

- and tolerance to plum pox virus.
(PPV).

- Disadvantage of the cultivars Graf Althan's, Stanley and Strinava, introduced in producing variety because of their tolerance to plum pox virus, is receptivity to brown rot. Also the cultivars Graf Althan's, Kyustemdilska sinya sliva and Opal have to be protected with fungicides against the disease red spots.

Key words: plum cultivars, red leaf spots, brown rot, plum pox (sharka)

INTRODUCTION

- Plum is a traditional fruit culture and is widely grown in Bulgaria. Plums are a very valuable food for humans because they contain sugars, organic acids, vitamins and microelements. 'Kystendilska plum' and 'Stanley' were widely used in the recent past (Iliev et al., 1999).

(Iliev

et al., 1999).

- In recent years, plum cultivars were spread that were selected in a certain European countries.

(Dragoyski et al., 2011; Iliev and Stoev, 2008; 2011; Iliev et al., 2011).

- The most common diseases in plum culture are early (*Monilinia laxa*) and late brown rot (*M. fructigena*), red leaf spot (*Polystigma rubrum*) and plum pox virus (PPV) (Dragoyski et al., 2011; Iliev and Stoev, 2008; 2011; Iliev et al., 2011).

- The selection of varieties for the creation of a new orchard is an important point in preparing for a profitable fruit-growing agribusiness. The right choice of variety reduces the cost of growing fruit trees, reduces the risk of disease and enables the rhythm of harvesting. Moreover, through the variety set, the farmer can respond more flexibly to market requirements (Iliev et al., 1999, Vitanova et al., 2014; Stefanova et al., 2016).

(Iliev et al., 1999, Vitanova et al., 2014; Stefanova et al., 2016).

- The study of the main features of the agrobiological characterization of established plum varieties aims to identify

varieties with complex resistance to pathogens that are of economic importance.

MATERIAL AND METHODS

In the period 2014-2016 a survey was conducted covering seven plum varieties with different agrobiological characteristics (Table 1 and 2). Cultivars such as, Althan's Gage, 'Gabrovska', 'Kystendilska plum', 'Nevena', 'Opal', 'Stanley' and 'Strinava' are a part of the collection of the Experimental Fruit Growing Station in the town of Dryanovo, which is a branch of RIMSA in the town of Troyan.

Trees of the selected varieties are 9 years old. The distance between the trees is 4 meters, and between the rows in the plantation - 5 meters. The ground surface of the plantation is maintained in black fallow.

In the period of rest, tree crown pruning was made, regulation of growth and fruit bearing, and removal of diseased and dry branches.

The plantation is maintained according to Methods for Studying Plant Resources in Fruit Orchard Cultivars of Yoncheva et al. (1979). Trees are grown under non-irrigating conditions.

The trees were not treated by any insecticide and fungicides. The exclusion of pesticides facilitates the accumulation of infection in the orchard and the attack of trees from *P. rubrum*, *M. fructigena* and PPV.

The following indicators were taken into account: blossoming period, fruit ripening, and resistance to diseases, such as sharka, late brown rot, and red leaf spots.

The indicators for resistance to these diseases are: the condition of fruits in the presence of sharka (plum pox virus) and brown rot, as well as signs on the leaves of the observed diseases (Yoncheva et al., 1979).

2014-2016

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Yoncheva et al. (1979).

rubrum, *M. fructigena* and P V.

(Yoncheva et al., 1979).

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Preliminary visual evaluation was conducted in case of red leaf spot. A scale of 6 degrees was used according to the spots on the leaves:

0. no spots - immunity;

1. single small spots - practical resistance;

2. spotted up to 5% - low susceptibility (strong resistance);

3. spotted up to 10% - average susceptibility (average resistance);

4. spotted up to 25% - susceptible (resistant);

5. up to 50% - highly susceptible (low resistance).

RESULTS AND DISCUSSION

The air humidity during the vegetation season is one of the main factors for development of fungal diseases. Regarding the rainfall amount, Dryanovo area is within the average rain amount for the country, which varies from about 400 liters per m² in the period from March to August. An exception is made only in 2014, when the rainfall for Dryanovo from March to August was 693 l/m².

Data for the blooming period for the varieties observed are shown in Table 1.

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The results obtained are averaged

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according to the statistical methods of Lidanski (1988). 'Opal', 'Althan's Gage', 'Strinava', 'Gabrovska' and 'Stanley' have

an average early blooming period, and 'Nevena' and 'Kystendilska plum' are late

,

blooming.

According to the fruit ripening, 'Opal' variety is the earliest (10-15 July),

followed by 'Althan's Gage' (1-10 August), 'Stanley', 'Gabrovska' and 'Strinava' (15-

20 August) 'Nevena' and 'Kystendilska plum' (1-10 September).

2014

400 l/m²

693 l/m².

1.

Lidanski (1988).

(10-15

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(15-20

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Table 1. Blossoming of plum cultivars average in the period 2014-2016.

Cultivars	Fertility	Period of blossoming	Beginning of blossoming		Beginning of full blossoming		End of blossoming	
			$\pm Sx$	x	$\pm Sx$	x	$\pm Sx$	x
Althan's Cage	Self sterile	Moderate early blossoming	6.IV	7,42	7.IV	7,42	16.IV	7,58
Gabrovska	Self sterile	Moderate early blossoming	4.IV	10,89	5.IV	10,02	15.IV	9,49
Stanley	Self fertile	Moderate early blossoming	4.IV	11,59	5.IV	10,27	15.IV	9,16
Strinava	Self fertile	Moderate early blossoming	5.IV	15,28	6.IV	10,61	15.IV	9,49
Opal	Self fertile	Moderate early blossoming	3.IV	10,72	4.IV	10,02	14.IV	10,02
Nevena	Self sterile	Late blossoming	9.IV	6,48	10.IV	6,20	20.IV	6,67
K Kyustendilska plum	Self fertile	Late blossoming	9.IV	6,67	11.IV	6,08	20.IV	7,00

(2).

- The attack of red leaf spot was observed in all varieties. It was most obvious in 'Opal' and 'Kystendilska plum' as it damaged more than the half of the leaves in all parts of the tree crown (Table 2).

- The late brown rot appeared widely on fruits of 'Althan's Gage' and 'Stanley'. Without use of fungicides and in case of delayed harvesting, the harvest can be completely failed. 'Strinava' variety is averagely susceptible to the disease.

- Under conditions of natural infection background the signs of plum pox were observed on the leaves of trees of all tested varieties (Table 2). 'Stanley' appeared as tolerant to plum pox virus according to fruit damage, as it is included in the study as a standard for Bulgaria. Such a characteristic can also be given to 'Nevena' and 'Gabrovska' cultivars.

- There was no surface deformation of fruit of the infected treed in these cultivars and internal damage to the fruit flesh.

- There was sharka on the surface of single fruits of 'Althan's Gage' in the

10%

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30%

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ripening period. In 'Strinava' and 'Opal' some areas of fruit flesh became red, as well as 5-10% of fruits fell off before the harvest maturity.

The strongest damage to the fruits as a result of PPV infection was reported in the trees of 'Kystendilska plum'.

More than 30% of the fruit had significant surface deformations that degraded the commercial appearance of the fruit. They fell off before maturity and were unsuitable for consumption in fresh state and as raw material for processing.

Table 2. Comparative agrobiological characteristic of plum cultivars in collection orchard of RIMSA – town of Troyan, branch – town of Dryanovo

Cultivar	Kinds of fruit bearing branches	Fruit ripening	Resistance / susceptibility to diseases		
			red spot	brown rot	Plum pox (sharka)
Althan's Cage (Graf Althan's)	bouquet branches and spurs	1-10.08. August	susceptible	susceptible	tolerant
Gabrovska	bouquet branches and spurs	10-15.08. August	moderately resistant	resistant	tolerant
Kyustendilska plum	/ spurs	1 – 10.09. first half of September	strongly susceptible	resistant	susceptible
Nevena	bouquet branches	1 – 10.09. first half of September	resistant	resistant	tolerant
Opal	bouquet branches, long fruiting branches	10 -15. 07.	strongly susceptible	resistant	resistant / tolerant
Stanley Strinava	bouquet branches	10 – 15.08	resistant	susceptible	tolerant
	bouquet branches	15 – 20. 08 last decade of August	resistant	moderately susceptible	resistant / tolerant

According to the ripening period of fruits, the varieties observed provide a

- harvesting period of two months.

It is sufficient to engage pickers in order to ensure conditions for storing the production and its realization on the market.

- It should be noted that plantations of 'Kystendilska plum' can be created with planting material free of any disease of selected large-sized forms, some of which with low damages on fruits by plum pox virus.

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Another condition is that the plantation should be distant from sources of PPV infection carried by the aphids. It is difficult to implement that condition given the widespread distribution of infected Prunus trees. The use of insecticides for the protection of trees from infectious virus carriers is not a reliable measure, and their application will further increase the price of fruit production.

Prunus.

- Notwithstanding the above mentioned disadvantages, the variety should not be overlooked because it has valuable taste properties, making it suitable for small non-market and semi-subsistence farms satisfying the needs of a limited number of consumers with special requirements for organic fruit.

CONCLUSIONS

- The susceptibility to late brown rot is the disadvantage of 'Stanley' and 'Althan's Gage' cultivars, which were introduced into the plum assortment in view of their tolerance or resistance of fruit to damages, caused by PPV infection. This requires the use of fungicides in order to preserve the harvest of trees of the varieties mentioned.

- In 'Kystendilska plum' and 'Opal' it is also necessary to preserve the leaf mass from the damage of red leaf spot disease.

'Nevena', 'Gabrovska' and 'Strinava' varieties are characterized by complex resistance to the economically significant diseases for Bulgaria.

By means of a suitable fungicidal kit and the inclusion of copper containing preparations, diseases of brown rot and red leaf spots can be prevented.

Self-sterility is a disadvantage of varieties of 'Althan's Gage', 'Gabrovska' and 'Nevena', which are recommended for introduction into the plantations due to their tolerance to the virus of sharka. This requires the planting of trees of varieties that are suitable pollinators.

