AGRICULTURAL ACADEMY OF BULGARIA

Research Institute of Mountain Stockbreeding and Agriculture of Troyan

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STUDY ON PLUM CULTIVARS OF *PRUNUS DOMESTICA* L. SUITABLE FOR ORGANIC PRODUCTION

DISSERTATION ABSTRACT

for awarding an educational and scientific degree “Doctor”

Scientific Specialty “Fruit Growing”
Professional Field 6.1. “Plant Growing”

Scientific Supervisor Assoc. Prof. Petko Minkov
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I express my gratitude to Assoc. Prof. *Petko Minkov, Ph.D., for his cooperation, guidance and support during the development of the dissertation. I also express my gratitude to the management of RIMSA Troyan and my colleagues from the Department of Mountain Horticulture for their cooperation.*

The dissertation is written on 143 pages, contains 25 tables, 9 figures, 4 diagrams and an attachment of 8 photographs. The cited literature includes 241 sources, of which 165 are in Latin and 76 in Cyrillic. The experimental work was carried out during the period 2010-2012. and 2016 – 2018, in collection plants at the experimental station on plum Dryanovo, RIMSA – Troyan.

The public defense of the dissertation work will take place on 20.09. 2023 from 11:00 a.m. in RIMSA Troyan
before SCIENTIFIC HURRY

Prof. Dr. Valentin Lichev, AU Plovdiv - reviewer
Prof. Dr. Zarâ Rankova FGI Plovdiv - reviewer
Prof. Dr. Mariana Ivanova UARD Plovdiv - opinion
Prof. Dr. Boryana Stefanova RIMSA Troyan - opinion
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I. INTRODUCTION

The plum is the main fruit species for Bulgaria. Its main advantage is the high productivity and the relatively lower demand for soil conditions, which is why it is widely distributed in mountainous areas, where some fruit species such as peach, apricot and cherry do not develop well.

In recent decades, in the context of Bulgaria's accession to the EU, interest in organic farming has increased. One of the main principles of this production is to promote the introduced and selected cultivars that are adapted to the local soil and climate conditions. The inclusion in the production of more introduced and selected (at the Experimental station - Dryanovo) plum cultivars, some of which are not well known to the producers, necessitates the study of some more important biological indicators such as reproductive and vegetative manifestations, and their reaction to the economically important fungal diseases. It is necessary to diversify the plum assortment by including cultivars with different ripening periods and in this way to provide the market with plum production in a longer period, i.e. from mid-July to the beginning of September. Offering producers a range of cultivars suitable for organic farms will significantly increase interest in this crop, as its fruits can be used for fresh consumption and processing. When growing the given cultivar, according to the rules of organic farming, it is extremely important to replace chemical pesticides with alternative products with biologically active substances.

II. PURPOSE AND OBJECTIVES

The aim of the dissertation work is to conduct a study on plum cultivars, introduced and selected in the Plum Experimental Station Dryanovo, suitable for biological production and their relation to diseases in the conditions of the Central Balkan region. To achieve the set goal, it is necessary to perform the following tasks:

1. Study of the biological characteristics of the introduced and selected plum varieties in the Plum Experiment Station in the town of Dryanovo:

1.1. Monitoring the phenology of the studied cultivars of *Prunus domestica* L. in the experimental plantations of Dryanovo;

1.2. Biometric analysis of plum fruits in the conditions of the Central Balkan Mountain region (Dryanovo);

1.3. Biochemical composition of plum fruits in the conditions of the Central Balkan Mountain region (Dryanovo);

2. Attitude of the investigated plum cultivars to diseases:

2.1. Monitoring and determining the infection rate of fungal diseases - red leaf spot (*Polystigma rubrum* P.), early brown rot (*Monilia laxa*), late brown rot (*Monilia fructigena*), plum rust (*Tranzschelia pruni-spinosae* P.) and sachmianka syndrome, with the causative agent of the fungal shot hole disease (*Stigmina carpophila*) on the fourteen plum cultivars in the plantations in the area of the town of Dryanovo;

2.2. Evaluation of the efficacy of the applied control systems based on the authorized preparations within the standards of organic production and possible recommendations for its improvement.

III. MATERIAL AND METHODS

1. MATERIAL

The research was conducted in two periods, 2010 - 2012 and 2016 - 2018, in the experimental collection plantations of the branch in Dryanovo of the Research Institute of Mountain Stockbreeding and Agriculture of Troyan. The objective of the study are widespread introduced plum cultivars and cultivars, a selection of the Experimental Station of Dryanovo. The experiment of the both trials included five trees each of the indicated plum cultivars as follows:

First period 2010 – 2012 (Experiment I)

A collection of plum cultivars in a 20 da plantation established in 1991, in a 5x5 m planting scheme. The cultivars were engrafted on the Yellow cherry plum (*Prunus cerasifera* Ehrh.) and are grown at the same level of agrotechnics. The soil surface is maintained in black fallow, under non-irrigated conditions.

- Cultivars: Althan's Gage, Balvanska slava, Gabrovska, Nevena, Pacific, Opal, Stanley, Strinava, Čačanska lepotica

Second period 2016 – 2018 (**Experiment II**)

A plum plantation of 7 da, created in 2008. The cultivars were engrafted on Yellow cherry plum (*Prunus cerasifera* Ehrh.), in a 5x4 m planting scheme, the soil surface was maintained in black fallow during the first year after planting. At the onset of the period of full fruit bearing, the inter-row spacings are mowed, and the inter-row strips are dug up, under non-irrigated conditions.

- Cultivars: Althan's Gage, Balvanska slava, Gabrovska, Jojo, Nevena, Pacific, Stanley, Strinava, Tegera, Hanita, Čačanska najbolja, Čačanska lepotica and Čačanska rodna.

For each of the above-mentioned cultivars, a characteristic is presented, based on the selected literature.

2. SOIL AND CLIMATE CHARACTERISTICS OF THE AREA

The plantations were created on a pseudopodzolic gray forest soil, deeply carbonated. It is characterized as moderately stocked with alkali-hydrolyzable nitrogen, poor in mobile phosphorus, comparatively better stocked with mobile potassium. The soil has a slightly acidic to acidic reaction and a low humus content.

The climatic conditions of the region are determined by the direct influence of the Central Balkan Mountain. For the area, the altitude is 300 m. The average annual air temperature for Dryanovo is 12.4^{o}C (2010 - 2018), which does not differ significantly from the average for a 30-year base period (1980 - 2009). The years 2011, 2016 and 2017 are marked with lower average annual temperatures compared to the average for the research period. The highest average annual temperature was recorded in 2010 (14.1^{o}C). Extreme high and low temperatures during the study period were not noted.

Precipitation has a continental character. For the study period, there are large differences in the amount of precipitation by year. In 2014, the amount of precipitation reached 1147.8 l/m^2, which is 402.5 l/m^2 above the normal for the area (745.3 l/m^2 for a 30-year period). In most of the years of the study, the annual amount of precipitation was lower compared to the 30-year base period, ranging between 662.3 l/m^2 (2012) and 728.2 l/m^2 (2018).).

The continental nature of the climatic factors for the period of the study (2010 – 2018) is typical for the area and favorable for the normal development of plum culture.

3. RESEARCH METHODS

3.1. Phenological phases. The following phases are reported: swelling of buds (beginning of vegetation); blossoming: (beginning of blossoming; full blossoming; end of blossoming); leaf emergence; technological maturity of fruits; end of vegetation.

- According to the period of blossoming - the cultivars are divided into three groups:
  - early blossoming;
  - medium blossoming;
  - late blossoming.
- Ripening period - the cultivars are grouped:
  - with a very early ripening period;
  - with a early ripening period;
  - with a mid-early ripening period;
  - with a mid-late ripening period;
  - with a late ripening period

3.2. Biometric measurements of fruit.

Indicators are calculated on an average sample of 30 fruits of each variety (Nedev et al. 1979), determining:

- Fruit size – length, width and thickness (mm), and petiole length (mm).
- Weight of fruit and fruit stone (g)
- Relative share of the stone (%), compared to the weight of the whole fruit;
- Fruit yield in kg/tree – determined by weighing the amount of fruit immediately after harvesting.

3.3. Chemical composition of fruits:

- Dry matter (%) – determined refractometrically;
- Content of total (soluble) sugars (%) – sucrose, fructose and glucose according to Bertrand;
- Organic acids (%) – by titration with 0.1 n NaOH;
- Tanning substance (%) – according to Leventhal-Neubauer.

3.4. Susceptibility to diseases In Experiment I and II, two sections were determined, one of which was not treated with

pesticides, and the second was treated according to the indicated schemes - 1 and 2.

