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Black rot of grapes (*Guignardia bidwellii* (Ellis) Viala & Ravaz) in the area of the city of Burgas under the conditions of integrated plant protection

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Abstract: *The study of the disease Black rot of grapes was carried out in the village of Galabets, Pomorie municipality. The study was carried out in the period of 2022 - 2023. The vine varieties that were monitored were Dimyat, Pamid, Misquet red, Chardonnay, Misquet Ottonel, Naslada, June Blanc and Cabernet Sauvignon. In the village of Galabets, the Misquet Ottonel variety is 2.5/1.4 m apart and the other varieties at distances of 3.2/1.4 m. The vines are grafted onto Berlandieri x Riparia SO4 rootstock. The preplanting preparation of the area includes stock fertilization with 40 kg of P2O5, 50 kg of K2O (active substance) and 3 t of stable manure per decare, harrowing, discing and leveling. The vines are planted in pits of 60/60/70 cm. According to McKinney's classification (1923), slightly sensitive /class 1/ are June Blanc and Naslada (0.1-25%), moderately sensitive is the variety Pamid (25-50%). Misquet Otonel, Misquet Red, in fourth variant compared to the other variants and the lowest, are sensitive. This is due to the application of green pruning operations combined with the use of chemical preparations with a proven effect against black rot.*

Keywords: grapes, varieties, *Guignardia bidwellii*, susceptibility

Introduction

Viticulture is an applied science, the object of which is the vine and its requirements to the factors of the external environment.

Black rot of grapevine disease is known in the United States, where it has been found on wild vines in the Eastern Rockies. It was discovered in 1805 by Micheaux in the vineyards of Dufour. It is especially common in vineyards located along the Atlantic coast or in states where summer moisture is abundant and

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temperatures are high, such as Ohio and Missouri. In these parts of the US, black rot is causing serious losses. It is also found in Brazil and Argentina [13, 14, 16, 17].

In 1885, it was observed in France by *Viala and Ravaz*, who reported it for the first time in the phytopathological literature. It is the most widespread and damaging disease, which predominates in the humid regions of the southern United States and along the Gulf of Mexico [3].

Later, the disease was found in Italy, Russia, Georgia and Azerbaijan, Ukraine, etc. Since 2002/2003, the black rot has occurred regularly in organically grown vineyards of the Mosel and Middle Rhine Valley regions of Germany [15].

In Bulgaria, black rot is considered to be little widespread, however, with wet weather and very frequent rains, it can cause significant losses. The vineyards located along the Black Sea coast and those in low, unventilated places are most often attacked [4, 7].

In our country, the disease was detected for the first time by Kozarev in the region of Vidin in 1904 [7].

Some authors reported [13] on observed vines with the disease black rot of leaves, shoots and grains, in the region of Pomorie. At the same time, the disease was found on ripe grains of the Bolgar variety in the experimental field of ILV-Pleven. In 1961, an attack by black rot was observed in the Pleven, Ruse, Plovdiv and Vidin districts in limited proportions [2]. It is characteristic of the pathogen that it attacks all green parts of the vine - leaves, shoots, bunches and grains [1, 5, 10, 11, 12, 20].

According to some authors [19, 20], the duration of the incubation period of *G. bidwellii* is strongly influenced by the temperature. In this regard, a model has been developed according to which the first symptoms of the disease on the leaves appear after reaching the threshold of 175 cumulative day-degrees, calculated on the basis of the sums of the average daily temperatures between 6 and 24ºC from the day after infection.

The causative agent of black rot on the vine is *Phyllosticta ampelicida* (Englem.) Van Der Aa = *Phoma uvicola* (Viala et Ravaz) with a telemorph *Guignardia bidwellii* (Ellis) Viala & Ravaz [5]. *G. bidwellii* is an ascomycete fungus that forms pseudothecia with cylindrical to club-shaped asci that contain 8 unicellular hyaline ascospores [2, 12].

The aim of the present study is to prove that it is quite possible to control the disease by applying agrotechnical and chemical ways of control, as well as by applying integrated plant protection.