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Study on the influence of some conventional and organic fertilizers on the biochemical composition of fresh and dried fruits of 'Elena' cultivars

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SUMMARY

Fertilization is essential for the normal course of physiological and biochemical processes in fruit trees. In 2016 a scientific experiment was conducted at the Research Institute of Mountain Stockbreeding and Agriculture - Troyan, on the influence of certain fertilizers for conventional and organic fertilization over the biochemical composition of fresh and dried fruits. The object of the study is the fruit of 'Elena' cultivar. Their positive effects were found in the following indicators: dry matter, total sugars, anthocyanins, tanning substances and antioxidant activity.

The highest value of antioxidant activity for fresh and dried fruit was recorded in organic fertilization – 200.00 µmolTE/00 g

200.00 µmolTE/100 g
180.00 µmolTE/100 g

– for fresh fruit and 180.00 µmolTE/100 g for dried fruit. Lower values were recorded for the other variants.

Key words: plums, fertilization, biochemical composition, anthocyanins, total polyphenols, antioxidant activity

INTRODUCTION

domestica L.) (*Prunus* -
300-700 m (Djouvinov and Vitanova, 2002)
(Anzin, 1956; Enikeev, 1960).
(Li, 2008).
(Miloševi and Miloševi , 2012).
(Auger et al., 2004)
(Kazimierczak et al., 2006).
(Morabbi Najafabad and Jamei (2014),
(O2-)
(ROO).

Plum (*Prunus domestica* L.) is a promising orchard culture widespread in foothill and mountain regions in Bulgaria. The main plum production area is the region of the Central Balkan Mountains, i.e. the region of Lovech - Gabrovo, situated at 300-700 m above sea level (Djouvinov and Vitanova, 2002). This is due to the favorable soil and climate characteristics that plum orchard culture finds in the foothill and mountain conditions (Anzin, 1956; Enikeev, 1960). Plums are considered as healthy food because of their low fat content and significant amount of important nutrients, such as carbohydrates, vitamins and minerals (Li, 2008). They are a source of vitamin A, calcium, magnesium, potassium and fiber (Miloševi and Miloševi , 2012). They contain large amounts of antioxidant compounds (Auger et al., 2004) and low levels of vitamin C (Kazimierczak et al., 2006).

Plums can be eaten fresh, dried or processed into various products (juice, jam, preserve, pestil, etc.). Unfortunately, the consumption of fresh plums is seasonal. The processing offers an alternative that allows their availability and consumption throughout the year. The application of different processing techniques can lead to significant loss of natural bioactive compounds.

Morabbi Najafabad and Jamei (2014) found that fresh plums compared to dried have more success in gathering free oxygen radicals, such as superoxide (O2-) and peroxyacid radicals (ROO).

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(Stockdale et al., 2002; WWOOF, 2011).

- The quality of production depends
- on the soil fertility management, the
- activity of the root system and the
- absorption of nutrients from plants.
- Improving soil fertility is a long process that is expressed not only in the diet but also in the structure and properties of the soil. It is changed under the influence of the physical, chemical, physico-chemical, and biological processes that are constantly evolving. These processes are influenced by various factors, incl. the imported fertilizers. Fertilization is a serious soil intervention and only its appropriate application can achieve good results. Problems are most likely to arise in case of improper fertilization, which will impair its fertility, and it is very difficult to eliminate them (Stockdale et al., 2002, WWOOF, 2011).

This study aims to trace the impact of different types of fertilization on the biochemical composition of fresh and dried plum fruit of 'Elena' cultivar.

MATERIAL AND METHODS

The experiment was carried out in 2016. The object of the study is plum fruits of cultivar 'Elena', harvested in the collection plantation of RIMSA - Troyan. The following fertilization variants have been applied in the experiment:

- 2016 .
- I variant – Bio fertilizers including the following fertilizers: Agriful (soil) – 5l/da, Tecamin Flower (foliar) – 0,3%, Tecnokel Amino Ca (foliar) – 0,4%;
 - II variant – Conventional – Yara Mila Complex (soil) – 0.500 kg/da, YaraVita Frutrel (foliar) – 0.500 ml/da, Yara Vita Universal Bio (foliar) – 0.500 ml/da;
 - III variant – Granulation of chicken manure – 0.500 kg/da;
 - IV variant – Control.

- I variant – Bio fertilizers including the following fertilizers: Agriful (soil) - 5 l/da, Tecamin Flower (foliar) – 0.3%, Tecnokel Amino Ca (foliar) – 0.4%;
- II variant – Conventional – Yara Mila Complex (soil) – 0.500 kg/tree, YaraVita Frutrel (foliar) – 0.500 ml/da, Yara Vita Universal Bio (foliar) – 0.500 ml/da;
- III variant – Granulation of chicken manure – 0.500 kg/tree;
- IV variant – Control.

Fertilization schedule:

- Agriful – applied five times from the beginning of vegetation over a period

15-20 ;

- ;
- Ca – ;
- Yara Mila Complex – ;
- YaraVita Frutrel – ;
- Yara Vita Universal Bio – ;
- ;

(%), (%) (Re (%),
) – (%,) – 0,1n
 NaOH; (mg %) – (mg %) –
 ; Fuleki Franciss,
 (%)– (%,) –
 (mgGAE/100)
 g) (μmolTE/100
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of 15-20 days;

- Tecamin Flower – imported twice. Applied before flowering and during the formation of a fruit-set;
- Tecnokel Amino Ca – imported twice. Applied after flowering and a month before harvesting;
- Yara Mila Complex – imported once in the interrow space;
- YaraVita Frutrel – four-fold application. First in the phase of winter buds, in phase of white button, during the formation of fruit-set and a month before the harvest;
- Yara Vita Universal Bio – three-fold application. Applied before and after blossoming and after harvest;
- Granulation of chicken manure – one application in the interrow space.

The biochemical composition of fresh and dried fruit has been studied in the chemical laboratory of RIMSA-Troyan. The following indices are followed: dry matter according to Re (%), dry matter weight (%), sugars (%) (total, inverted and sucrose) – according to School and Regenbogen method, acids (%) - by titration with 0.1n NaOH; ascorbic acid (mg %) - according to Fialkov method; anthocyanins (mg %) - according to Fuleki and Franciss method, pectin (%) - according to Melitz method, tanning substances (%) - according to Levental method. The total polyphenols (mgGAE/100) and the antioxidant activity (μmolTE/100 g) of fruits were determined in the laboratory of Food Research and Development Institute in Plovdiv. The drying process of fruits was carried out in the FRDI-Plovdiv, by means of a heat pump.

Drying took place at temperatures up to 45 °C, which preserved high quality and native properties of the product. The process runs in a closed cycle using the same air and eliminates the additional microbial visitation from outside air.

RESULTS AND DISCUSSION

'Elena' is characterized as a late-ripening cultivar, and fruits ripen from the end of August to the first half of September for the region of Troyan. During the year of study they were harvested on August 26th.

The results of the biochemical composition of fresh fruits are presented in Table 1.

1.
Table 1. Biochemical composition of fresh plums of 'Elena' cultivar

/Variant	Dry weight matter, %	Re DM in Re, %	Total sugars, %	Inverted sugars, %	Sucrose, %	Acids as malic, %	Anthocyanins, mg %	Pectin, %	Tannins, %
I	20,46	21,00	14,30	6,00	7,89	0,45	13,39	0,91	0,145
II	18,70	18,00	10,05	5,35	4,47	0,32	18,23	0,86	0,145
III	19,89	20,25	10,40	5,70	4,47	0,45	34,52	0,42	0,233
IV	21,02	19,00	10,90	5,35	5,27	0,45	18,23	0,94	0,187
CV %	4,95	6,80	17,17	5,53	29,35	15,57	43,81	30,77	22,22

– 21.02 %
20.46 %.

Družić et al. (2007) ” Vo a et al. (2009).

21.00 %, 6.80 %.

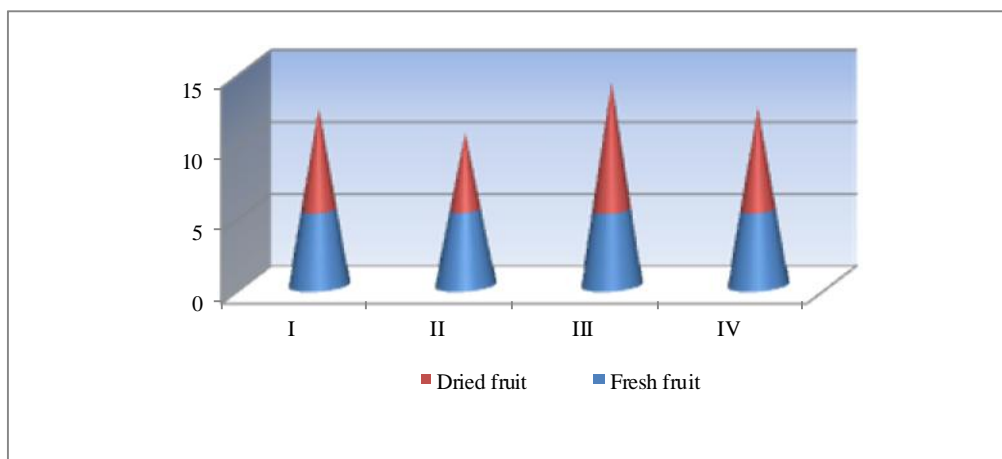
20.25 %

(14.30 %)

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The results of values of dry weight matter in fruits of 'Elena' cultivar are within the narrow range between the variants. They were higher for the control – 21.02% and in bio-fertilization – 20.46%. Similar results of analysis of plum cultivar 'Elena' are established by Družić et al. (2007) and Vo a et al. (2009). According to this indicator the variability in the values is very low. There are no significant differences in the content of dry refractometric substances between the variants that are higher in the case of chicken manure and bio-fertilization, respectively 20.25% and 21.00%, with a variation coefficient of 6.80%. Concerning the total sugars, the difference between the first variant (14.30%) and the other ones, where the content is in very close limits, with an average variation coefficient (17.17%), is distinguishable.