Observation. The objective of research are the fungal diseases of plums - red leaf spot (*Polystigma rubrum*), rust (*Tranzdchelia prunispinosae*), shot hole disease (*Stigmina carpophila*), early brown rot (*Monilia laxa*) and late brown rot (*Monilia fructigena*). An average sample of 200 leaves (100 fruits) was taken, observing for the manifestation of typical symptoms for each disease and evaluating them according to accepted categories (Nakov et al., 2007). Based on the obtained data, a damage index (expressed as % affected area) calculated according to the formula of McKinney (1923) was determined. All studied cultivars were compared by values of the calculated infection index (%) and classified by degree of susceptibility using a 5-point scale, according to the methodology for studying plant resources (Nakov et al., 1979).

- **Microscopic observations.** In 2010 and 2011, the development of the overwintering perithecia of the pathogen Polystigma rubrum was monitored. The method of Holtz (1939) was used to determine the dynamics of ascospore maturation and release.

Testing of authorized conventional products and biological agents for plum disease control.

- **Early brown rot control scheme using conventional plant protection products.**

The action of the fungicides under field conditions was tested on Stanley and Čačanska lepotica cultivars in the period 2010-2011. The treatment was carried out on the basis of phenological development of the culture. The experiments were conducted in five variants, with replications of 5 trees per cultivar, with the following products, according to scheme 1:

Scheme 1. Applied plant-protection system to combat early brown rot (*Monilia laxa*) in 2010 and 2011.

Variant	Phenophase	Date of treatment	Preparations
I	Bud-formation period - bud burst Begining of blossoming End of blossoming	(30.03.10/09.04.11) (09.04.10/18.04.11) (23.04.10/02.05.11)	Tiram
II	Bud-formation period - bud burst Begining of blossoming End of blossoming After blossoming	(30.03.10/09.04.11) (09.04.10/18.04.11) (23.04.10/02.05.11 (30.04.10/14.05.11)	Cyprodinil - 0.045%
III	Begining of blossoming End of blossoming After blossoming	(09.04.10/18.04.11) (23.04.10/02.05.11) (02.05.10/14.05.11)	Myclobutanil - 0.04%
IV	Begining of blossoming End of blossoming After blossoming	(09.04.10/18.04.11) (23.04.10/02.05.11) (02.05.10/14.05.11)	Tebuconazole - 0.1%
V control			Untreated - -

- **Testing of Green Smile's biopreparations to combat diseases and enemies of the plum.**

The experiment was conducted in the period 2016 - 2018 with Čačanska lepotica and Stanley cultivars. Variants with biologically certified fungicidal products of the Green Smile company (biological,

I), variants using conventional pesticides to combat fungal diseases (chemical, II) and a variant with an untreated control were set. Each variant is represented by 5 trees of a cultivar. Red leaf spot, rust and shot hole disease attack rates were reported. The experiments were conducted in scheme - 2.

Scheme 2. Application of products to combat fungal diseases on plum.

Phenophase	Biological products (I)	Chemical products (II)
Bud-formation period, beginning of blossoming (30.03)	Amynelos – 0,20%	Cyprodinil - 0.045%
Full blossoming, fruit set (12.04)	Myel Complex – 0,15%; Demulution – 0,20%; Kuore Cristal – 0,20%	Cyprodinil - 0.045%
First post-blossoming spraying (25.04)	Myel Complex – 0,15%; Demulution – 0,20%; Kuore Cristal – 0,20%; Gescen – 0,20%; Alud – 0,20%; Grafox – 0,20%; Amynelos – 0,20%	Myclobutanil - 0.05; Thiophanate-methyl - 0.1%
Second post-blossoming spraying (03.05)	Myel Complex – 0,15%; Triven – 0,20%; Demulution – 0,20%; Kuore Cristal – 0,20%; Gescen – 0,20% Alud – 0,20%; Grafox – 0,20%; Molek – 0,20%	Myclobutanil - 0.05; Thiophanate-methyl - 0.1%
Third post-blossoming spraying (03.05)	Demulution – 0,20%; Kuore Cristal – 0,20%; Gescen – 0,20%; Alud – 0,20%; Grafox – 0,20%; Molek – 0,20%	Myclobutanil - 0.05; Thiophanate-methyl - 0.1%
Fourth post-blossoming spraying (03.05)	Demulution – 0,20%; Kuore Cristal – 0,20%; Gescen – 0,20%; Alud – 0,20%; Grafox – 0,20%; Molek – 0,20%	Myclobutanil - 0.05; Thiophanate-methyl - 0.1%

The mean values (x), their errors (± Sx) and coefficient of variation (CV %) of the biometric measurements concerning the tracked morphological characteristics of the fruits were determined. To evaluate the genotypic differences in the monitored indicators, a one-way analysis of variance of variance (ANOVA, single-factor) was conducted by year. For comparison of mean values and assessment of significance/evidence of

differences compared to standards, the LSD indicator was used at a significance level of 5% ($P<0.05$). The statistical program Data Analysis of Microsoft Excel, 2010 was used to perform the calculations.

IV. RESULTS AND DISCUSSION

1. Phenological observations

The occurrence and duration of phenophases depend on a number of factors, the most important of which are cultivar characteristics and meteorological conditions (air temperature, winds and precipitation). Climatic factors for the last years included in the study show certain fluctuations, which affect the changes in the course of the phenophases, for the study area. Depending on the climatic conditions of the respective vegetation, the blossoming periods and ripening of the fruits were established.

Analyzing the data from the two experiments, it can be seen that in 2010 and 2016, the vegetation started at the earliest, in the middle of March, because the average monthly temperature was higher compared to the base period. In 2011d and 2018, all plum cultivars entered the bud swelling phase in the third ten days of March, which was because of the lower temperatures at that time. This phase occured earliest for Čačanska lepotica, Gabrovska, Tegera and Althan's Gage, and the latest in the cultivars Balvanska Slava, Pacific and Nevena.

The bursting of the leaf buds and the emergence of leaves was observed in the second and third ten days of April in all cultivars. During the entire period of the study, the leaf buds of Čačanska lepotica burst first, followed by Opal and Strinava. From 5 to 10 days later, Balvanska slava, Pacific and Nevena entered this phase. The leaves of the respective cultivars also appeared in this sequence. Summarizing, we can conclude that the appearance of leaves in most cultivars occured during the full blossoming phase.

Vegetation ends with leaf fall, but with plum trees it is sometimes forced – as a result of the first autumn frosts. Earliest leaf fall dates were established in 2011 and 2016 (October 15-25) for all

cultivars. In 2010, 2017 and 2018, the first autumn frosts fell at the beginning of November, with leaf fall occurring in the period 01 – 12 November. Only in 2012, due to higher temperatures in October, we observed the latest leaf fall dates for all cultivars (November 15 – 26). The early ripening cultivars completed their vegetation the earliest: Opal, Čačanska lepotica and Althan's Gage.

Table 1 presents data on the course of blossoming by dates and its duration in Experiment I. The earliest blossoming began in 2012 (April 6 to April 22) and the latest in 2011 (April 22 to May 7). The duration in days between the beginning of blossoming and the end of blossoming depends on the climatic conditions of the period. In 2012, blossoming lasted from 10 to 14 days (variety Čačanska lepotica, Opal and Gabrovska), which was due to the higher temperature for the month of April and the lower amount of precipitation. The shortest blossoming period was reported for the varieties Althan's Gage, Balvanska Slava, Stanley and Čačanska lepotica - 9 days in 2011. This is due to the unusually low temperatures for the months of April and May, compared to the base period.

Table 2 presents the course of blossoming by dates for the period 2016 - 2018. The earliest blossoming of the studied cultivars occurred in 2016 (from March 24 to April 17). The reason for this is the higher temperatures in the month of March (2016), which caused an earlier exit from winter dormancy. The latest blossoming began in 2018 (April 08 to April 20). The end of blossoming for each year varied between cultivars within a narrow range – up to 2 days, at the latest, this phase ended in the Nevena cv. The length of blossoming during this period was in the range of 8 to 14 days. It is noteworthy that in 2016 and 2017 blossoming length was longer in most cultivars, with Pacific and Stanley lasting 14-15 days. In 2018, blossoming took place in a shorter time, compared to previous years, for all cultivars, which was provoked by the higher average monthly temperatures for April (2018), compared to the base period.

Table 1. Length of blossoming in various cultivars (2010 – 2012).