Material and Methods

The study of the disease Black rot of grapes was carried out in the village of Galabets, Pomorie municipality). The study was carried out in the period 2022 and 2023. The grape varieties that were monitored

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were Dimyat, Cabernet Sauvignon, Chardonnay, Misquet Otonel, Misquet red, Pamid, June Blanc and Naslada. In the village of Galabets, the Misket Otonel variety is 2.5/1.4 m apart and the other varieties at distances 3.2/1.4 m. The vines are grafted onto Berlandieri x Riparia SO4 rootstock. The pre-planting preparation of the area includes stock fertilization with 40 kg of P_2O_5, 50 kg of K_2O (active substance) and 3 t of manure per decare, harrowing, discing and leveling. The vines are planted in pits of 60/60/70 cm.

Scheme of treatments V2:

1. When the shoot is 5-15 cm long, Danitron + Topaz.
2. When the shoots are 20-25 cm long, Coprantol duo + Tiovit jet
3. Before flowering Ridomil gold + Topaz
4. Flowering Coprantol duo + Tiovit jet + Karate Zeon 5 KS
5. End of flowering Ridomil gold + Topsin M 70 + Sumicidin
6. Fruit growth Coprantol duo + Tiovit jet + Karate Zeon 5K
7. Closing of a cluster Ridomil gold + Topsin M 70 + Sumi alfa 5 EK
8. Crossing Bordomix + Score 250 EC + Zipperfor 100 EC
9. Before harvesting Funguran + Flint max + Karate zeon 5 HP

Scheme of treatments V3:

1. When the shoot is 5-15 cm long, Danitron + Topaz.
2. When the shoots are 20-25 cm long, Coprantol duo + Reviona
3. Before flowering Ridomil gold + Topaz
4. Flowering Coprantol duo + Tiovit jet + Dinali 5 HP
5. End of flowering Ridomil gold + Reviona + Sumicidin
6. Fruit growth Coprantol duo + Dinali + Karate Zeon 5K
7. Closing a cluster Ridomil gold + Reviona + Sumi alfa 5 EC
8. Prosharvane Bordomix + Dinali + Ziperfor 100 EC
9. Before harvesting Funguran + Topsin M 70 + Karate Zeon 5 HP

Scheme of treatments V4 + summer pruning operations

1. When the shoot is 5-15 cm long, Danitron + Topaz.
2. When the shoots are 20-25 cm long, Coprantol duo + Reviona
3. Before flowering Ridomil gold + Topaz
4. Flowering Coprantol duo + Tiovit jet + Dinali 5 HP
5. End of flowering Ridomil gold + Reviona + Sumicidin

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6. Fruit growth Coprantol duo + Dinali + Karate Zeon 5K
7. Closing a cluster Ridomil gold + Reviona + Sumi alfa 5 EC
8. Prosharvane Bordomix + Dinali + Ziperfor 100 EC
9. Before harvesting Funguran + Topsin M 70 + Karate Zeon 5 HP

The rows are oriented in the east-west direction, according to the southwest and west winds prevailing in the area.

The reporting was done according to the route method. From each variety, 4 variants were counted in 4 repetitions /10 vines per repetition/, planted according to the block method. The number of vines with symptoms of the disease was reported by varieties and repetitions in all varieties of cultivation. The distribution results are presented in percentage of attacked vines by varieties and variants. Susceptibility of cultivars was assessed each year at the end of October, after the end of the infectious period, when symptoms on leaves and clusters were visible. The experiment was set up in four replicates for each variant, from which 200 leaves and bunches from each vine were collected randomly to determine the level of *G. bidwellii* infection. Leaf symptoms were determined visually, and leaves with symptoms were graded, depending on the degree of attack, on a five-point scale. For each variant, an infection index was calculated using the formula of McKinney [18]:

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

where: I is the attack index, in %; ∑ (n.k.) – the sum of the products of the number of attacked leaves (n) by the corresponding class of attack (k); N – the total number of reviewed sheets; K – the highest degree in the relevant scale. All investigated varieties were compared by the value of the calculated infection index and classified by degree of sensitivity using a 5-point scale: Class 0. – resistant – infection index - 0 Class 1. – slightly sensitive – infection index – 0.1 - 25; Class 2. - moderately sensitive - infectious index – 26 - 50; Class 3. – sensitive – infectious index – 50 - 75; Class 4. – highly sensitive – infection index > 75.