(17.17 %).	-	From an analysis of the same indicator,
Kaulmann t. al. (2014)	-	Kaulmann et al. (2014) found that the
19.6g/100g	8.5	total sugar content of plums ranged
	-	between 8.5 and 19.6g/100g of fresh
	-	weight. For inverted sugar, a low variation
	-	coefficient is reported for different
	-	fertilization variants. It reached the
	-	highest values in bio-fertilization – 6.00%.
%.	-	The same tendency of analyzes
	-	continues for the indicator of sucrose. It is
	-	in the range of 7.89 % in fruits with bio-
- 7.89 %.	1.8	fertilization. In the second and third
	-	variant, its value was 1.8 times lower than
	-	the application of bio-fertilizers.
	-	The amount of organic acids is in
	0.32 %,	close limits, from 0.32%, reported by
0.45 %	-	conventional fertilization to 0.45% for the
	-	other variants.
	-	The range of anthocyanin content
	-	is significantly large among some of the
	-	fertilization variants, therefore the
	-	variation coefficient is high. The control
	-	and conventional fertilization overlap with
18.23 %.	-	18.23%. In the third variant, their content
	-	increased almost twice – 34.52%.
- 34.52 %.	-	With regard to pectin, it is reported
	0.91-0.94 %,	that in the first and fourth variants it is in
	-	the range of 0.91-0.94%, that is to say, in
	-	a near interval. It is about twice lower in
	-	the variant with chicken manure – 0.42%,
- 0.42 %,	-	which makes the CV% high.
CV %	-	The tannin content in the first two
	0.145 %	variants and the control ranges from
0.187 %.	-	0.145% to 0.187%. The values for
	-	chicken manure are more pronounced -
0.233 %.	-	0.233%.
	-	The reported values of the ascorbic
	-	acid indicator indicate that fertilization
	-	does not significantly affect its amount in
	-	fruits in the variants (Figure 1).
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(1).	



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(mg/%)

Fig. 1 Effect of different fertilizing variants on ascorbic acid (mg/%) in fresh and dried plums of 'Elena' cultivar

(mgGAE/100)

($\mu\text{molTE}/100\text{ g}$)

2.

The results of total polyphenols (mgGAE/100) and the antioxidant activity ($\mu\text{molTE}/100\text{ g}$) are presented in Table 2.

2.

(mgGAE/100)

Table 2 Influence of different fertilization variants on total polyphenols (mgGAE / 100) and the antioxidant activity in fresh plums of 'Elena' cultivar

/ Variant	Total polyphenols mgGAE/100	Antioxidant activity $\mu\text{molTE}/100\text{ g}$
I	115.00±0.2	200.00
II	115.00±0.2	110.00
III	104.00±0.1	120.00
IV	119.00±0.2	123.00
CV %	5.69	30.05

mgGAE/100 (III) 104.00
mgGAE/100 (IV) 119.00

The values of total polyphenols are in the range of 104.00 mgGAE / 100 (III variant) to 119.00 mgGAE / 100 (IV variant). The results are of a very low coefficient of variation.

A high variation coefficient and a distinct difference among the first and the other variants were obtained in relation to the antioxidant activity. It varies from 200.00 $\mu\text{molTE}/100\text{ g}$ in the bio-fertilizer

110.00
 123.00 µmolTE/100.
 -

variant to the other ones where their values are in the range of 110.00 µmol/100 g to 123.00 µmol / 100.

Data for biochemical composition of dried plum fruits are presented in Table 3.

3.
Table 3. Biochemical composition of dried plums of 'Elena' cultivar

/ Indices	Dry weight matter, %	Total sugars %	Inverted sugar, %	Sucrose, %	Acids as malic, %	Anthocyanins,mg %	Pectin, %	Tannins, %
/ Variant								
I	83,49	6,70	5,70	0,95	0,64	37,10	0,07	0,249
II	85,59	17,80	9,40	7,98	0,52	21,13	0,27	0,125
III	85,43	12,70	9,00	3,52	0,52	17,90	0,93	0,125
IV	85,40	15,40	7,70	7,32	0,64	20,65	0,30	0,083
CV %	1,16	36,34	21,01	67,00	12,07	36,05	94,87	50,00

83.49-85.59 %,

- 6.70 %

ú - 17.80 %.

% 9.00 %, 5.70 %.

% - 7.32 %.

- 0.95 %.

The dry weight matter values between the variants, similar to the results obtained with fresh fruit, are in a narrow range – 83.49-85.59%, indicating that the drying process has been carried out in standard norms. A very low variance coefficient is found.

The total sugars content is lowest for the bio-fertilization variant - 6.70% compared to the other ones. The highest values are in the fruit of conventional fertilization – 17.80%. Almost analogous are the results of the inverted sugar and sucrose variants. For inverted sugar, the values for the second and third variants are respectively: 9.40% and 9.00%, and the lowest for the first variant – 5.70%. With regard to the quantities of sucrose, they are the largest in fruits with conventional fertilizers – 7.98% and the control – 7.32%. A lower level of sucrose was reported in the first variant – 0.95 %.

0.52-0.64 %.

17.90 mg/% (III),
37.10 mg/% (I).
20.65 mg/%.

0.07 %, -
- 0.93 %.

0.249 %.
- 0.125 %
- 0.083 %

8.80 mg/%
- 5.28 mg/%.
- 7.04 mg/%

4.

Organic acids are in values close to those ranging from 0.52-0.64%.

The other indicator, which shows significant differences and a high variation coefficient, is the anthocyanins. Their range is within the limits from 17.90 mg/% (III variant) to 37.10 mg/% (I variant). The values in the control were 20.65 mg/%.

There is a difference in the results for the pectin content. Fruits with the application bio fertilizers had the lowest value – 0.07%, the highest value was recorded for chicken manure - 0.93%. Extremely high variation coefficient is recorded.

The variation in the content of tanning substances is significant in the different types of fertilization. In the first variant, they reached 0.249%. They were twice lower in the second and third variants – 0.125% and they had the lowest content in the control - 0.083%

Ascorbic acid values were the highest in the variant with chicken manure of 8.80 mg/% and the lowest for the conventional fertilization – 5.28 mg/%. The results for bio-fertilization and the control are the same – 7.04 mg/%

The results of total polyphenols and antioxidant activity ($\mu\text{molTE}/100\text{ g}$) are presented in Table 4.

4.

(mgGAE/100)

Table 4. Influence of different fertilization variants on the content of total polyphenols (mgGAE/100) and the antioxidant activity in dried plums of 'Elena' cultivar

/ Variant	Total polyphenos mgGAE/100	Antioxidant activity $\mu\text{molTE}/100\text{ g}$
I	186.00±0.2	180.00
II	116.00±0.9	173.00
III	183.00±0.1	100.00
IV	271.00±0.2	103.33
CV %	33.60	31.18

-
 - 271.00
 mgGAE/100
 186.00 mgGAE/100
 183.00 mgGAE/100.
 -
 - 180.00 $\mu\text{molTE}/100\text{ g}$
 $\mu\text{molTE}/100\text{ g}$.
 -
 Walkowiak-
 Tomczak et. al. (2008)
 " "
 -
 : 31.77 32.81
 (5).
 -
 , 3
 -
 .

For dried fruits, the highest content of total polyphenols was recorded in the control – 271.00 mgGAE/100 and the variants with bio fertilizers – 186.00 mgGAE/100 and the chicken manure – 183.00 mgGAE/100.

Antioxidant activity was the highest in the variant with bio-fertilizers – 180.00 $\mu\text{molTE}/100\text{ g}$ and the conventional fertilizers – 173.33 $\mu\text{molTE}/100\text{ g}$. In the other two variants lower activity was recorded, corresponding to the established by Walkowiak-Tomczak et. al. (2008) of dried plum fruit 'Elena' cultivar.

Both general polyphenols and antioxidant activity indicators show a high variation coefficient.

The acidimetric coefficient of fresh fruit is the highest for bio and conventional fertilizers, respectively: 31.77 and 32.81 (Table 5). Close values were reported in the application of chicken manure and the control.

The acidimetric coefficient of dried fruits was lower for the bio-fertilizer variant, which was 3 times smaller than fresh fruits. There is no significant difference between fresh and dried fruit in the other fertilization variants.

5.

Table 5. Acidimetric coefficient values for fresh and dried plums of "Elena" cultivar

/ Variant	Acidimetric coefficient	
	Fresh fruits	Dried fruits
I	31,77	10,47
II	32,81	34,23
III	23,11	24,42
IV	24,22	24,06
CV %	17,94	41,91

CONCLUSIONS

The influence of fertilization in a conventional and biological aspect on the biochemical composition of fresh and dried fruits of Elena cultivar was studied.

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Key words: plums, cultivars, agrochemical indicators, humus, pH

INTRODUCTION

Fertilization is one of the main agro-technical factors that directly affect soil properties and quantitative and qualitative characteristics of plum yield.

The soil is a "living" and active environment. Continuous physical, chemical, physico-chemical and biological processes, influenced by various factors, including imported fertilizers, are constantly taking place. Fertilization is a necessary agro-technical impact on soil operation and only its appropriate application can achieve good results. In case of improper fertilization, environmental problems are likely to arise which may impair soil fertility (Stockdale et al., 2002)

The period and method of fertilizer application must be in accordance with the biological requirements of the cultivated crop and with the possibility of maximum absorption of the nutrients (Kanazirska, 2012). The organic materials, introduced into the soil, are subjected to different processes, because of that influence, they change. As a result of these changes, the biodegradable organic (animal manure, compost, peat, plant residues, etc.) that has entered the soil is converted into a soil organic substance consisting of a complex system of humus substances, proteins, amino acids, hydrocarbons, fatty acids, biologically active substances, waxes, lignin etc. (Filcheva et al., 2004).

Fertilization also significantly determines the properties that increase the storage capacity of fruits (Emerson et al., 1994; Sams, 1999; Hunsche et al., 2003), their sensitivity to mechanical damage, physiological disturbances and decay (Kader and Rolle, 2004).

- - ;
- .N - . ;
- P₂O₅ - . ;
- K₂O - . ;
- - .

analyzed:

- pH – potentiometric;
- minN – methodology of Bremner and Kinay;
- P₂O₅ – methodology of P. Ivanov;
- K₂O – methodology of P. Ivanov;
- Humus – methodology of Turin.

RESULTS AND DISCUSSION

The agrochemical composition determination of soil profiles is of crucial importance in cultivation of crops concerned. Each crop needs an optimal nutrient balance in the soil for the proper development of plants. The optimum ratio determination of the major biogenic macroelements is an important prerequisite to obtain a cost-effective and environmentally friendly production.

The composition of agrochemical indicators of soil profiles is presented in Table 1.

