The attack of the studied diseases was reported on the respective ball scales (Nedev et al., 1979), according to the spotting of the leaf blade. Mc Kenney's (1923) formula adopted in phytopathology was used to calculate the attack degree.

$$I=\Sigma\frac{n.k}{N.K}100,$$

where:

I - infestation index of disease in %;

n - number of infested leaves of the respective degree;

k - the number of the degree;

N - number of degrees;

K - number of all reported leaves.

RESULTS AND DISCUSSIONS

For the course of the infectious process of the causative agent of red leaf spots *Polystigma rubrum* De Candolle, the climatic factors of the months of April and May cause a direct impact. A characteristic feature of *Polystigma rubrum* (Persoon) De Candolle is that it's monocyclic, i.e. there are no secondary infections. Ascospores mature and shoot almost together over a period of 2-4 weeks at temperatures of 10 to 26ºC and precipitation. Symptoms, such as relatively large-sized, rounded spots, which colour gradually changes during the growing season from pale green, pale yellow, red to blood red, concave on the upper and convex on the lower side, were observed only on young growing leaves up to 40 days of age. The tissue of the spots was 2-4 times thicker.

The spring months of 2017 are characterized by abundant rainfall, for the months of April (90 mm) and May (133 mm) and high average monthly T°C April 18°C, May 21°C (Figure 1). This favors the infection and development of *Polystigma rubrum* (Persoon) De Candolle.

The highest infestation index was registered in 3 of the variants of 'Čačanska Lepotica' (Brompton, Wangenheims) (28.7%) and SJ A (26%), with 'Jojo' ranging from 6% (Brompton) to 25.3% (Wavit), and with 'Hanita' from 2% to 20%.

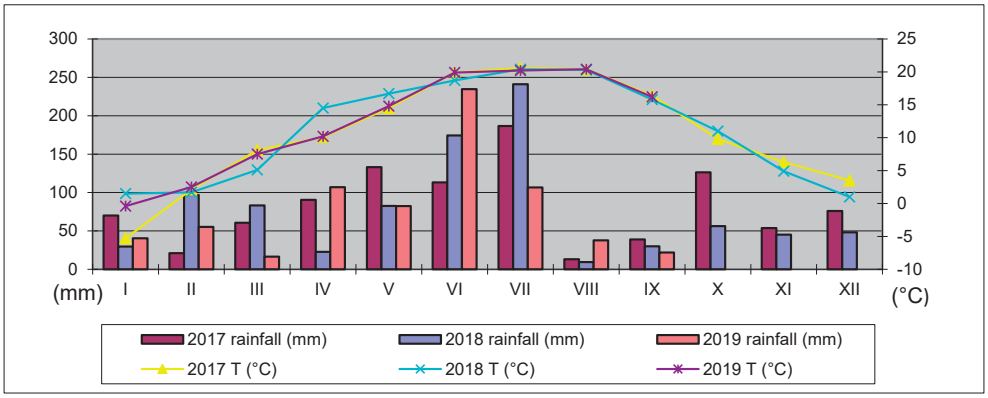

Figure 1. Climatic conditions (2017-2019)

In 2018, the reported infestation index was significantly lower than in 2017, due to climatic conditions, namely low rainfall (April - 22 mm, May - 82 mm) (Figure 1). An infestation of the disease was reported in one variant of 'Hanita' (SJ A 4.00%), in 'Čačanska lepotica' from 0.67% (Brompton) to 5.33% (Wangenheims) and in 'Jojo', on Wavit

(4.67%), and in the control *P. cerasifera* (1.33%).

For the conditions of 2019, no manifestation of the disease was registered in all studied variants. The low average monthly T(°C) (for April 10°C, for May 14°C) proved to be insufficient for mass infection and development of *Polystigma rubrum* (Persoon) De Candolle, despite the more precipitation, April 106 mm and May 82 mm, respectively.

'Stanley' was not affected by *Polystigma rubrum* (Persoon) in any of the years studied, in any of the variants (Figure 2).