Year	Althan's Gage	Balvanska slava	Gabrovska	Nevena	Pacific	Opal	Stanley	Strinava	Čačanska lepotica
				Begining of blossoming					
2010	10.04	10.04	09.04	12.04	12.04	07.04	08.04	09.04	08.04
2011	23.04	24.04	22.04	25.04	25.04	22.04	24.04	22.04	23.04
2012	07.04	10.04	07.04	12.04	12.04	06.04	10.04	06.04	06.04
				Full blossoming					
2010	12.04	12.04	10.04	14.04	13.04	10.04	10.04	10.04	10.04
2011	24.04	26.04	23.04	27.04	27.04	23.04	26.04	23.04	24.04
2012	08.04	12.04	08.04	13.04	13.04	07.04	12.04	07.04	07.04
				End of blossoming					
2010	20.04	21.04	21.04	23.04	23.04	20.04	21.04	20.04	20.04
2011	02.05	03.05	01.05	07.05	04.05	01.05	03.05	02.05	02.05
2012	20.04	21.04	21.04	22.04	22.04	20.04	20.04	19.04	20.04
				Length of blossoming /days/					
2010	10	11	12	11	11	13	13	11	12
2011	9	9	10	12	9	10	9	10	9
2012	13	11	14	10	10	14	10	13	14

Table 2. Length of blossoming in verious cultivars (2016 - 2018)

Year	Althan' s Gage	Balvanska slava	Gabrovska	Jojo	Nevena	Pacific	Stanley	Strinava	Tegera	Hanita	Čačanska najbolja	Chachanska rodna	Čačanska lepotica
						Begining of blossoming							
2016	03.04	25.03	25.03	25.03	05.04	05.04	25.03	24.03	24.03	30.03	04.04	31.03	28.03
2017	03.04	03.04	02.04	31.03	03.04	03.04	02.04	01.04	30.03	31.03	02.04	01.04	31.03
2018	09.04	10.04	10.04	08.04	11.04	10.04	08.04	09.04	09.04	09.04	10.04	10.04	08.04
						Full blossoming							
2016	04.04	27.03	28.03	28.03	07.04	07.04	28.03	27.03	28.03	01.04	06.04	01.04	30.03
2017	05.04	04.04	03.04	02.04	05.04	05.04	04.04	03.04	01.04	02.04	03.04	02.04	01.04
2018	10.04	11.04	11.04	10.04	12.04	12.04	10.04	10.04	10.04	10.04	12.04	11.04	09.04
						End of blossoming							
2016	11.04	05.04	07.04	03.04	17.04	17.04	07.04	06.04	03.04	07.04	15.04	08.04	07.04
2017	15.04	15.04	10.04	12.04	16.04	17.04	15.04	10.04	12.04	10.04	14.04	13.04	10.04
2018	18.04	20.04	18.04	17.04	20.04	20.04	17.04	18.04	17.04	17.04	20.04	17.04	17.04
						Length of blossoming							
2016	8	11	13	9	12	12	14	13	9	8	11	8	10
2017	12	12	8	12	13	14	15	8	13	10	12	10	13
2018	9	10	8	9	9	10	9	9	8	8	10	7	9

Depending on the blossoming period, plum cultivars are divided into early-, mid- and late-blossoming. Summarizing the results of both experiments, it should be noted that the cultivars can be referred to the following groups:

- the early blossoming cultivars are Opal, Strinava, Čačanska lepotica and Tegera;
- mid-blossoming - Gabrovska, Stanley, Jojo, Althan's Gage, Balvanska slava, Hanita, Čačanska rodna and Čačanska najbolja.
- late blossoming are Nevena and Pacific.

The onset of ripening stage of fruits is an important period in the characteristics of cultivars. The follow-up of these periods of the investigated cultivars was conducted in both experiments (I and II). The data are summarized and presented in Figures 1 and 2. Regarding the ripening periods, plum cultivars are grouped into:

- early ripening, with a ripening period in the second half of July - Opal, Tegera and Čačanska lepotica;
- with an early-mid ripening period (first and second ten days of August) are cultivars, such as Althan's Gage, Gabrovska, Balvanska Slava, Pacific, Hanita, Strinava and Čačanska rodna;
- with mid-late ripening period (the last decade of August) - Stanley, Nevena and Čačanska najbolja;
- late ripening cultivar is Jojo, in the beginning of September.

Summarizing the data, a conclusion can be made that the investigated cultivars offer fresh fruit on the market from mid-July to the beginning of September.

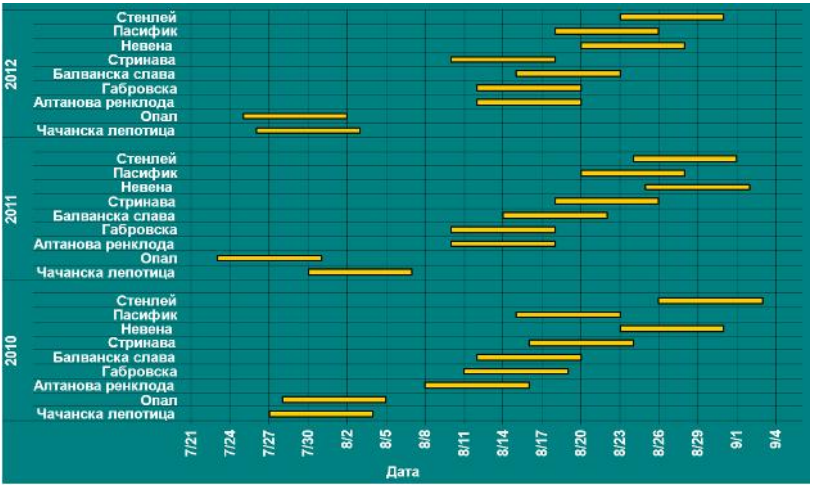


Figure 1. Harvest maturity of fruit in various cultivars, average dates for the period (2010 - 2012) Experiment I

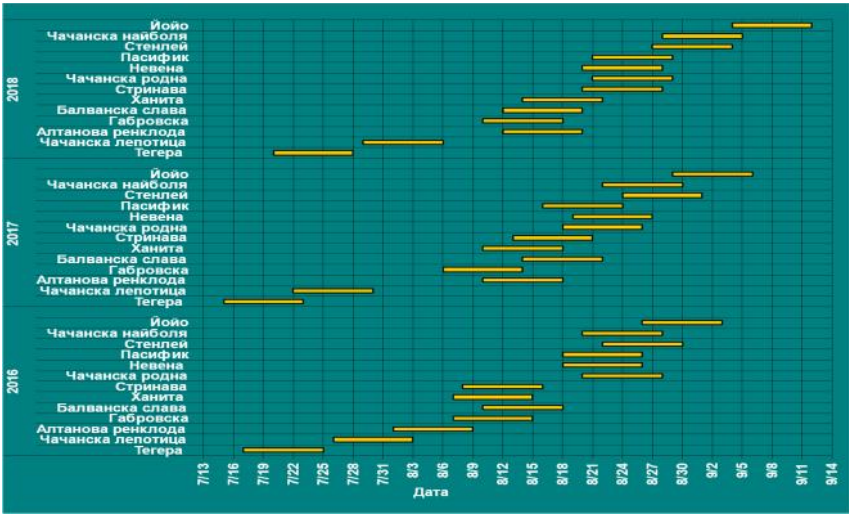


Figure 2. Harvest maturity of fruit in various cultivars, average dates for the period (2016 - 2018) Experiment II.

2. Biometric characteristics of fruit

Fruit size

The size of plum fruits is a characteristic pomological sign for all cultivars and is strongly influenced by the abiotic and biotic conditions of the environment.

The results of the biometric measurements in Experiment I and Experiment II show that the cultivars, such as Pacific, Jojo, Čačanska najbolja and Balvanska slava stand out with the greatest fruit height with 48.39 mm (2011) to 54.63 mm (2012). In the Stanley standard, the height is in the range of 41.14 mm (2012) to 45.35 mm (2018) The rest of the cultivars that have similar fruit shape as in the Stanley standard, the height is in the range of 40.43 mm to 44.04 mm. The selection cultivars of the Experimental Station on Plum of Dryanovo, according to this indicator, approach the Stanley standard. Cultivars whose fruits have a globose shape have a small height. Such are the Althan's Gage cultivar with a height between 38.33 mm and 33.06 mm, and Opal, in which the smallest height was measured from 28.75 mm to 31.59 mm. The coefficient of variation of this indicator in the varieties Nevena, Opal, Strinava, Čačanska lepotica, Gabrovska and Stanley has low values, below 7%, where their fruits are equal in height.

In terms of width, for both periods, the highest values were measured in the cultivars Pacific and Althan's Gage from 41.59 (2017) mm to 44.87 mm (2010). In Jojo and Čačanska najbolja, the width is more than 40 mm in individual years. For the Stanley standard, the values range from 35.18 mm to 38.13 mm, and similar values are observed for most cultivars. The lowest width is registered in Čačanska rodna 20.42 mm (2017) and Opal 24.25 mm (2016). During both periods, the coefficient of variation compared to this indicator was below 8% for most of the studied cultivars, which shows that there is a stable appearance of the respective genotypes by year.In the case of Tegera, Hanita and Čačanska rodna varieties, a significant variation

in values is observed (from 1.83% to 12.33%), which shows that in individual years their fruits are not equal in width.