1. “ ”
Table 1. Composition of agrochemical indicators of soil profiles in the intra row spacing of 'Tegera' cultivars

Soil profiles cm				N- NH ₄ +NO ₃	P ₂ O ₅	K ₂ O	Humus /
		H ₂ O	KCl	mg / kg	mg / 100 g	%	
0-20 cm	Minimum	4.7	4.5	14.4	9.9	28.5	2.46
	Maximum	5.9	5.4	37.4	15.8	51.2	3.06
	Mean	5.1	4.8	24.6	13.23	41.63	2.74
	/St err	0.38	0.3	6.77	1.74	6.79	0.17
	/StDev	0.66	0.52	11.73	3.02	11.76	0.30
	CV	12.94	10.83	47.68	22.83	28.25	10.95
20-40 cm	Minimum	4.8	4.6	21.9	9.3	26.5	1.93
	Maximum	5.4	5.3	37.4	79.6	49.1	5.08
	Mean	5.2	5.0	32.07	43.03	39.9	3.53
	St err	0.2	0.22	5.08	20.34	6.85	0.91
	StDev	0.35	0.38	8.8	35.23	11.87	1.57
	CV	6.73	7.6	27.44	81.87	29.75	44.47
40-60 cm	Minimum	6.9	6.1	10.9	23.1	14.0	0.60
	Maximum	7.5	6.8	20.7	51.7	120.8	3.38
	Mean	7.23	6.57	14.43	39.2	45.23	1.42
	Sterr	0.06	0.08	1.02	2.99	13.09	0.30
	StDev	0.19	0.24	3.07	8.98	39.28	0.91
	CV	2.63	3.65	21.27	22.90	86.84	64.08

0-20 cm
5.4,

cm, pH 5.0 (

20-40
)

40-60 cm

6.57.

40-60 cm

2.

In the intra row spacing, where 'the depot' of the stockpile organic fertilizer is located, the soil reaction in a KCl solution in a 0-20 cm soil horizon ranges from 4.5 to 5.4, as the average value is 4.8, which is characterized by an average to a highly acidic reaction.

The acidic reaction of the medium remains the same in the next soil layer of 20-40 cm - pH 5.0 (average value).

The reaction is slightly acidic to neutral with a value of 6.57 at a depth of 40-60 cm.

The variation coefficient for the first two depths is low and in the profile 40-60 cm is very low, due to the agro-technical treatments performed in the different studied soil layers.

The composition of agrochemical indicators of soil profiles in the inter row spacing is presented in Table 2.

Table 2. Composition of the agrochemical indicators of soil profiles in the inter row spacing of 'Tegera' cultivar

Soil profile cm		N- NH4+NO3		P ₂ O ₅	K ₂ O	Humus /	
		H ₂ O	KCl	mg / kg	mg / 100 g	%	
0-20 cm	Minimum	4.6	4.5	13.8	2.6	15.0	1.88
	Maximum	6.0	5.5	41.5	35.0	44.7	2.94
	Mean	5.39	5.02	21.82	12.2	23.93	2.33
	St Error	0.16	0.12	3.01	3.94	3.68	0.11
	St Dev	0.48	0.36	9.04	11.83	11.03	0.34
	CV	8.90	7.17	41.43	96.97	46.09	14.59
20-40 cm	Minimum	4.5	3.9	12.7	0.1	11.4	0.43
	Maximum	6	5.3	20.2	10.1	39.6	1.59
	Mean	5.12	4.52	17.23	1.98	17.9	1.12
	St Error	0.18	0.18	0.75	1.04	3.05	0.13
	St Dev	0.55	0.54	2.26	3.13	9.15	0.38
	CV	10.74	11.95	13.11	158.08	51.12	33.93
40-60 cm	Minimum	5	4.5	8.1	0.9	11.6	0.76
	Maximum	6.6	5.9	17.8	3.5	18	1.63
	Mean	6	5.27	14.67	1.9	14.42	1.13
	St Error	0.35	0.29	2.22	0.58	1.54	0.19
	St Dev	0.7	0.59	4.44	1.16	3.09	0.38
	CV	11.67	11.19	30.26	61.05	21.42	33.63

40cm) 5.9 (40-60cm).
 0-20 cm, pH 5.02,
 20-40 cm 4.52 (pH)
 40-60 cm - 5.27 (pH).

The acidity level in the inter row spacing of all the three profiles is from acid to slightly acidic, with a range of 3.9 (20-40cm) to 5.9 (40-60cm). On average, pH is 5.02 in the depth of 0-20 cm, it is 4.52 (pH) in the next soil profile of 20-40 cm and the highest 5.27 (pH) is in depth of 40-60 cm. The variability of the three profiles is low, which is an indicator of the precise introduction of the specific amounts of fertilizers in the soil.

0-20 cm
 14.4-37.4 mg/kg,
 24.6 mg/kg,
 cm
 32.1 mg/kg,
 40-60 cm - 14,4mg/kg

The nitrogen content reported within the intra row spacing, represent in ammonia and nitrate form at a soil profile of 0-20 cm, was in the range of 14.4-37.4 mg/kg, indicating a broad range of variation of the element. The average value of nitrogen content was 24.6 mg/kg, determining the profile as well-stocked.

8.1-41.5mg/kg.
 20 cm (21.82 mg/kg),
 20-40 cm - 17.23
 mg/kg 14.67 mg/kg
 cm.
 20-40 cm

In 20-40 cm horizon, the nitrogen content was more and reached 32.1 mg/kg, values showing very good stockpile. In profile 40-60 cm it is the lowest - 14,4mg/kg.

0-20 cm 9.9 15.8 mg/100 g.
 13.2 mg/100 g,
 (20-40 cm),

In the inter row spacing, the nitrogen content of the three depths is within the range from 8.1-41.5mg/kg. The highest mean value is found in the profile of 0-20 cm (21.82 mg/kg), which is defined as low to well-stocked. At a depth of 20-40 cm, it is lower-17.23 mg/kg and it is 14.67 mg/kg in the profile of 40-60 cm. There is a medium and high variation in the element values at a depth of 20-40 cm for the other two profiles. It is possible to take into account the decrease of nitrogen content in depth due to soil retention and absorption by the crop.

The phosphorus values in the intra row spacing at a depth of 0-20 cm vary from 9.9 to 15.8 mg/100 g. On average, it is 13.2 mg/100 g for the horizon, which determines the profile as a well-stocked. The phosphorus content in the next soil horizon (20-40 cm) is significantly higher, where the average values reach 43.0

43.0 mg/100 g.

-

20-40 cm
0.1 mg/100 g,
10.1 mg/100 g.

0-20 cm –
12.2 mg/100 g,
– 35.0 mg/100 g.

: 1.98 mg/100 g

1.9 mg/100 g.
0-20 cm,

0-20 cm
28.5 51.2mg/100 g.
41.6 mg/100 g,

20-
40 cm,
39.9 mg/100 g,

40-60 cm,
– 45,23mg/100 g,

mg/100 g. The high variation in the element content and its higher values in some samples can be assumed to be due to the manure amount in this sector.

There is a strong variation of phosphorus in the inter-row spacing, indicating significant differences in the phosphorus amount in the individual samples. As for a 20-40 cm soil profile, the minimum value is 0.1 mg/100 g and the maximum is 10.1 mg/100 g. The highest average phosphorus content is recorded at a depth of 0-20 cm – 12.2 mg/100 g, as the highest value is 35.0 mg/100 g.

For the other two depths, the mean phosphorus values are almost equal: 1.98 mg/100 g and 1.9 mg/100 g. Based on data obtained, the soil profile of 0-20 cm can be determined as a medium stockpiled and the other two profiles, as poorly stockpiled.

The analysis on the potassium content in soil show, that these soils are naturally very well stocked with this nutrient element, which is characteristic for the soils in the area and the method of soil tillage.

In the intra row spacing, the values of potassium in the horizon of 0-20 cm range from 28.5 to 51.2 mg/100 g. On average, it is 41.6 mg/100 g, which records a very good stockpile in this soil profile. At a depth of 20-40 cm, potassium has an average value of 39.9 mg/100 g, a result that shows high amounts of the element in this soil profile, too. The analysis of the third horizon of 40-60 cm shows that average values are high – 45.23mg/100g, probably due to the basic manure amount in this soil layer. The variation coefficient is reported in high values for all three soil profiles.

High potassium values have also been recorded in the inter-row spacing,

11.4 mg/100 g (20-40 cm)) 44.7 mg/100 g (0-20 cm).

23.93 mg/100 g, 0-20 cm –

20-40 cm 17.9 mg/100 g, 40-60 cm 14.42 mg/100 g.

0-20 cm ,

2.74 % (20-40 cm) – 3.5 %, 40-60 cm -

1,4 %.

20 cm (– 2.33%),

:1.12 % 1.13 %.

0-20 cm; 20-40 cm 40 cm 40-60 cm “ ”.

pH.

20-40 cm.

ranging from 11.4 mg/100 g (20-40 cm depth) to 44.7 mg/100 g (0-20 cm depth). The variation in the content of this element in the profiles is high. The highest average content is 0-20 cm - 23.93 mg/100 g, which determines the profile as a well-stocked. Its content decreases in descending line in depth, as at a depth of 20-40 cm it is 17.9 mg/100 g, and at a depth of 40-60 cm it is 14.42 mg/100 g.

The reported results in the humus content indicate that its values from the soil depths are low, which is characteristic of the soil diversity. From a profile of 0-20 cm from the row, the humus content is on average – 2.74%. In the next horizon (20-40 cm), it is more – 3.5%, probably because of the larger amount of manure. The lowest content of 1.4% is found in a profile of 40-60 cm. The variation in the organic matter is from medium to high at the three depths.

The highest humus content in the inter row spacing is in the profile of 0-20 cm (average – 2.33%), which determines the profile as poorly stockpiled. For the other two depths the humus content is almost equal, respectively: 1.12% and 1.13%. The variation in organic substance values for the first profile is average and high for the other two depths.

CONCLUSIONS

An assessment was made of the soil stockpile with the main nutrients - nitrogen, phosphorus and potassium in soil profiles of 0-20 cm; 20-40 cm and 40-60 cm in a plum plantation of 'Tegera' cultivar.

The humus content and pH was recorded in different depths.