The experience for each of the studied varieties was laid out in three variants. V1 – no treatment with chemicals /zero control/, V2 – treatment with preparations for blight, powdery mildew /oidium/ and pests, V3 – treatment with chemicals for blight, powdery mildew /oidium/, black rot and pests. V4 - treatment with chemical preparations for blight, powdery mildew /oidium/, black rot, pests, and carrying out green pruning operations in summer. The sugars contained in the grapes were measured with a refractometer at a sugar content of 0 to 32% Brix.

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Soil and climate characteristics of Galabets village, Pomorie municipality

The village of Galabets is located 21 km northwest of Pomorie, characterized by an altitude of 160 m. The climate is temperate continental. Climatic conditions are extremely favorable for the development of viticulture: the region is characterized by prolonged sunshine - up to 2360 hours per year, the average air temperature in July is 23.6°C. The winter is mild and there is very little snowfall. The main soil type that is characteristic for the area is cinnamon-forest. The annual temperature sum is 4104.9°C, and the active temperature 1817°C. The annual sum of precipitation is 478 mm on average. The duration of the frost-free period is 248 days. The average hydrothermal coefficient /HTK/ for July and August is 0.6.

The presented data on the amount of precipitation in 2022 (see Figure 1) show that the amount during the year is good and favors the development of vineyards in the area of Galabets village. In this regard, we can define 2022 as a "dry" year with pronounced seasonal dryness from mid-May to mid-October. The hydrothermal coefficient for the year is very low - 0.4, which confirms the conclusion that the year is "dry". It can be seen that in the months of March, July and October the rainfall is times less compared to the other months. In the months of February and June, the amount of precipitation is 68.8 and 96.7 mm, respectively. The average monthly amount for the year is 175.4 mm.