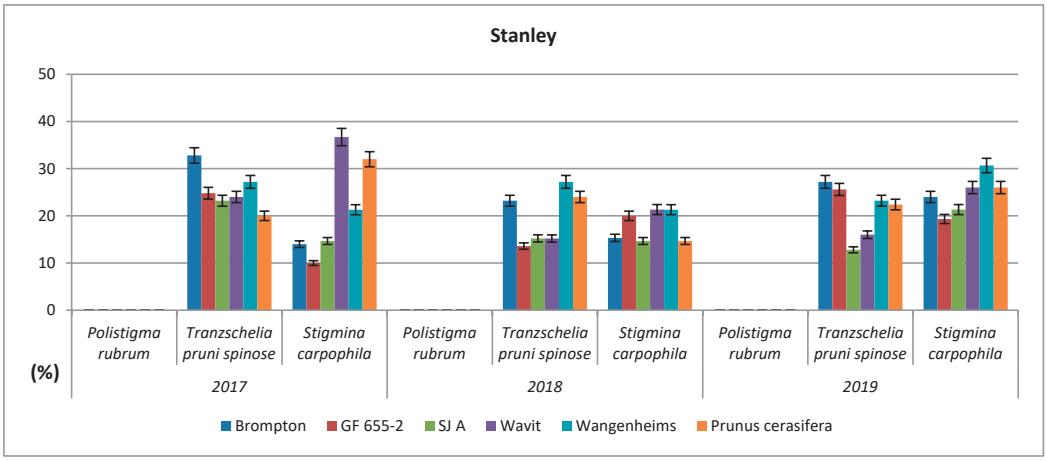

Figure 2. *Polistigma rubrum* (Persoon) De Candolle, *Tranzschelia pruni spinose* (Persoon) Dietel, *Stigmina carpophila* (Lev Ellis) degree of attack (%) on 'Stanley' (2017-2019)

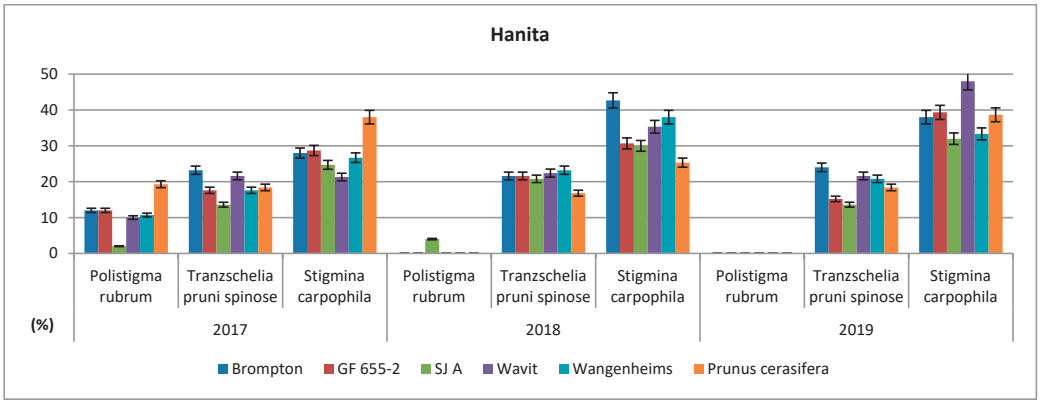

Figure 3. *Polistigma rubrum* (Persoon) De Candolle, *Tranzschelia pruni spinose* (Persoon) Dietel, *Stigmina carpophila* (Lev Ellis) degree of attack (%) on 'Hanita' (2017-2019)