The average value of fruit thickness ranges from 45.44 mm (2017) in Althan's Gage variety to 24.10 mm in the Opal variety (2011). In the Stanley standard, the thickness is in the range of 31.19 mm to 39.49 mm, and for most cultivars the values are in this range. In a large part of studied cultivars, the values of fruit thickness by year are stable, since the coefficient of variation, for both experiments, is low – below 8%.

Based on the data from the fruit weight and the stone, the relative share of the stone to the fruit weight for the study period was calculated. In Experiment 1, the highest percentage of stone weight in relation to the fruit was found in Opal with 6.1%, whereas the lowest was found in Pacific with 2.32%. With the Stanley standard, its value is 3.94%, and with all other varieties, the percentage is close to the standard. These data are presented in Figure 3.

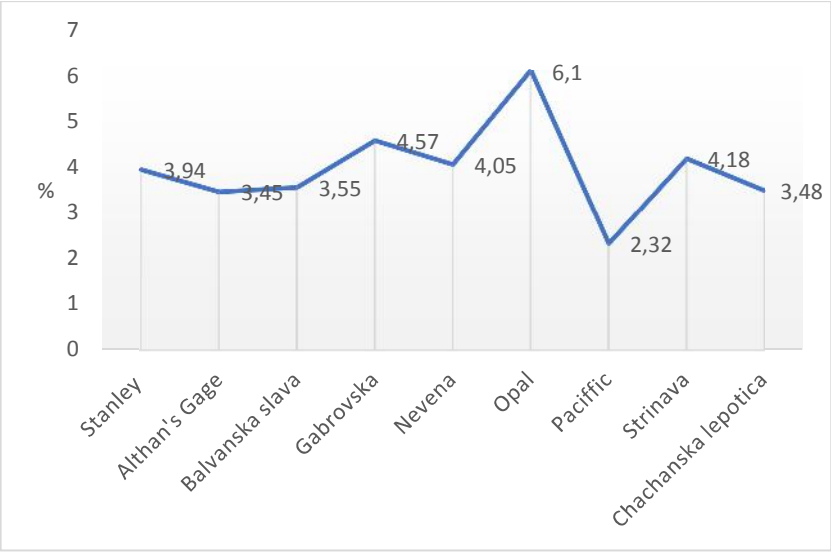


Figure 3. Relative share of stone (%) against fruit weight, averaged over the period 2010 – 2012.

In terms of the relative share of the fruit stone to the fruit weight in experiment II, the highest share was found in Stanley with 5 % and the lowest in Pacific with 3.04%, whereas the percentage of the remaining cultivars was in these limits. These data are presented in Figure 4.

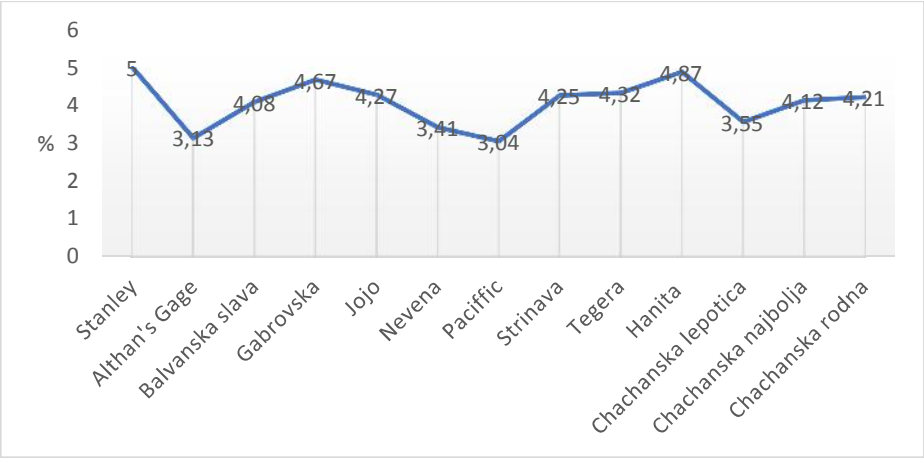


Figure 4. Relative share of stone (%) compared the fruit weight, averaged over the period 2016 – 2018.

3. Yield

Under the conditions of Dryanovo, the calculation of the yield in kg/tree was made in 2017 and 2018, because after the eighth vegetation, the plum trees enter a period of full fruit bearing. In both reporting years, the yield for the Gabrovska, Čačanska rodna, Čačanska lepotica, Čačanska najbolja, Jojo, Nevena, Strinava and Stanley varieties was over 21 kg/tree.

The data in Table 3 show that on average over two years, the coefficient of variation is the largest in Tegera variety (47.97%) and Hanita variety (47.53%), while in Jojo it is the smallest (4.47%) . Jojo, Gabrovska, Althan's Gage, Strinava, Pacific, Čačanska najbolja and Čačanska rodna have low values of the coefficient of variation below 15%, which shows that they have a regular yield under the conditions of Dryanovo. While cultivars with high percentages of variation show fluctuation in yield.

Table 3. Yield (kg/tree) of plum cultivars (2017-2018).

Cultivar	2017	2018	*CV (%)*
Althan's Gage	17,6	15,2	*7,31*
Balvanska slava	22,4	8,1	*43,36*
Gabrovska	53,0	42,2	*11,34*
Jojo	28,0	25,6	*4,47*
Nevena	34,2	23,6	*18,33*
Pacific	23,5	18,2	*12,70*
Stanley	28,6	42,5	*19,54*
Strinava	21,8	25,1	*6,83*
Tegera	15,5	5,4	*47,97*
Hanita	24,8	8,8	*47,53*
Čačanska najbolja	42,5	36,8	*7,18*
Čačanska lepotica	22,7	42,4	*30,16*
Čačanska rodna	26,4	32,3	*10,05*

4. Chemical composition

The analysis of the chemical composition of the fruits was carried out in 2017 and 2018. Plum fruits are characterized by a high content of dry matter, which varies greatly among individual varieties in different years under the influence of atmospheric conditions and agricultural techniques. The dry matter ranges from 15.14% (2017) for the Balvanska Slava variety to 23.78% (2018) for Čačanska rodna. In terms of dry matter content, Althan's Gage, Jojo, Nevena and Tegera cultivars surpass the Stanley standard (18.57%). As a result, we can summarize that in 2018, higher values of dry matter were measured than the previous year (2017) for all studied varieties.In the cultivars studied by us, the organic acids ranged from 0.48% for Althan's Gage for 2018 to 1.78% for 2017 for Hanita.

Under the conditions of Dryanovo, Hanita, Tegera, Strinava and Čačanska lepotica stand out with high acidity of the fruits - over 1.10%. The fruits of Stanley, Althan's Gage, Čačanska najbolja and

Gabrovska are poor in acids, their values are between 0.48% and 0.99%.

Plum fruits contain a significant amount of tannins, which range from 0.217% for Čačanska rodna to 0.506% for Strinava.

The main constituent of soluble solids are sugars. In the studied cultivars, the content of the total amount of sugars for 2017 ranged from 9.31% for Balvanska Slava to 15.54% for Tegera. In 2018, it should be noted that the lowest value of total sugars is in Gabrovska - 9.42%, and the highest in Čačanska rodna - 13.78%. Althan's Gage, Jojo, Pacific, Tegera, Hanita and Čačanska rodna have higher values of total sugars compared to the Stanley standard.

The differences in the qualitative composition of the sugars of the fruits of the individual plum cultivars are significant. Of the 13 cultivars studied, it is noticeable that the sucrose values range from 3.16% for Nevena to 7.28% for Tegera. Regarding fructose, the fruits of Tegera and Čačanska lepotica have the highest values with 7.92%, where as it was the lowest in Gabrovska with 1.63%. From the aggregated data, it can be seen that the Althan's Gage, Hanita, Čačanska rodna and Strinava cultivars surpass the Stanley standard on this indicator throughout the entire period. Regarding glucose, Čačanska lepotica and Tegera cultivars have the lowest content with 0.336 and 0.728% for the entire period. In the other cultivars, the glucose content is in the interval from 1.94 for Strinava to 4.97% for Stanley.

For dried fruit, cultivars with a good ratio between sugars and acids are recommended. It was found that suitable for drying are cultivars, such Gabrovska, Nevena, Stanley and Čačanska najbolja

5. Attitude of the investigated plum cultivars to diseases:

The present study shows that the cultivars grown in the area of the Plum Experimental station of Dryanovo have a great diversity in terms of resistance to fungal diseases. The phytosanitary status of

individual plum cultivars during both periods in Experiment I (2010 – 2012) and Experiment II (2016 – 2018) under field conditions is presented.