The results show a good soil stockpile with phosphorus and potassium from the intra row spacing of the tree area and nitrogen from a soil profile of 20-40 cm.

In the inter-row spacing was

	0-20 cm	
20-40 cm	40-60 cm.	0-20
cm		.

registered a low nitrogen content and an average phosphorus stockpile in a soil profile of 0-20 cm and a potassium of 20-40 cm and 40-60 cm. The soil was well-stockpiled with potassium at a profile of 0-20 cm.

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L.) (*Sambucus ebulus*
(*Prunus domestica* L.)

	1*	2	3
1			
2			
3			

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**Content of antioxidants in *Sambucus ebulus* L.
and in different plum cultivars *Prunus domestica* L.**

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SUMMARY

- Comparative study was done on
- the content of bio-antioxidants in different
- cultivars of *Prunus domestica* L., which
- are typical for Bulgaria and cultivated in
- Dryanovo region. The term bio-
- antioxidants refer to biologically active
- compounds with antioxidant potential,
- some of which are polyphenols and
- tocopherols. The accumulation of
- secondary metabolites, such as
- polyphenols and anthocyanins, is
- genetically determined, but it depends to
- a great extent on the environmental
- conditions. The present study determines
- the amount of anthocyanins, total
- polyphenols and antiradical activity in
- fresh plum fruits of the following cultivars:
- 'Stanley', 'Kystendilska plum' and
- 'Nevena' and the local form of
- *Pr.domestica* subsp.*insititia* L. - 'Lyatna

Prunus domestica L.,

Pr.domestica subsp.*insititia* L. –

ebulus L., - *Sambucus*
 -
 (2.8
 mgGAE/gFW),
 (2,5 mg),
 (1,9 mg) (1,6 mg).
 -
 -3- (31
 mg/100 gFW),
 (25 mg/100 gFW),
 (13 mg/100 gFW)
 (4 mg/100 gFW).
 DPPH
 - 83 %, - 63 %,
 38%, - 29% - 12 %.
 :
 , *Prunus domestica* L.

Sambucus ebulus L.

Marchev et al. (2013)

(, , 1, 2,)
 . (Stacewicz-
 Sapuntzakis et al., 2001).
Prunus domestica L.

trunkosliva'. As a standard were used
 fresh fruits from *Sambucus ebulus* L. due
 to their high content of studied
 components and their application in the
 folk medicine. The fruits of 'Lyatna
 trunkosliva' (2.8 mgGAE/gFW) are
 distinguished with the highest content of
 polyphenols after the fruits of *Sambucus*
ebulus L., expressed as an equivalent to
 the gallic acid, followed by 'Stanley' (2,5
 mg), 'Kystendilska plum' (1,9 mg) and
 'Nevena' (1,6 mg). The highest content of
 anthocyanins after *Sambucus ebulus* L.,
 expressed as an equivalent to cyanidin-3-
 glucoside, is found in 'Stanley' (31 mg/100
 gFW), followed by 'Lyatna trunkosliva' (25
 mg/100 gFW), 'Kystendilska plum' (13
 mg/100 gFW) and 'Nevena' (4 mg/100
 gFW). Regarding the antiradical activity,
 which is determined by DPPH rapid test,
 the studied cultivars are set in the
 following order: *Sambucus ebulus* L. –
 83%, 'Lyatna trunkosliva' – 63%, followed
 by 'Kystendilska plum' – 38%, 'Stanley' –
 29% and 'Nevena' – 12%.

Key words: antiradical activity,
 anthocyanins, *Prunus domestica* L.

INTRODUCTION

Since ancient times, people have
 been using ripe fruits of *Sambucus ebulus*
 L. in the region of the Central Northern
 Bulgaria as a source of antioxidants and a
 means of increasing human immunity.

Marchev et al. (2013) finds that both fruits
 and blossoms of *Sambucus ebulus* L.
 contain bioactive triterpenoids with
 antioxidant activity.

Plum is widely spread and
 traditional fruit species in Bulgaria. This is
 due to the valuable bioactive substances
 contained in fruits - vitamins (C, A, B1,
 B2, PP), sugars, organic acids,
 microelements, phenolic compounds, etc.
 (Stacewicz-Sapuntzakis et al., 2001).
 Plum cultivars of *Prunus domestica* L.
 differ in the chemical composition of fresh

(Bennett et al., 2011; Brashlyanova et al., 2013; Miletic et al., 2013). Arion et al. (2014)

Piga et al. (2003)

4
Sambucus ebulus L.

2016

Prunus domestica L.:

60-70

Pr. domestica subsp. insititia L.

Sambucus ebulus L.

fruits, the skin coloring and the ripening period. The accumulation of secondary metabolites, such as polyphenols and anthocyanins, is genetically determined, but it depends to a large extent on environmental conditions and the conditions of fruit processing and preservation (Bennett et al., 2011, Brashlyanova et al., 2013, Miletic et al. 2013).

Arion et al. (2014) have found that autumn plum cultivars have a higher antioxidant capacity than summer cultivars, even after ten days of storage. Piga et al. (2003) have found that a part of the polyphenols and of vitamin C is lost during two types of plum air drying.

We have not found in the literature review any comparative research on the content of antioxidants and polyphenols in *Sambucus ebulus* L. and plums that ripen at about the same time.

The purpose of this study was to compare 4 plum cultivars with *Sambucus ebulus* L. fruits in terms of total polyphenols, anthocyanins and antiradical activity.

MATERIAL AND METHODS

Fresh, ripe fruit plums were studied from the harvest of 2016. The trees are grown under non-irrigated conditions in a collection plantation in the town of Dryanovo. The following cultivars of *Prunus domestica* L were included: 'Stanley' which is widely distributed in Bulgaria; 'Kystendilska plum' – widespread in 60-70 years of the last century; 'Nevena' – a Bulgarian cultivar, selected in the Experimental Station in Dryanovo and 'Lyatna trunkosliva' – *Pr. domestica subsp. insititia* L. Fresh fruits of local form of *Sambucus ebulus* L. were used as a comparison.

The chemical analyzes were carried out in the laboratory at the Department of Plant Physiology and

Biochemistry at Agricultural University - Plovdiv.

All variants were analyzed in four repetitions. Samples were extracted into acidic methanol/ The extracts were analyzed for the content of polyphenols, anthocyanins and antiradical activity.

Quantitative determination of total polyphenols

The determination of the total phenols was performed spectrophotometrically by Singleton & Rossi method, (1965), with small modifications (Koleva-Valkova, 2016). The absorption was measured at 765 nm wavelength. Phenols were calculated according to the standard curve equation: $y=1.421x+0.0074$ with coefficient $R^2=0.9997$, as they were expressed as gallic acid equivalent (GAE) mg/g of fresh matter. The standard curve was prepared with gallic acid (Sigma-Aldrich, St. Louis, MO) ranging from 0 to 500 mg/l.

Quantitative determination of anthocyanins by pH difference method

Two parallel tubes were prepared from the extracts of all variants. The extract of 1 ml was put in them, then it was added up to 5 ml with buffer of pH1 or pH4.5 (this procedure gave a dilution factor DF 5). Extract of 250 µl was put only for variant 4 as it was added up to 5 ml with the respective buffer (dilution factor DF 20). Thus the diluted samples were read after 15 minutes of incubation at room temperature at the following wavelengths: 520 nm and 700 nm. The calculations for the amount of anthocyanins expressed as cyanidin – 3 - glucoside mg/100 g of fresh matter were as follows:

$$A = \frac{(A_{520} - A_{700}) \cdot 1 - ((A_{520} - A_{700}) \cdot 4,5)}{(A \cdot MW \cdot DF \cdot V \cdot 100) / (e \cdot l \cdot m)}$$

Anthocyanins where:

- MW - molecular weight of cyanidin-3-glucoside (449.2 g/mol)
- DF - dilution factor
- V - final volume of the extract - 50 ml
- e - molar absorption (26,900)
- l - length of the light path through the

Singleton & Rossi, (1965),
(Koleva-Valkova,

2016).
765 nm

$$y = 1,421x + 0,0074$$

$$R^2 = 0,9997$$

(GAE) mg/g

(Sigma-Aldrich, St. Louis, MO)
0 500 mg/l.

2
1 ml

5 ml

1 4,5 (DF 5). 4

250 µl

5 ml (

DF 20).

15

: 520 nm

700 nm.

- 3- mg/100 g

$$= \frac{(A_{520} - A_{700}) \cdot 1 - ((A_{520} - A_{700}) \cdot 4,5)}{(A \cdot MW \cdot DF \cdot V \cdot 100) / (e \cdot l \cdot m)}$$

MW -

(449,2 g/mol)

-3-

DF -

V -

- 50 ml

e -

(26900)

l -

m – (1 cm)
 (g).
DPPH –
 2,2- -1-
 (DPPH) (Blois, 1958).
 517
 nm 0 15
 Pharo 300.
 ,
 .

$$= (1 - \frac{A_{15min}}{A_{0min}}) \times 100.$$
 %
 ,
 - F.
 LSD.
 0,05.
 (Maneva, 2007).

cuvette (1 cm)
 m - weight of the sample taken for analysis (g).

Determination of antiradical activity by DPPH – test

Antioxidant activity was measured by 2,2-diphenyl-1-picrylhydrazyl (DPPH) (Blois, 1958). The absorption of the extracts was determined spectrophotometrically at a wavelength of 517 nm at 0 and 15 minutes from the beginning of mixing with a Pharo 300 spectrophotometer. At the same time, a blank sample with a test solution of distilled water was studied by a photometering device. Antiradical activity was defined as % decolorization = $(1 - A_{15min}/A_{0min}) \times 100$.