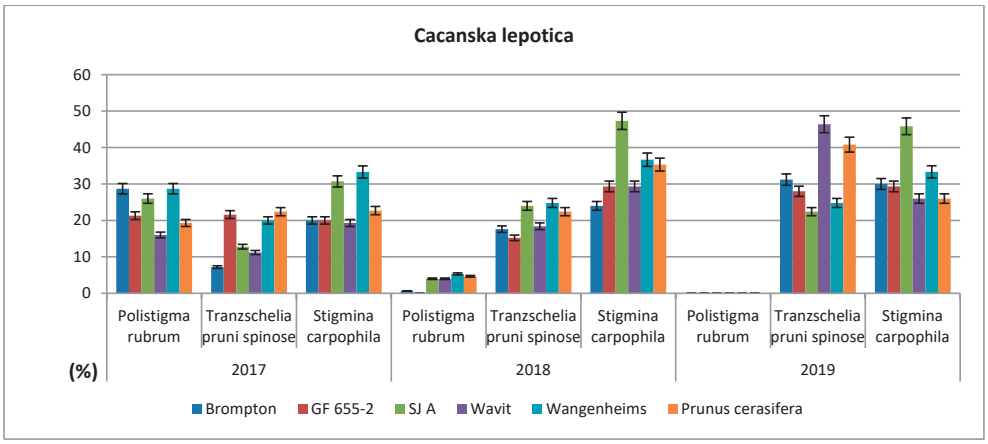

Figure 4. *Polistigma rubrum* (Persoon) De Candolle, *Tranzschelia pruni spinose* (Persoon) Dietel, *Stigmina carpophila* (Lev Ellis) degree of attack (%) on 'Cacanska Lepotica' (2017-2019)

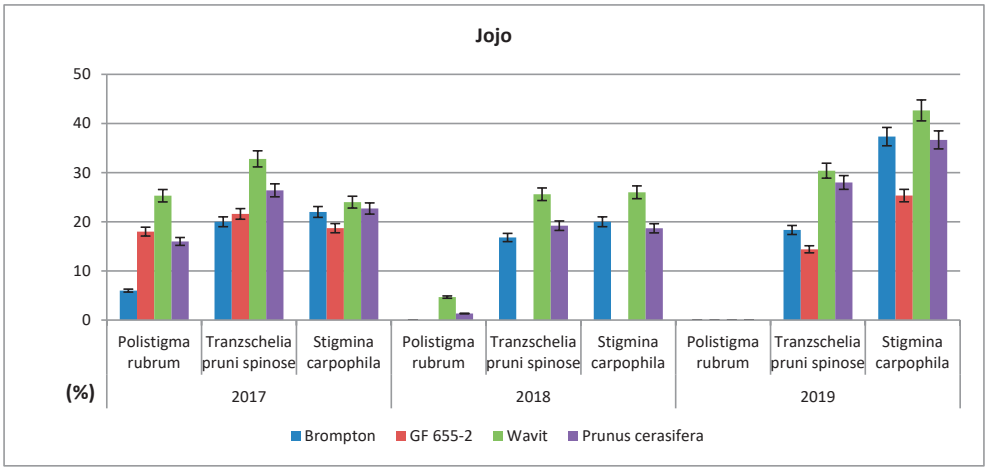

Figure 5. *Polistigma rubrum* (Persoon) De Candolle, *Tranzschelia pruni spinose* (Persoon) Dietel, *Stigmina carpophila (*Lev Ellis) degree of attack (%) on 'Jojo' (2017-2019)

The symptoms leaf rust of the pathogen ***Tranzschelia pruni spinose* (Persoon) Dietel** in plum cultivar rootstock combinations were observed on the leaves, on which small-sized, angular, yellowish or violet-red spots can be seen on the upper side. On the underside below them, in summer, uredosorus with light brown uredospores are formed, and in the autumn (September-October) black teliosorus with teliospores.

Infection in the spring passed at average monthly temperatures for April and May 20-23ºC and humid weather (Figure 1).

Transzchselia pruni spinozae (Persoon) Dietel differs from other fungal diseases with its large uneven distribution during the current growing season, due to the strong influence of climatic conditions during the study period. The first symptoms of *Tranzschelia pruni spinose* (Persoon) Dietel were registered at the end of June, the disease developed more strongly in August, and the peak of the attack was reported in September and October. An exceptional manifestation of rust was reported in all rootstock combinations during the three years of the study.

For 'Stanley' on Brompton rootstock, the highest infestation index was in 2017 (32.8%) and 2019 (27.2%) (Figure 2).