In both experiments (I and II) of the 14 investigated cultivars, the highest infection rate of red leaf spots was found in Opal with 55.4% (2010), as it was defined as susceptible. Figure 5 shows that cultivars, such as Nevena, Pacific, Hanita, Čačanska lepotica and Čačanska rodna have less than 25% infection, as they are defined as mid- susceptible. Under the climatic conditions of the Dryanovsk region, none of the tested cultivars can be referred to the group of practically resistant (tolerant) varieties. The varieties Althan's Gage, Gabrovska, Balvanska slava, Jojo, Tegera, Strinava, Čačanska najbolja and Stanley are defined as slightly susceptible.

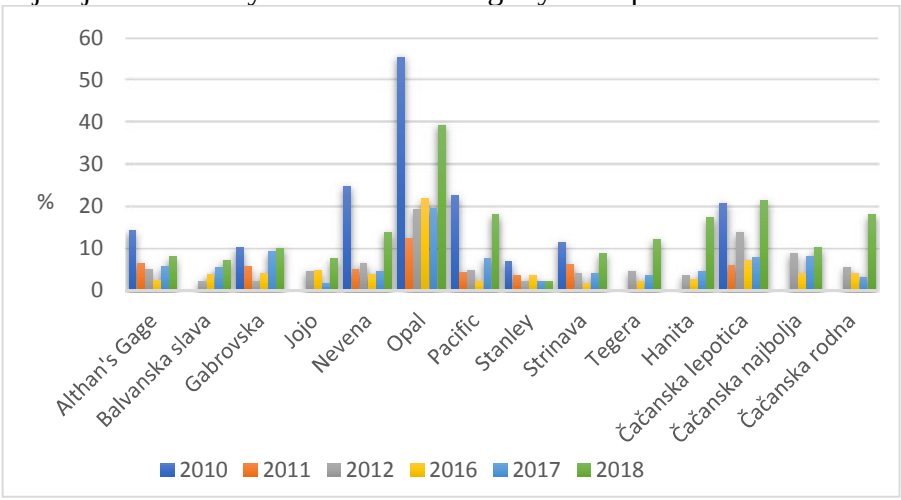


Figure 5. Infection rate (%) of red leaf spot (*Polystigma rubrum*) for the period (2010 – 2012) and (2016 – 2018).

For both periods of the study, the cultivar Stanley was determined to be susceptible to rust. The highest value was reported in 2010 with 44.8%. The cultivars Čačanska lepotica, Čačanska rodna,

Čačanska najbolja are defined as mid-susceptible. The group of slightly susceptible cultivars includes Althan's Gage, Opal, Gabrovska, Nevena, Tegera Strinava and Pacific, whereas Balvanska Slava, Jojo and Hanita are tolerant. In Experiment I in 2011 and 2012, the disease appeared in very low values, with no damage detected in the tolerant cultivars (Figure 6). During Experiment II, a higher infection rate was reported in 2018, whereas in 2016 and 2017 it was very low. This is very well seen in the susceptible Stanley cv. with 2.83% (2017).

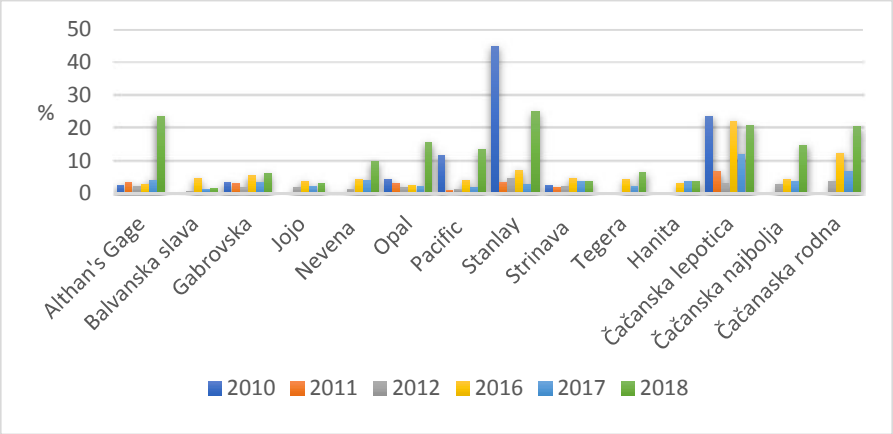


Figure 6. Infection rate (%) of rust (*Tranzschelia-pruni spinosae*) for the period (2010 – 2012) and (2016 – 2018).

There was a strong manifestation of shot hole disease in 2010 and 2018, due to favorable conditions for infection, as the highest values were recorded for the Čačanska lepotica (26.60%) and Gabrovska (25.80%) cultivars. In the same cultivars, in years with a low damage degree, an infection index of less than 14% was reported. Therefore, both cultivars are referred to the susceptible group. The cultivars, such as Jojo, Hanita, Opal, Nevena, Strinava, Pacific, Čačanska rodna and Althan's Gage show average susceptibility, with values not exceeding 18%, especially in years with favorable

conditions for the development of the disease (figure 7). In both periods (Experiment I and II), values below 10% were noted for the cultivars Balvanska Slava, Tegera and Čačanska najbolja, and we define them as slightly susceptible.

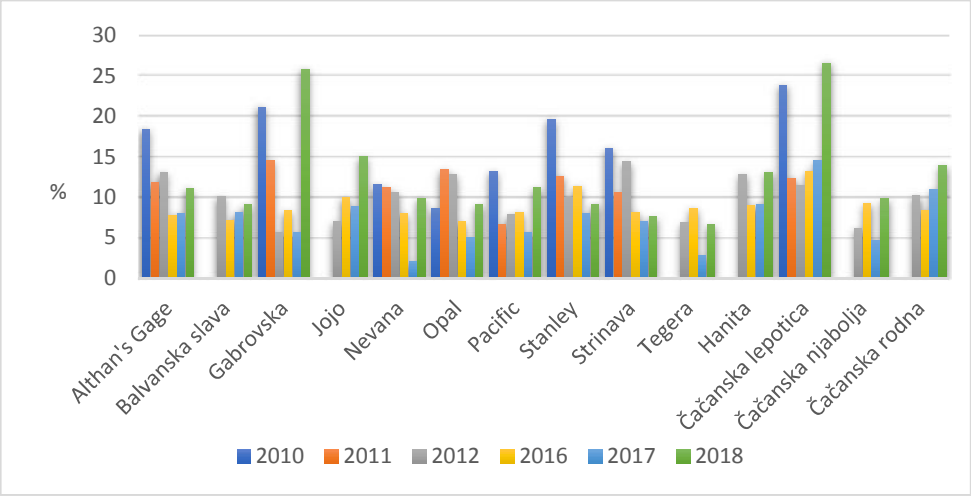


Figure 7. Infection rate (%) for shot hole disease (*Stigmina carpophila*) for the period (2010 – 2012) and (2016 – 2018).

During the three years of Experiment I, there were conditions for the development of early brown rot. According to Figure 8, the greatest damage was found in the susceptible cultivars Stanley and Čačanska lepotica, as the index was between 30.50 and 42.83%. For Althan's Gage and Opal cultivars, an infection rate less than 28% was reported, which defines them as susceptible. All other cultivars have infection index below 20%, for the same period.

In Experiment II (2016 – 2018), the disease caused a lower infection rate in the cultivars studied, caused by the impact of climatic conditions. Therefore, a low infection rate was reported for the susceptible cultivars Čačanska lepotica (12.50%) and Stanley – 3.2%

in 2018. In the same year, for most of the cultivars, an infection less than 1% was reported.

Summarizing the data from both experiments, it can be confirmed that Stanley and Čačanska lepotica are susceptible to early brown rot, followed by Althan's Gage and Opal. The damages inflicted by the pathogen is extremely influenced by the climatic conditions at the beginning of vegetation, which is why slight manifestations are observed in individual years even in susceptible cultivars. The cultivars, such as Balvanska Slava, Jojo, Pacific and Strinava are defined as moderately susceptible, whereas Gabrovska, Nevena, Tegera, Hanita, Čačanska najbolja and Čačanska rodna are slightly susceptible.

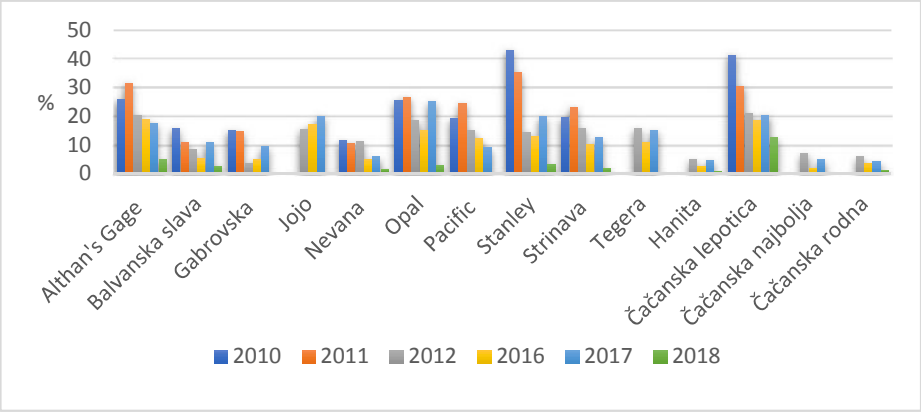


Figure 8. Infection rate (%) of early brown rot (*Monilia laxa*) for the period (2010 – 2012) and (2016 – 2018).