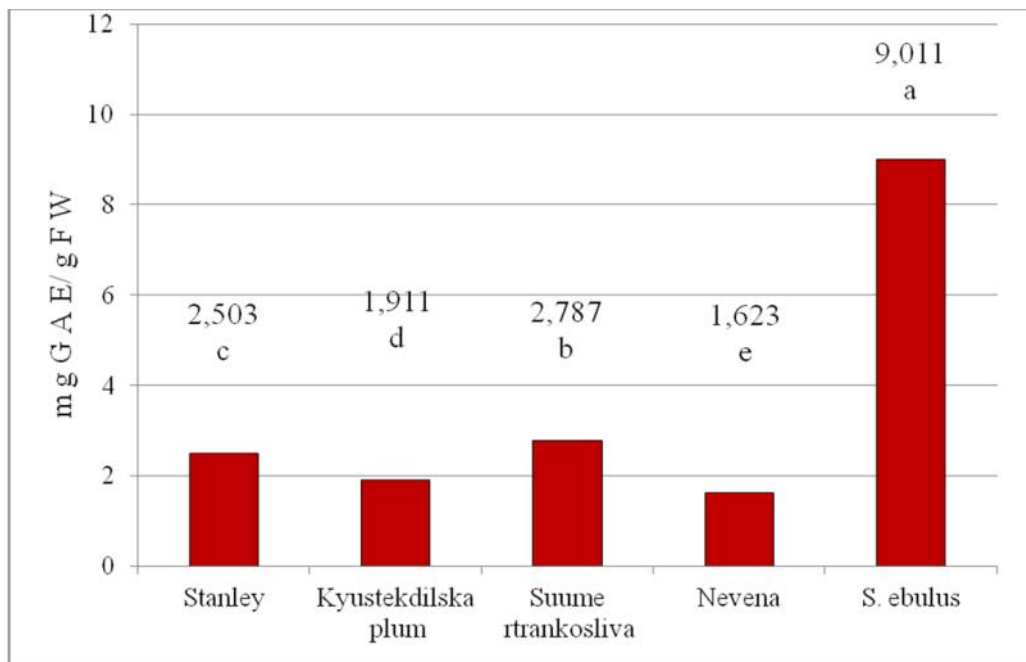
The data were processed by the dispersion analysis method, using the Fischer-F criterion for evaluation. The reliability of the differences obtained between the control and the variants was based on the LSD. The data were arranged into groups by the Duncan method at P 0.05. A software product performed the statistical analysis (Maneva, 2007).

RESULTS AND DISCUSSION

The data from the total polyphenols content in fresh prunes and *Sambucus ebulus* L. are presented in Figure 1. A very high content was found for the *Sambucus ebulus* L. – 9.01 mgGAE/g FW, followed by 'Lyatna trunkosliva' – 2.79 mgGAE/g FW. Fruit of 'Stanley' cultivar is third, and the lowest polyphenol content is found in 'Nevena' cultivar – 1.62 mgGAE/g FW. Differences between cultivars are statistically proven at $LSD_{0,05}=0.142$.

The fruits of 'Kystendilska plum' according to this indicator are in the position before the last, prior to 'Nevena' cultivar.

1. (*S.ebulus* L.)
 9,01 mgGAE/g FW,
 mgGAE/g FW. – 2,79
 ,
 -
 – 1,62 mgGAE/g FW. -
 LSD_{0,05}=0,142.



1. , mg/ g . $LSD_{0,05} = 0,142$
Fig.1. Content of total polyphenols in fresh fruit of plum and *Sambucus ebulus* L., expressed as gallic acid, mg/ g fresh matter. $LSD_{0,05} = 0,142$

2.
 -3-
 -
 (S.ebulus L.) – 400,40
 mg/100g FW.
 ,
 -
 30,57 mg/100g FW 24,77 mg/100g FW.
 -
 - 4,25
 mg/100g FW.
 $LSD_{0,05} = 6,22$.

In Figure 2 is presented the anthocyanin content in fresh fruit, expressed as cyanidin-3-glucoside. Extremely high anthocyanin content is found in *Sambucus ebulus* L. fruit (S.ebulus L.) – 400.40 mg/100g FW. The second place according to this indicator is for 'Stanley' and 'Lyatna trunkosliva', which are distinguished from other cultivars by their dark blue color of fruit flesh. The results are 30.57 mg/100 g FW and 24.77 mg/100 g FW respectively. The lowest anthocyanins content is in 'Nevena' cultivar – 4.25 mg/100g FW. Differences are statistically proven by $LSD 0.05 = 6.22$.

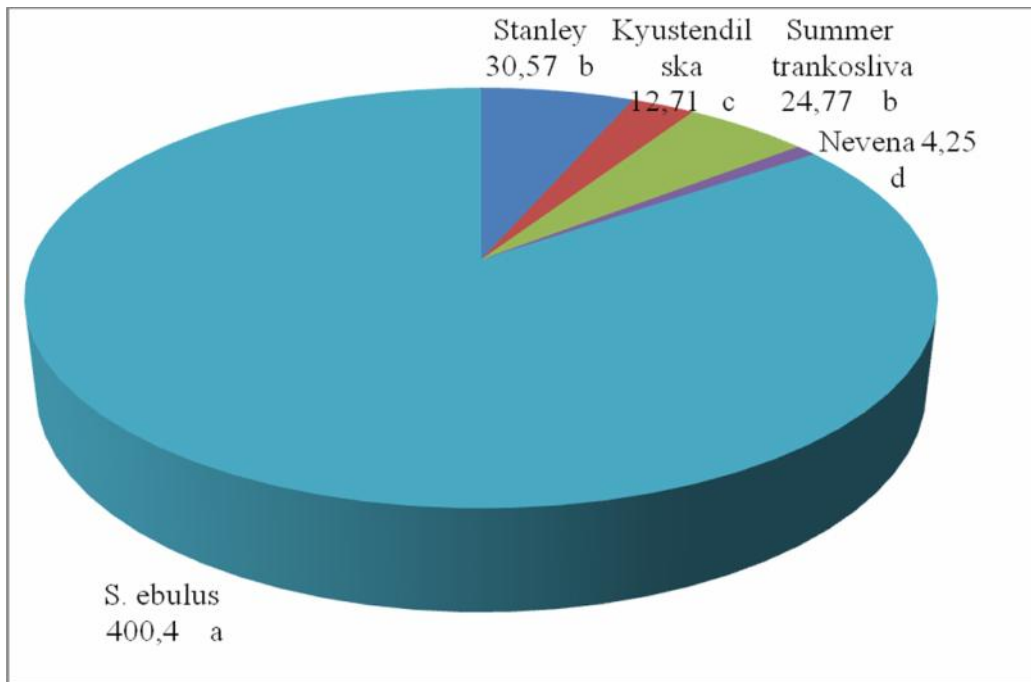


Fig. 2. Content of anthocyanins in fruit of plum and *Sambucus ebulus* L., expressed as cyanidin-3-glucoside, mg/100 g fresh matter. $LSD_{0,05} = 6,22$

3. 83,49 %

63,12 %, (37,94%).

- The anti-radical activity of different fruits, such as blueberries, sour cherries, plums, grapes, *Sambucus ebulus* L., etc., is of great importance for maintaining good health and successful counteraction to a number of human diseases.
- Our data on the anti-radical activity in plum and *Sambucus ebulus* L. fruits is very interesting.
- They are presented in Figure 3. *Sambucus ebulus* L. fruit is distinguished by 83.49% anti-radical activity, making it extremely useful for human health.
- The second position according this indicator is for fruit of 'Lyatna trunkosliva' – 63.12%, which shows that the multiplication and cultivation of this variety of local plum deserves more attention. Third place is for 'Kystendilska plum' (37.94%). After that, 'Stanley'

– 28,57%,
 11,54 %.
 LSD_{0,05}= 2,83.

– cultivar ranks 28.57%, and 'Nevena' cultivar is on the last place with 11.54%.
 Differences between cultivars are statistically proven for LSD_{0,05}=2.83.

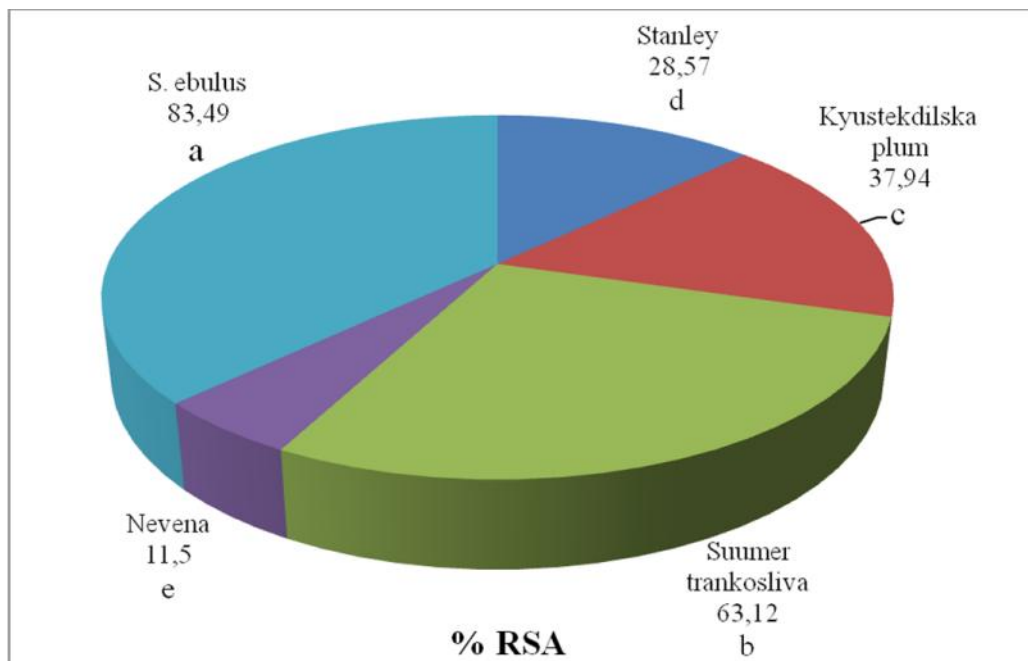


Fig. 3 Antiradical activity of plums and *Sambucus ebulus* L., expressed in %. LSD_{0,05}= 2,83

The results show that *Sambucus ebulus* L. and plum fruits contain important bioactive substances. However, data show that these bioactive substances are very different in quantity for individual plum cultivars, largely due to their biological and genetic features.