The same trend was observed in 'Hanita' on Brompton in 2017 (23%) and 2019 (24%), as the lowest infestation index values of

susceptibility to rust for the three years were observed in 'Hanita' in all variants (*Tranzschselia pruni spinozae* (Persoon) Dietel) (average for the three years 20%) (Figure 3).
For 'Čačanska Lepotica' the data are different, the highest index was observed on Wavit rootstock - for 2019 - 46.4% (Figure 4).
In the case of 'Jojo' cultivar for the three years, Wavit rootstock also had the highest index (average 30%) (Figure 5).

***Stigmina carpophila* (Lev Ellis)**

The development of fungal shot hole disease (*Stigmina carpophila)* (Lev Ellis) on the leaves was observed almost throughout the growing season. The meteorological conditions in the region of Troyan in the months of April, May and June and during the three years of the study created favourable conditions for mass infection and strong development of the pathogen on the leaves in the observed rootstock combinations. The mass infestations took place at temperatures of 18-22ºC and significant precipitations (Figure 1), as small-sized reddish-spotted spots were formed on the leaves, which reached 2-5 mm with a light central part. A characteristic feature is the appearance of a reddish-purple wreath around the spot. In the more susceptible cultivar rootstock combinations, due to the higher degree of infestation, the spots acquired an irregular shape, as the tissue in the center necrotized, fell off and we observed round perforations on the infested leaves.
For 2017 the highest indices for shot hole disease were reported for 'Hanita', on *P. cerasifera* (38.00%) (Figure 3), for 2018 'Čačanska Lepotica' on SJ A (47.33%) (Figure 4), for 2019 'Hanita'/Wavit (48.00%) and 'Jojo'/Wavit (42.66%).
In all variants of the study, the highest values for the *Stigmina carpophila* (Lev. Ellis) infestation index were reported in 2019, due to the fact that the pathogen is most common in years with heavy and prolonged rainy periods, such as June 2019. The amount of precipitation was 234.6 mm (Figure 1). This led to the creation of optimal conditions for the course of the infectious process and mass infections in almost all studied rootstock combinations.
The lowest values of the index were registered in the control cultivar 'Stanley' throughout the study period (Figure 2).
The highest index for the three years was reported for 'Čačanska Lepotica' for all rootstock variants, as in the combination with SJ A rootstock the maximum values were registered (30.70-47.30%) (Figure 4).

CONCLUSIONS

The climatic factors during the period of infection and development had a direct impact for the course of the infectious process of the causative agents of *Polistigma rubrum* (Persoon) De Candolle*, Tranzschelia pruni spinose* (Persoon) Dietel*, Stigmina carpophila* (Lev Ellis),
In all survey treatments, the highest values of the degree of attack of *Polistigma rubrum* (Persoon) De Candolle*, Tranzschelia pruni spinose* (Persoon) Dietel*, Stigmina carpophila* (Lev Ellis) were reported in 2019, due to the fact that the year is characterized by heavy and prolonged rainy periods, especially in June (234,6mm).
In 2018, the degree of attack of *Polistigma rubrum (*Persoon) De Candolle was lower than in 2017, due to climatic conditions, namely low rainfall.
For the period 2017-2019, *Tranzschelia pruni spinose* (Persoon) Dietel occured exclusively for 'Hanita' and 'Stanley' cultivars on Brompton rootstock and in 'Čačanska Lepotica' and 'Jojo' on Wavit rootstock. The lowest degree of infestation was registered in 'Hanita' on average 23%, and the highest is in 'Čačanska Lepotica' on Wavit (46.4%).
'Stanley' and 'Jojo' can be defined as less attacked by the *Stigmina carpophila* (Lev Ellis), compared to 'Hanita' and 'Čačanska. Lepotica'. The highest degree of attack was registered in 'Čačanska lepotica' for the whole period (2017-2019) especially on SJ A rootstock (30.70 - 47.30%). During the study period, rootstock combinations Wavit rootstock were characterized by a high degree of attack for *Stigmina carpophila* (Lev Ellis).

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