During the study period, the cultivars Stanley, Althan's Gage, Jojo and Strinava showed a strong susceptibility to late brown rot, and in some years the damage was over 25%, (figure 9). The remaining cultivars show a slight reaction, even in years with favourable conditions for the development of the disease. The cultivars Čačanska lepotica, Čačanska rodna, Čačanska najbolja, and Gabrovska and are defined as medium susceptible. In 2016, Nevena cv. and in 2018, the

Tegera and Balvanska Slava cultivars had very low yields, in which the reaction to late brown rot was not taken into account.

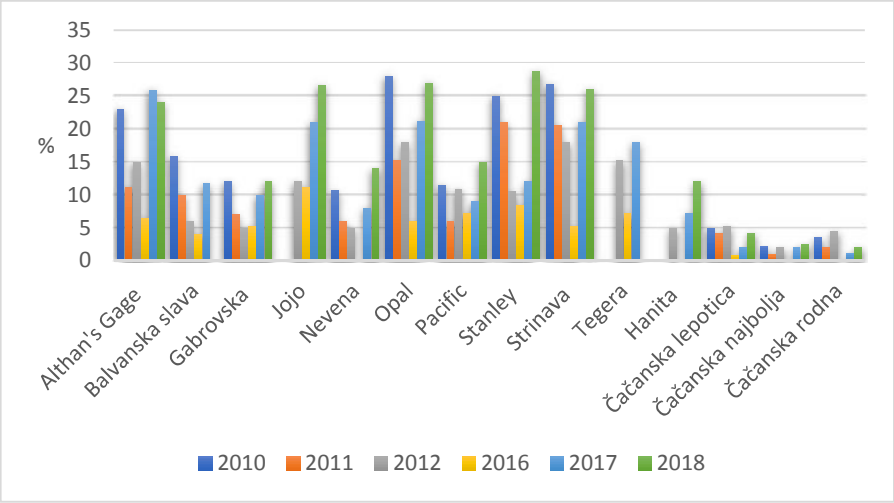


Figure 9. Infection rate (%) of late brown rot (*Monilia laxa*) for the period (2010 – 2012) and (2016 – 2018).

The in-depth research conductedd in the both experiments, over three years each, gives us a more objective view of the reaction of individual cultivars to fungal diseases. Climatic conditions in each year are different and their impact on the life cycle of individual pathogens is reflected in such a way that their virulence manifests itself with different strength. This can be seen very clearly in years where there is a high degree of damage in some cultivars. These are the years 2010 and 2018, because at the beginning of the growing season, in the months of April and May, higher average monthly temperatures were recorded compared to the base period, and in the period of fruit growth, in the months of June and July, high average temperatures were measured monthly amounts of precipitation (over 100 l/m^2), compared to the base period. During the other years of the study, there were no sharp fluctuations in the temperature and

precipitation regime in the Dryanovo region, compared to the base period. Based on this, high infection values (over 50%) of the studied fungal pathogens were not reported in all cultivars. It can be concluded that under the climatic conditions of the Dryanovo region, none of the tested cultivars can be referred to the group of practically resistant ones.

6. Microscopic observations

During the months of March and April of 2010 and 2011, a microscopic observation was made on the development of the overwintered fruiting bodies of *Polystigma rubrum*. A comparison was made between the moment of ripening and shooting of ascospores and the phenological development of plum crops.

The earliest formation of ascospores was observed on 22.03. 2010, and in 2011 it is later - 28.03. A single flight of ascospores occurs about 20 days after the formation of the first spores. The earliest single flight of ascospores was on 13.04. 2011, and in 2010 it is delayed by five days - 18.04. For practice, it is more important when the mass flight of spores begins and how this coincides with the appearance of the leaves.

From the research carried out on the dynamics of ascospore maturation of *Polystigma rubrum*, it was found that under our climatic conditions the development of perithecia in spring proceeds in such a way that at the time of leafing of plum cultivars, which usually happens during blossoming and immediately after re-blooming, large quantities of mature and fledged ascospores are already present. Therefore, it can be concluded that for the correct conduct of treatments with products against red leaf spots, it is not necessary to organize a special warning service. The control can be conducted completely successfully if the spraying plan is carried out depending on the phenophases of development of the plum trees The first application of fungicides against the cause of red leaf spot should be

in the phase of emergence of single leaves, which phase in most cultivars coincides with the end of blossoming. The next one or two treatments are applied in the mass defoliation phase until the final leaf growth. It is known from the literature that the plum leaves become immune after 41-43 days and no infection occurs, i.e. the application of fungicides against this pathogen is not necessary.

7. Testing preparations

7.1. Test scheme of conventional products for plant protection against early brown rot

The experiment was conducted in two consecutive years (2010 and 2011) under field conditions. Spraying was conducted based on the phenological development of the plum trees. The test results of the different products are shown in Table 4.

During the study period, optimal conditions were observed that provoked the development of the spores of *Monilia laxa*. This is clearly seen in variant V (control - not treated), where high values were recorded for both cultivars tested. In 2010, the susceptible cultivar Stanley had the highest rate with 41.80% affected blooms, and in 2011, the infection was 37.83%. In the same variant for Čačanska lepotica, the rate in 2010 was 39.16%, and in 2011 – 32.8%.

Of the treatments performed, the best results were obtained in variant IV – the systemic fungicide with the active substance tebuconazole (Folicur 250 EW) was applied. The scheme of application in both years had a good effect, and in 2010, both cultivars had an infection rate less than 20%. In 2011, it was 17.6% for Čačanska lepotica, and 18.3% for Stanley. The effectiveness of tebuconazole significantly exceeded that of the other products, as the average value for the study period was over 50%. Another product that affected the pathogen was myclobutanil (Systane Super 25 EC) in variant III, with the effectiveness ranging from 31.74% to 38.22%. With this variant, good results were reported in 2010. whereas for

Čačanska lepotica the infection rate was 20.50%, and for Stanley – 20.91%. In the other two variants – I and II, the products limited the disease with an Infection rate below 30%. For Čačanska lepotica in 2010, both variants recorded lower percentages of damage compared to 2011. Accordingly, it was 22.33% for variant I and 22.91% for variant II sprayed with cyprodinl (Horus 50 VG). Similar values are also observed in Stanley cv., in variants I and II. The active substance cyprodinil has a significant effectiveness that affects the degree of damage. In variant I, the slighter effect of the product is observed for both cultivars. This is indicative in 2011 for Stanley with 28.33% and Čačanska lepotica with 29.0%. Based on this, an efficiency of less than 30% was reported, on average for the study period. The results have statistically proven differences for each of the variants in the experiment.

Analyzing the data from the experience, we come to the following conclusion, which can be applied in practice, significantly reducing the degree of damage: application of one of the systemic fungicides with the active substance tebuconazole - 0.1% or myclobutanil - 0.04%; the first treatment, with one of the specified products, should be carried out at the beginning of blossoming, and the following ones should be at the end of blossoming and up to ten days after blossoming. When using the products, such as thiram - 0.3% or cyprodinil - 0.1%, the first treatment should be done in the "bud burst" phase, and the next two in the beginning and end of blossoming phases. Monitoring the phenophases of plum trees is of utmost importance, as they are indicative of the correct moment of spraying

Table 4. Infection rate (%) of early brown rot and effectiveness (%) of conventional plant protection products (PPPs) in plum cultivars (2010 - 2011).

Variant/ Product	Čačanska lepotica						Stanley					
	Infection rate %			Effectiveness %			Infection rate %			Effectiveness %		
	2010	2011	average	2010	2011	average	2010	2011	average	2010	2011	Average
I Thiram - 0.3%	22.33	29.02	25.67a	42.98	11.52	27.25a	27.91	28.33	28.12ab	33.22	25.10	29.16a
II Cyprodinil - 0.1%	22.91	28.5	25.70a	41.49	13.10	27.29a	25.58	26.6	26.09ab	38.82	29.79	34.30b
III Myclobutanil - 0.04%	22.5	27.6	24,05a	47.65	15.85	31.75b	20.9	27.83	24.36a	50.00	26.45	38.22b
IV Tebuconazole - 0.1%	18.1	17.6	17.85a	53.77	46.34	50.05c	19.2	18.3	18.73a	54.16	51.62	52.89c
Control	39.16	32.8	35.98c				41.8	37.83	39.82c			
2010			24.6ns						26.99ns			
2011			27.10ns						27.73ns			
LSD<0.05			*11.4*			*26.2*			*7.9*			*20.2*

Mean values followed by difference in letters in one column indicate a statistically significant difference (P<0.0)

7.2. Scheme for testing organically certified products of Green Smile and conventional preparations for plant protection.