CONCLUSIONS

According to our data, the following important conclusions can be drawn:

Sambucus ebulus L. fruits contain the highest content of bioactive substances – total polyphenols (9,011 mgGAE/g fresh matter); anthocyanins – 400.40 mg/100g fresh matter and

mgGAE/g
 400,40 mg/100g

		- 83,49 %.	antiradical activity – 83.49%.
			Fruits of 'Stanley' and 'Lyatna trunkosliva' show a high content of anthocyanin (30.57 mg/100g and 24.77 mg/100g, respectively) and polyphenols (2.50 mg/g and 2.79 mg/g, respectively)
24,77	(30,57 mg/100g	
(2,50 mg/g	2,79 mg/g).	
63,12 %			Regarding the anti-radical activity, 'Lyatna trunkosliva' has 63.12% and is on the second place after <i>Sambucus ebulus</i> L.
			The fruits of 'Nevena' cultivar are distinguished by the lowest values of the tested parameters.

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Productive events of sweet cherry varieties and elites studied in the region of Kyustendil

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SUMMARY

2014-2016 .
-
- Pobeda
Krimaska, Vega, Merchant, Tragana Edesis,
Vanda - 6546,
6374 6541.
Van, Bigarreau Burlat, Bing
Kozerska
(*Prunus mahaleb*)
2002 .
Vanda (36.2 kg),
Bing (33.9 kg), Van (32.2 kg) Pobeda
Krimaska (31.1 kg).
Bing (0.38
kg/cm²).
Van (2.65 kg/m³) Bing (2.53
kg/m³), - Tragana Edesis
(1.36 kg/m³).
:

The investigation was carried out in the period 2014-2016 at the Institute of Agriculture - Kyustendil. Five sweet cherry cultivars – Pobeda Krimaska, Vega, Merchant, Tragana Edesis, Vanda and three elites – 6546, 6374 and 6541 were obtained. As a standard varieties were used Van. Bigarreau Burlat, Bing and Kozerska were used as indicators of widespread cultivars. The trees were grafted on (*Prunus mahaleb*) rootstocks and planted in the spring of 2002. They were grown without irrigation and were formed in freely growing crown. Very good yield per tree is obtained from trees of Vanda (36.2 kg), Bing (33.9 kg), Van (32.2 kg) and Pobeda Krimaska (31.1 kg). Bing stood out with a higher degree of productivity (0.38 kg/cm²). The yield per unit volume of the tree crown is the highest for the standard for Van (2.65 kg/m³) and Bing (2.53 kg/m³), and lowest for Tragana Edesis (1.36 kg/m³).

Key words: average yield, productivity coefficient, yield per unit crown volume

INTRODUCTION

The main priority for fruit species is the continuous improvement of the cultivar. In our country, besides the breeding activity, intensive introduction of new foreign cultivars is also taking place. The most valuable and economically most efficient ones are offered for distribution in manufacturing practice (Lichev et al., 2004). Fertility is one of the most important qualities on which a cultivar is evaluated. The variety loses its significance when it has weak productivity, despite other valuable qualities it possesses. It was found that some introduced cherry cultivars with low fertility have (from the English Merton series) due to their poor adaptability to our ecological conditions (Georgiev, 1985; Christov, 2000). From the studied Italian cultivars with high productivity was Mora de la punta (404.6 kg/da). With weak yielding are Bianka di Verona (176.8 kg) and Modenes (195.7 kg) (Georgiev et al., 2007).

The yields are largely influenced by the imbred features of the cultivar, the used rootstocks and the applied agro-technics (Lichev, 2005; Sotirov, 2015).

The purpose of the present study was to identify productive events of introduced cherry varieties and selected elites under the conditions of the Kyustendil region.

MATERIAL AND METHODS

The surveys are conducted in 2014-2016 at the Institute of Agriculture - Kyustendil. Subject of study were the introduced cherry cultivars Pobeda, Krimaska, Vega, Merchant, Tragana, Edesis, Vanda and three selected elites – 6546, 6374 and 6541. Van is used as a standard variety, and Bigarreau Burlat, Bing and Kozerska are indicators of widespread varieties under continually changing climatic conditions.

The total area of the experimental plantation is 5 da. The trees were grafted

(Lichev et al., 2004).

Merton),

(Georgiev, 1985; Christov, 2000).

Mora de la punta (404.6 kg/da).

Bianka di Verona (176.8 kg) and Modenes (195.7 kg) (Georgiev et al., 2007).

(Sotirov, 2015).

2014-2016 .

Pobeda, Krimaska, Vega, Merchant, Tragana, Edesis, Vanda

– 6546, 6374 and 6541.

Van, Bigarreau Burlat, Bing and Kozerska

5 da.

(Prunus mahaleb) 2002 .	-	on (<i>Prunus mahaleb</i>) rootstock in the spring of 2002. They are grown under irrigated conditions and are formed in a free growing crown, with a stem height of 40-45 cm.
40-45 cm.	-	The soil surface in the spacing is maintained with black fallow, through periodic shallow soil cultivation during the vegetation period, and in autumn with plowing at a depth of 15-18 cm. A total herbicide Glyphan 480 SL (glyphosate) was introduced into the strips. The plant protection was carried out according to the adopted scheme for cultivation of this fruit species at the Institute of Agriculture - Kyustendil.
15-18 cm. 480 () .	-	The evaluation of the indicators is according to the established methodology of Nedev et al. (1979).
et al. (1979).	Nedev	Brief characterization of the weather conditions for the 2014-2016 period related to the cultivation.
2016 ., 2014 . -	2014-	2014 – From the analysis of meteorological conditions, we found that the year was specific with regard to the total rainfall (766.1 mm). The flowering of this fruit species was normal. For April, the average monthly air temperature is low (10.9°C) and the rainfall was high (125.4 mm). This led to a decrease in pollinated blossom fertilization the percentage of the cherry trees, respectively to the fertility of the cherry trees. During fruit ripening in June and July, average monthly air temperatures were significantly low (16.7°C and 20.8°C).
(10.9°C), (125.4 mm).	-	2015. - The absolutely minimum temperatures for March and April were in the range of - 5.8 °C and - 5.7°C and caused the trees to remain in forced dormancy until mid-April. The reported maximum temperatures in March and April were 17.7°C and 26.2°C. For June and July, the amount quantity of the rainfall was 46.2 mm and 7.7 mm with 46.3% humidity. This led to significant soil and atmospheric drought. The amount of rainfall during the three months of July, August and September was low (120.2
20.8°C). 2015 . -	-	
5.7°	-	
17.7° 26.2° .	-	
46.2 mm 7.7 mm 46.3%.	-	

(120.2 mm)
47.3%.

2016 . - 23 24 ,
18.3°

19.9° .

21- 22- ,
2°

27- -
4.0°

4.5 h.

80-90%.

mm) and atmospheric humidity 47.3%. The year was characterized by good fruit load of the trees and the reduced size of the fruit.

2016 – On January 23rd and 24th, the absolute minimum air temperatures reached -18.3°C and -19.9°C.

Damage to the buds and decrease of the number of young embryos have been detected. During the night of 21st to 22nd April, with the air temperature dropping to - 2°C, the damage to the newly formed young fruits was low. A few days later, on 27th April, a recurrent late spring frost was recorded. The absolute minimum temperature was -4.0°C with impact duration of 4.5 hours. The established defects in the formed fruits of the cultivars and elites studied were major, without significant differences. The cherry harvest was compromised to almost 80-90%. The weather conditions during the years of the study did not meet the cherry biological requirements, so the studied cultivars and elites did not present their morphological and reproductive events.

2014 2015 . -
-
.

16.3 kg (Vega) 39.7 kg (Vanda),
23.7 kg (Bigarreau
Burlat) 35.2 kg (6374) (1).
Vanda

Bigarreau Burlat, Bing Kozerska.
2016 .

6541 Pobeda Krimaska,
9.3 8.3 kg/

RESULTS AND DISCUSSION

In 2014 and 2015, no significant differences, were found regarding the average yields of the trees. In the first year the yield ranged from 16.3 kg (Vega) to 39.7 kg (Vanda) and the next from 23.7 kg (Bigarreau Burlat) to 35.2 kg (6374) (Table 1). Only the Vanda cultivar was superior to those listed as indicators for widespread varieties of Bigarreau Burlat, Bing and Kozerska.

In 2016, for all varieties and elites, the yield of berries was greatly reduced due to the loss of the young fruits, affected by the late spring frosts.

Under these conditions, elite 6541 and Pobeda Krimaska were found to be the most resistant to cold weather, with 9.3 and 8.3 kg/tree respectively, which

Van (P<0.001, P<0.01) (1). Vega significantly exceeded the Van standard (P<0.001, P<0.01) and the other varieties (Table 1). In the three years, there has been a tendency for the Vega cultivar to yield comparatively less than other varieties and elites. No significant difference was found between the three selected elites and the standard.

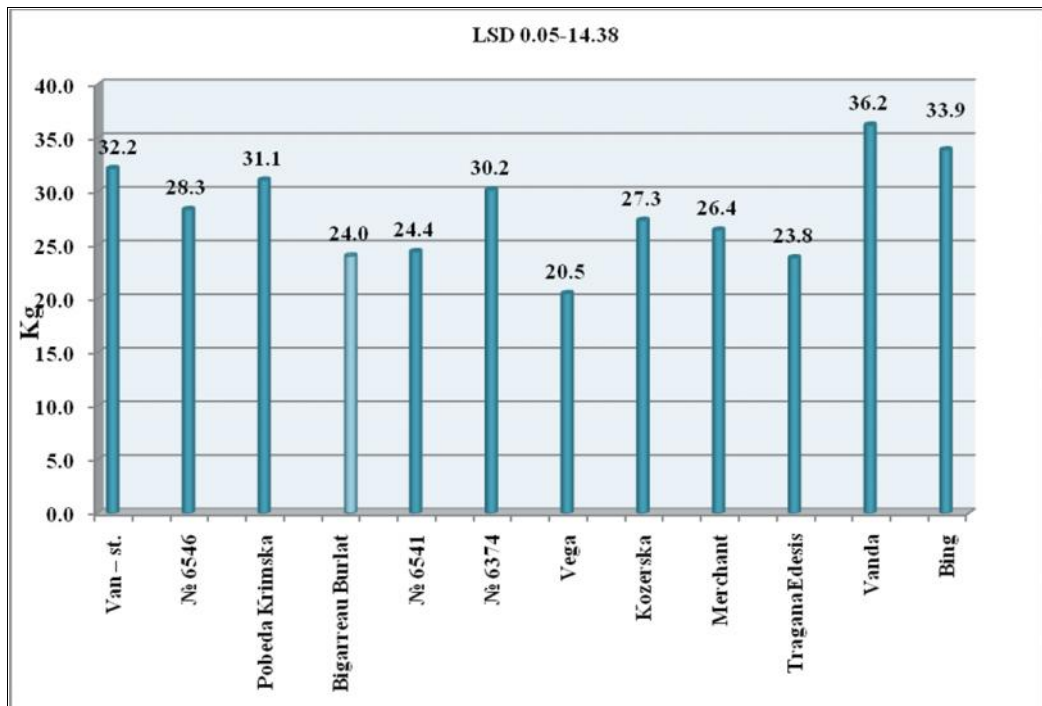
1.

Table. 1. Average fruit yield per tree of sweet cherry cultivars and elites for years

Cultivar/Elit	Average fruit yield per tree, (kg)		
	2014	2015	2016
/Van – st.	32.7	31.7	3.5
6546	26.0 ns	30.7 ns	3.7ns
/Pobeda Krimaska	32.8 ns	29.3 ns	8.3 ++
/Bigarreau Burlat	24.3 ns	23.7 ns	3.5 ns
6541	31.2 ns	26.3ns	9.3 +++
6374	25.2 ns	35.2 ns	3.3 ns
/Vega	16.3 ns	24.7 ns	1.8 ns
/Kozerska	23.5 ns	31.2 ns	4.1 ns
/Merchant	24.5 ns	28.3 ns	4.3 ns
/Tragana Edesis	17.3 ns	30.3 ns	5.0 ns
/Vanda	39.7 ns	32.7 ns	3.5 ns
/Bing	38.7 ns	29.0ns	4.3 ns
F	1.66	0.54	4.11
SD	8.20	6.32	1.49
LSD 0.05	16.97	13.08	3.09

*ns - , +/- (P 0.05), ++/-- (P 0.01), +++/--- (P 0.001).
 *no significant difference, +/- (P 0.05), ++/-- (P 0.01), +++/--- (P 0.001).

Vanda (36.2 kg), Bing (33.9 kg), Van (32.2 kg) and Pobeda Krimaska (31.1 kg). As an average for the period, the cultivars of Vanda (36.2kg), Bing (33.9kg), Van (32.2kg) and Pobeda Krimaska (31.1kg) were distinguished for a very good harvest. All the other cultivars and elites had a good yield (Figure 1).



. 1.

2014-2015 .

Fig. 1. Fruit of yield per tree of sweet cherry cultivars and elites, average for the period 2014-2015

2014-2015 . -

kg/cm²),
kg/cm²).
Bing (0.38
Van (0.29
-
6374 (0.34

kg/cm²).

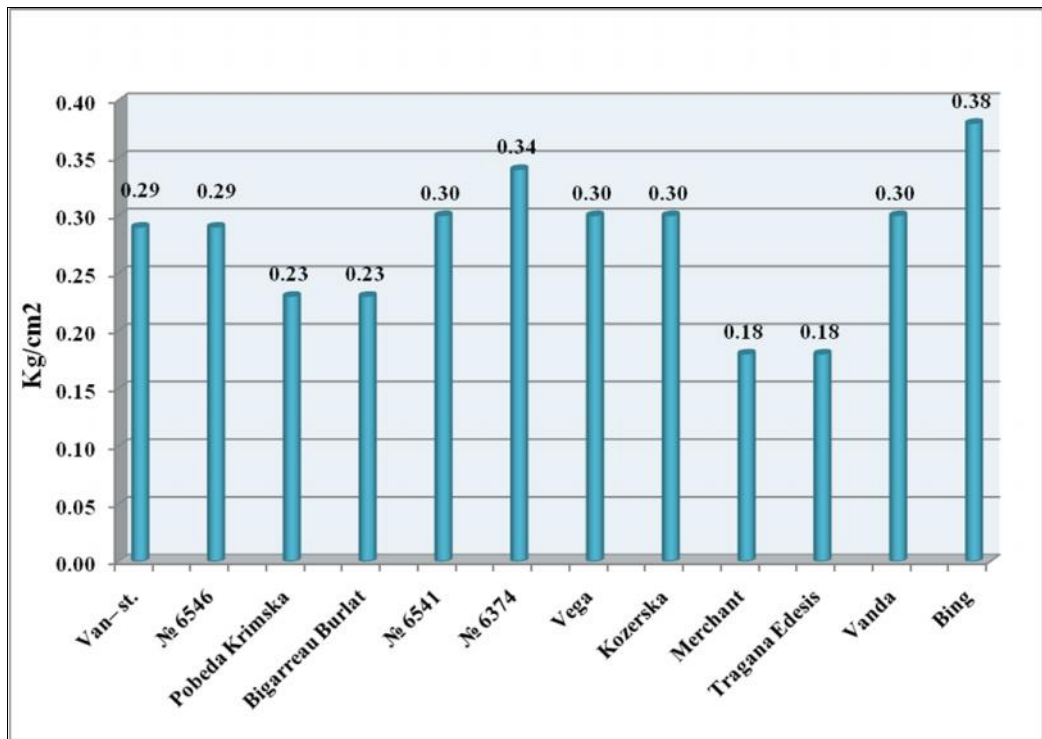
Vanda, Kozerska,
Vega 6541 (0.30 kg/cm²)

kg/cm²).

Pobeda Krimaska Bigarreau Burlat (0.23
kg/cm²), Merchant Tragana Edesis
(0.18 kg/cm²) (2).

The productivity coefficient was directly influenced by the biological features of each variety and elite. Average for the study period 2014-2015, higher specific yields had Bing trees (0.38 kg/cm) compared to the standart Van (0.29 kg/cm). A high product coefficient also has elite 6374 (0.34 kg/cm²).

Varieties of Vanda, Kozerska, Vega and No. 6541 (0.30 kg/cm) almost did not differ from the control. Intermediate yield was observed Pobeda Krimaska and Bigarreau Burlat (0.23 kg/cm), Merchant and Tragana Edesis (0.18 kg/cm) (Figure 2).



. 2.

2014-2015 .

Fig. 2. Productivity coefficient of the sweet cherry cultivars and elites, average for the period 2014-2015

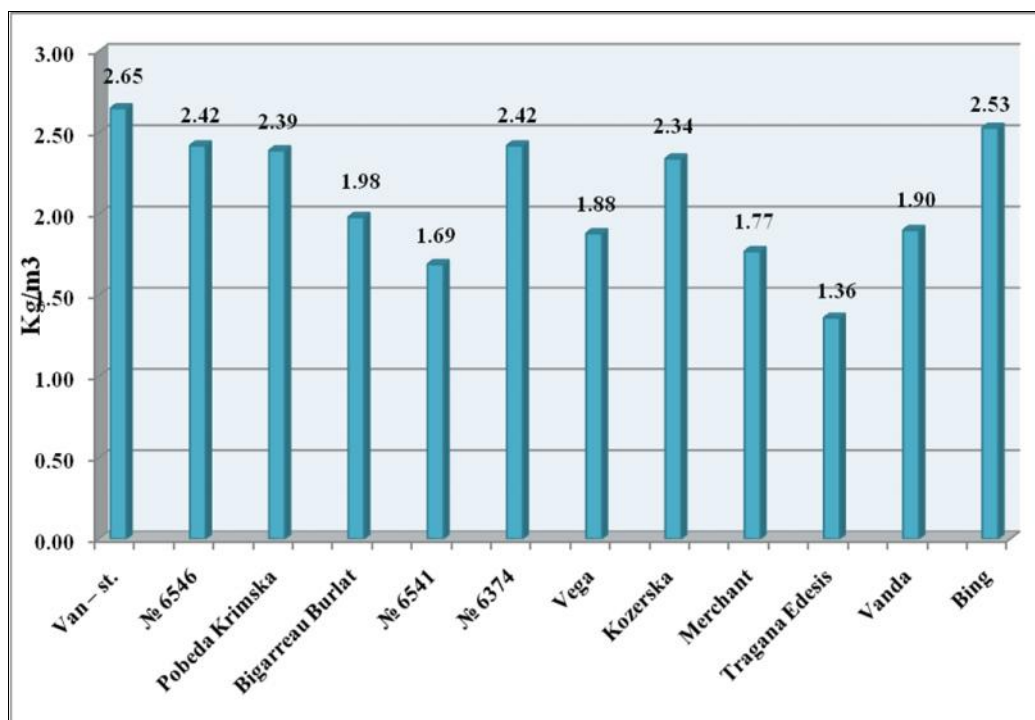
Van (2.65 kg/m³), Bing (2.53 kg/m³), 6546, 6374 (2.42 kg/m³) Pobeda Krimaska (2.39 kg/m³).

Bigarreau Burlat (1.98 kg/m³), Vega (1.88 kg/m³) Merchant (1.77 kg/m³).

Tragana Edesis (1.36 kg/m³) (3).

The yield per unit volume of tree crowns varied within a wide range. The highest value was found for the Van standard (2.65 kg/m³), followed by Bing (2.53 kg/m³), 6546, 6374 (2.42 kg/m³) and Pobeda Krimaska (2.39 kg/m³).

The other cultivars and elites had an intermediate yield – Bigarreau Burlat (1.98 kg/m³), Vega (1.88 kg/m³) and Merchant (1.77 kg/m³). The yield obtained for Tragana Edesis (1.36 kg/m³) is the lowest (Figure 3).



. 3.

2014-2015 .

Fig. 3. Yield per unit crown volume of sweet cherry varieties and elites average for the period 2014-2015

CONCLUSIONS

➤ Vanda (36.2 kg), Bing (33.9 kg), Van (32.2 kg) and Pobeda Krimaska (31.1 kg).

➤ -
Bing (0.38 kg/cm²),
6374 (0.34 kg/cm²),
Van (0.29 kg/cm²).

➤ 2.65 kg/m³ (Van) 1.36 kg/m³ (Tragana Edesis).

➤ The cultivars Vanda (36.2 kg), Bing (33.9 kg), Van (32.2 kg) and Pobeda Krimaska (31.1 kg) are distinguished with very good yield per tree.

➤ Higher yields are obtained for Bing (0.38 kg/cm²), followed by elite no. 6374 (0.34 kg/cm²) in comparison with Van (0.29 kg/cm²).

➤ The yield per unit volume of tree crowns varies from 2.65 kg/m³ (Van) to 1.36 kg/m³ (Tragana Edesis).

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