The purpose of this experiment is to determine how different plant protection products can reduce the extent of damage from economically important fungal diseases. The application of the products in both variants was done simultaneously, in the corresponding phenophase of the cultivar, described in scheme 2.

During the period (2016 – 2018) of experiment II, a very low infection rate by red leaf spot was observed in the cultivar Stanley. In both variants, the products have a good effect on this pathogen, with an infection rate of less than 2% and an efficiency of over 58%. The control variant in the Stanley variety showed low values from 2.22% in 2018 to 3.60% in 2016. In the control Čačanska lepotica, the highest value was recorded in 2018 – 21.31% infection by red leaf spots. In the same year, the conventional PPPs took effect, which limited the infection rate to 10.26%. In the first variant, damage from red leaf spots was 13.20%. In 2016 and 2017, the damages were low, and in the controls, the values ranged from 7.02% to 17.80%. In both variants, the applied products had an impact on reducing the power of manifestation of *Polystigma rubrum*, with the effectiveness of the products ranging from 52.94% to 65.72%. The stable effect of the products is due to the low variation of the results, after the statistical analysis.

In 2017, a slighter manifestation of rust was observed, in Čačanska lepotica controls with an infection rate of 12.02% and Stanley – 4.86%. Products from both variants of Čačanska lepotica reduce the damages, with values between 1.42 and 2.40%. In the experiment with the Stanley cv., the variants with applied products reduced the damages below 3%. The effectiveness of the products, in both variants, for the tested cultivars this year was over 61%. Rust damage was highly pronounced in 2016 and 2018, where more than

20% infection was noted during the control of Čačanska lepotica. In the first variant, for Čačanska lepotica, the biological products had a good effect and accordingly there was a 10.8% infection in 2018. The products used in the second variant reduced the degree of damage to 14.2%. In Čačanska lepotica cv., both types of products exhibited high efficiency (over 60%). In 2018, for Stanley cv., in the second variant, 12.02% were reported, whereas for the biological variant, the infection was 13.04%. With the same cultivar, the products from the chemical variant have a higher efficiency (35.57%) compared to the biological variant (29.68%). However, both types of products reduce the strength of rust manifestation, as the reported results show close values and the differences are statistically proven.

Due to the significant amounts of rainfall in June and July in 2018, the infection of the shot hole disease was stronger in Čačanska lepotica, which is susceptible and in the control there was a 26.6% damage, whereas in other years it was less than 15%. In the control cultivar Stanley in 2016, the highest level was recorded with 12.4%, and in 2018 the lowest - 9.82%. In the biological variant, in the studied cultivars, the products reduced the strength of the manifestation of the shot hole disease, with the values approaching those of the chemical variant. In the second variant (chemical), for the entire period of the experiment, the degree of damage was below 10% in both cultivars. During the test period, the biological variant with Stanley cv. (17.79%) had the lowest efficiency. The highest efficiency in both cultivars was shown after treatment with chemical products (over 39%). The effectiveness of both types of products used against the shot hole disease have an unproven statistical difference.

Table 5 shows that the highest efficiency (over 50%) of the applied products is found in both cultivars in variants I and II, which indicates that there is a low infection rate by red leaf spots and rust. In variant I, the effectiveness of the product is lower than that of the

chemical products, but nevertheless the damage from the shot hole disease is lower compared to the untreated variant.

Table 5. Effectiveness of plant protection products (%) against red leaf spot, rust and shot hole disease in plum for the period 211116 - 2018

Cultivar	**Red leaf spot**		**Rust**		**Shot hole disease**	
Variant	Biological	Chemical	Biological	Chemical	Biological	Chemical
Stanley	65.72a	58.38a	29.68b	35.57b	17.79b	39.23ab
Čačanska lepotica	52.94a	53.42a	68.04a	61.41a	28.06b	59.99a
2016	45.60b		54.35a		24.45ns	
2017	82.71a		61.94a		44.19ns	
2018	44.55b		29.74b		40.16ns	
LSD<0.05	*35.1*		*19.9*		*20.2*	

Mean values followed by a difference in letters in one column indicate a statistically significant difference (P<0.0)

The results show that organically certified products significantly reduce the extent of damage from red leaf spot, rust and shot hole disease. In the first variant, the obtained values approach those of the second variant. Products from variant II (chemical) also limit the development of fungal diseases. Products applied in variants I and II significantly reduced the damage index, compared to the untreated variant. The choice of products depends on the way the plum plantations are grown, since both types of products can provide optimal protection of the trees.

V. Conclusions

The dissertation presents results that can be interpreted in the context of the "green deal", in relation to achieving EU goals, which is an actual challenge for modern agriculture. The conducted studies and their conclusions have a high value for fruit growing science and practice. Introduced plum cultivars - world selection and selected cultivars of the Plum Experimental Station of Dryanovo, which are traditional for the region and Bulgaria and adapted to local conditions,

were studied. Their biological characteristics have been established under the conditions of organic production.

1. The vegetation of the studied plum cultivars was observed, which gives us the reason to propose a detailed phenological calendar for the Dryanovo region. The most important for farmers are the phases of blossoming and technological harvest maturity of the fruits.

Blossoming in plum cultivars has an average duration of 9 to 12 days. According to the course of blossoming cultivars are divided into:

- early blossoming cultivars such as Čačanska lepotica, Opal, Strinava and Tegera;
- medium blossoming - Gabrovska, Čačanska najbolja, Stanley, Althan's Gage, Jojo, Balvanska slava, Hanita, Čačanska rodna;
- late blossoming are Nevena and Pacific.

Regarding the ripening periods, plum cultivars are grouped into:

- early ripening, with a ripening period in the second half of July - Opal, Tegera and Čačanska lepotica;
- with an early-mid ripening period (first and second ten days of August) are cultivars, such as Althan's Gage, Gabrovska, Balvanska Slava, Pacific, Hanita, Strinava and Čačanska rodna;
- with mid-late ripening period (the last decade of August) - Stanley, Nevena and Čačanska najbolja;
- a late ripening period in the beginning of September - Jojo cv.

The grouping of the studied cultivars offers producers and consumers a choice of cultivars to provide them with a long marketing period of fresh fruit (from mid-July to early September).

2. According to biometric indicators for the study period, with climatic features of Dryanovo, plum cultivars are defined as:

- very large fruits have the cultivars, such as Pacific, Čačanska najbolja, Jojo and Althan's Gage, their average weight is over 35 g.
- large fruits - cultivars, such as Stanley, Balvanska Slava, Strinava, Gabrovska, Čačanska lepotica, Čačanska rodna, Hanita and Nevena, with fruit weight between 21 and 35 g.
- average-sized fruits - Opal cv. with weight under 21 g.

The cultivars, such as Gabrovska, Pacific, Tegera, Strinava, Balvanska Slava, Nevena, Čačanska lepotica and Stanley have a low coefficient of variation regarding fruit weight, which defines them as cultivars with a stable expression of the genotype, for the entire study period.

3. In a period of full fruit bearing, the trees have regular yields, with low to medium levels of variation, reported for Jojo, Strinava, Čačanska najbolja, Čačanska rodna, Pacific, Gabrovska and Althan's Gage cultivars.

4. Under the soil and climatic conditions of Dryanovo, plum fruits exhibit the following characteristics in their chemical composition:

- in dry matter content, the cultivars, such as Čačanska rodna, Althan's Gage, Jojo, Nevena and Tegera surpass the Stanley standard (18.57%);
- the cultivars, such as Hanita, Tegera, Strinava and Čačanska lepotica are characterized by high fruit acidity with values (from 1.10% to 1.78%), and those of Stanley, Althan's Gage, Čačanska najbolja and Gabrovska with low values (0.48 % and 0.99%);
- values of total sugars superior to those of the Stanley standard (11.83%) have the cultivars Althan's Gage, Jojo, Pacific, Čačanska rodna and the most Tegera (15.54%).

5. From the studies conducted in the untreated area in relation to the susceptibility to economically important diseases, it was established:

- Opal cv. is susceptible, whereas Nevena, Pacific, Gabrovska, Hanita, Čačanska lepotica and Čačanska rodna are moderately susceptible to red leaf spots. The cultivars, such as Althan's Gage, Balvanska slava, Jojo, Tegera, Strinava, Čačanska najbolja and Stanley are slightly susceptible.
- Stanley is defined as highly susceptible to plum rust. In 2010, it recorded the highest infection index - 44.8%. Čačanska lepotica, Čačanska rodna, Čačanska najbolja and Pacific are defined as medium susceptible. The tolerant cultivars include Jojo, Hanita and Balvanska Slava, whereas slightly susceptible cultivars are Althan's Gage, Gabrovska, Strinava, Nevena, Opal and Tegera.
- Čačanska lepotica and Gabrovska are susceptible to fungal shot hole disease. Stanley, Hanita, Opal, Strinava and Althan's Gage have medium susceptibility, whereas Jojo, Čačanska rodna, Nevena and Čačanska najbolja, Tegera and Balvanska slava are tolerant.
- The greatest damage from early brown rot (with an infection index between 30% and 40%) is found in the susceptible cultivars Stanley and Čačanska lepotica. The cultivars Stanley, Althan's Gage, Jojo and Strinava showed a strong susceptibility to late brown rot, and in some years the damage was over 25%.

6. For a period of two years, the development of ascospores in the overwintering stroma of the plantation was observed. The moment of ripening and release of ascospores was established, and a comparison was made with the phenophases of plum trees. It was confirmed that when the trees are in the leaf-emergence phase, which coincides with the end of blossoming phase, ripened and released ascospores were present in the plantations. This moment is important for the practice, because in these phenophases (they are key

to fight against this pathogen) it is recommended to use fungicides against red leaf spots.

7. Of the studied plant protection products for limiting damage from early brown rot, the following scheme for integrated control (Experiment I) gave the best results:

- choice of systemic fungicide with active substances - tebuconazole - 0.1% or myclobutanil - 0.04%;
- first treatment, with one of the listed fungicides, in the beginning of blossoming phase;
- second treatment, with the same fungicides, at the end of blossoming;
- third – after flowering treatment, with one of the listed fungicides.

8. Depending on the way the plum trees are grown, both conventional and certified organic products can be used in practice. From the study conducted in Experiment II, it was found that the biologically certified products (variant I) and the conventional PPPs (variant II) significantly reduced the damage index compared to the untreated variant.

CONTRIBUTIONS

With original nature

1. A study was conducted on introduced and selected plum cultivars suitable for organic production in the Plum Experimental Station Dryanovo.

2. It has been proven that the cultivars from the selection of the Plum Experimental Station Dryanovo in terms of biological and economic qualities are superior or have similar indicators to the studied introduced cultivars.

3. The attitude of the plum cultivars to diseases in the conditions of the Central Balkan region has been established and they

are divided into the following groups: tolerant, slightly susceptible and susceptible.

4. The adaptation of the introduced plum cultivars to the soil-climatic conditions of the region (the Central Balkan Mountain) was monitored, and their biological characteristics were analyzed.

5. Products for organic production have been tested to be recommended to agricultural producers.

6. The phenology of the studied cultivars of *Prunus domestica* L. in the experimental plantations of Dryanovo was observed which gives grounds for the release of cultivars suitable for zoning under the agro-ecological conditions of the area.

7. A study was conducted on the development of the overwintering stroma of *Polystigma rubrum* and the moment of ripening and release of the ascospores under the conditions of Dryanovo.

8. The relation of 14 plum cultivars to the diseases was determined - early and late brown rot (*Monilia laxa, Monilia fructigena*), red leaf spots (*Polystigma rubrum*), plum rust (*Tranzschelia pruni-spinosae*) and syndrome caused by a fungal shot hole disease (*Stigmina carpophila*) in the Dryanovo area.

9. The development of ascospores of *Polystigma rubrum* was followed and conventional products against early brown rot were tested, where it was found that the moment of application of fungicides should be consistent with the phenophase of the plum cultivars.

Contributions with a confirmatory nature

1. The reproductive characteristics of 14 plum cultivars from the world and Bulgarian selection, which are grown in the Central Balkan Mountain region, were studied.

2. According to the size of the fruits, the cultivars, such as Pacific, Čačanska najbolja, Althan's Gage, Jojo and Balvanska Slava can be recommended for growing in the soil and climatic conditions of the Central Balkan Mountain.

3. The susceptibility of a large number of cultivars to red leaf spot (Polystigma rubrum) and rust (*Tranzschelia-pruni spinosae*) was determined. The cultivars Jojo, Tegera, Balvanska slava, Strinava and Čačanska najbolja show tolerance to both diseases.

4. The reaction of the cultivars to early and late brown rot was monitored and their susceptibility was determined.

5. Plum cultivars (Stanley, Čačanska rodna, Čačanska najbolja, Tegera, Balvanska slava and Nevena) that are tolerant (slightly sensitive) to shot hole disease (*Stigmina carpophila)* were defined.

Contributions with an applied nature

1. An assessment was made of the efficacy of the applied control systems based on the authorized products within the standards of biological production and possible recommendations for its improvement and implementation in practice.

2. The in-depth study for the period 2010-2012 and 2016-2018 gives us an objective idea of the adaptation of the introduced plum cultivars to the agro-ecological conditions of the Pre-Balkans (the Central Balkan Mountain). The productivity, biometric and chemical indicators of the fruits were established and cultivars were proposed for inclusion in the practice, with indicators close to or higher than those of the Stanley standard.

3. The harvest maturity periods of the fruits was established and the group of each cultivar according to its ripening period was indicated.

4. Plum cultivars (Jojo, Pacific, Tegera, Hanita, Čačanska najbolja and Nevena) for the Dryanovo region were indicated as tolerant or slightly susceptible to economically important fungal diseases.

5. Conventional (fungicides: tebuconazole – 0.1% and myclobutanil – 0.04%) products against early brown rot, dosages and schemes were suggested.

6. A scheme of treatment with biological and conventional products was provided and Green Smile's biologically certified products were recommended for implementation in production.

7. For organic production of healthy fruit production, the cultivars Čačanska najbolja, Tegera, Althan's Gage, Čačanska rodna, Jojo, Gabrovska and Nevena are recommended.

8. Producers are offered an assortment of early-ripening to late-ripening plum cultivars to satisfy the market with fresh fruit production.

9. Cultivars are recommended for growing under Dryanovo conditions, depending on their susceptibility to fungal diseases: red leaf spots, plum rust, shot hole disease, early and late brown rot.

Scientific publications related to the dissertation work

Todorova S., N. Marinova, D. Ivanova, 2019. Susceptibility of plum cultivars to Fungi disaeses: Red leaf spot, Rust and Shot hole disaese. *Journal of Mountain Agriculture on the Balkans*, 22 (2), 177-184; ISSN 1311-0489 http://rimsa.eu/images/perennial_plants_vol_22-2_2019.pdf

Todorova S., P. Minkov, T. Mihova. 2022. Behavior of plum varieties grown in Dryanovo Experimental Station to economically important diseases. *Scientific Papers. Series B, Horticulture*, LXVI, (1), 207-212; Print ISSN 2285-5653 https://www.webofscience.com/wos/woscc/full-record/WOS:000888877000033

Todorova S., Ivanova D., N. Marinova, 2022. Biological characteristics of the Introduced plum cultivars Chachanska Najbolja and Chachanska Rodna of *Prunus domestica* L., in the Region of

Dryanovo. *Journal of Mountain Agriculture on the Balkans*, 25 (5), 334-343; ISSN 1311-0489
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STUDY ON PLUM CULTIVARS OF *PRUNUS DOMESTICA* L. SUITABLE FOR ORGANIC PRODUCTION

Summary

The present dissertation presents an in-depth study of fourteen introduced and Bulgarian plum cultivars grown in the Central Balkan region (Dryanovo), for their reproductive capabilities and their response to economically important fungal diseases.

The research was conducted in two periods, 2010 - 2012 (Experiment I) and 2016 - 2018 (Experiment II), in the experimental collection plantations of the Plum Experimental Station of Dryanovo, a branch of the Research Institute of Mountain Stockbreeding and Agriculture of Troyan.

The vegetation of the studied plum cultivars was observed, which gives us the reason to propose a detailed phenological calendar for the Dryanovo region. Based on the obtained data, the cultivars are grouped into early-, mid- and late-blossoming. By fruit ripening period, plum cultivars are grouped into: early ripening; early-mid; with a mid-late ripening period; late ripening.

The reproductive characteristics of the cultivars from the world and Bulgarian selection under the soil and climatic conditions of Dryanovo were studied. The productivity, biometric and chemical indicators of the fruits were established and cultivars were proposed for inclusion in the practice, with indicators close to or higher than those of the Stanley standard.

The reaction of the studied cultivars to the economically important fungal diseases was monitored: red leaf spot (Polystigma

rubrum P.), early brown rot (*Monilia laxa*), late brown rot (*Monilia fructigena*), plum rust (*Tranzschelia pruni-spinosae* P.) and shot hole disease syndrome, with fungal shot hole disease as an agent (*Stigmina carpophila*), as they are divided into the following groups: tolerant; slightly susceptible and susceptible.

In both experiments, schemes were proposed for testing conventional and biological products. Green Smile's biologically certified products are recommended for implementation in production.