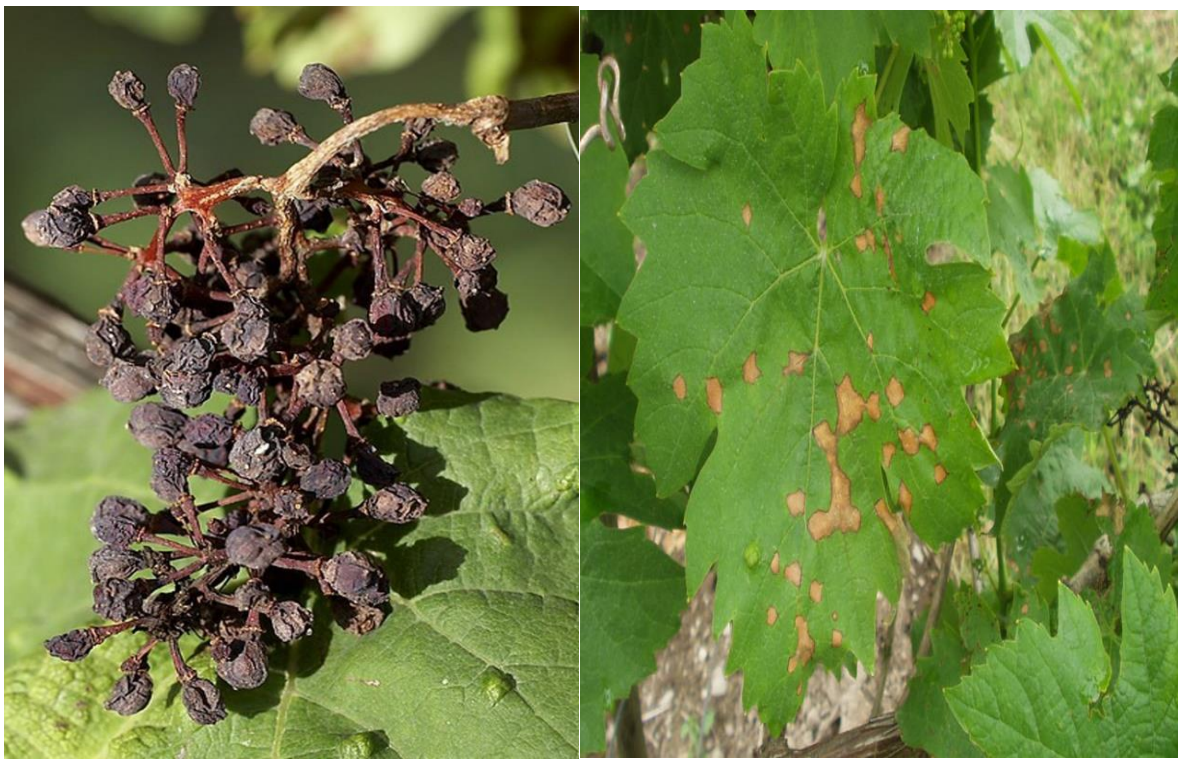

Figure 1. Symptoms of black rot on the vine

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Table 1. Precipitation for the growing season of 2022

Month	Precipitation, mm	Average monthly temperature °C
I	21.5	5.2
II	68.8	3.5
III	5.6	12.3
IV	48.5	13.7
V	17.4	17.4
VI	96.7	23.6
VII	0.9	25.8
VIII	21.9	26.1
IX	32.0	18,5
X	0.5	12.8
XI	40.0	10.3
XII	43.5	6.2
Amount	397.3	175.4

HTK for 2022 = 0.4

It is evident from the rainfall data (Figure 2), that during the months of January, February and March, the rainfall is scarce. The amount of precipitation is 29.8 and 19.2 mm in the months of April and May, respectively. The precipitation that fell in August was only 11.9 mm. The amount of monthly precipitation for the year is 397.3 mm, which is relatively less than the norm for the region – 478 mm. The hydrothermal coefficient was calculated for the period VI-VIII months [8].

Due to the low spread of the disease in our country, no organized fight has been carried out so far. However, in some years, when the weather in the spring and the summer is wet - with very frequent rains and with high relative humidity, the disease can cause significant losses. The problem with the disease black rot on the grapes in our country is that it is not widely recognized even by specialists. Another important problem is that many winegrowers underestimate the disease and do not consider it necessary to fight it. Control of the disease is possible through the application of chemical preparations, but a reference to the directory of

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permitted use of PRPs for 2024 shows that only 2-3 preparations are registered to combat black rot on grapes [9].

The meteorological data presented were measured with Meteobot.

Table 2. Precipitation for the growing season of 2023

Month	Precipitation, mm	Average monthly temperature, °C
I	18.5	5.9
II	20.2	6.5
III	31.8	7.9
IV	29.8	10.7
V	19.2	15.5
VI	16.3	20.7
VII	15.2	25.2
VIII	11.9	25.4
IX	14.4	21.7
X	13.5	17.3
XI	118.6	10.1
XII	47.2	6.8
Amount	416.6	173.7

HTK for 2023 = 0.7

Results and Discussion

Due to the low spread of the disease in our country, an organized fight has not been carried out in the recent decades. In some years, when the weather in the spring and the summer is cool and wet - with very frequent rains and with high relative humidity, the disease can cause significant losses. The problem with the disease black rot on grapes in our country is that it is not widely recognized even by specialists. Another important problem is that many winegrowers underestimate the disease and do not consider it necessary to fight it.

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Table 3 presents the results of the statistical processing and it is clear from them that according to the average degree of attack in V1, 5 pure groups and one mixed group are distinguished. The first group (I) contains variety with the highest resistance - June Blanc and Naslada, II group b - Pamid, III group c - Dimiat, IV group - Chardonnay and Misquet Otonel, V group - Cabernet Sauvignon, which has the highest degree of attack and VI mixed group – Misquet red.

According to McKinney's classification (1923), slightly sensitive /class 1/ are June Blanc and Naslada (0.1-25%), moderately sensitive is the variety Pamid (25-50%). The varieties Misquet Otonel, Misquet red are sensitive, and the wine variety Cabernet Sauvignon can be defined as highly sensitive. The same trend was observed in the data from V2, where treatment with plant protection preparations suppressed the development of the disease. The use of chemical treatment for plant protection can explain the relatively lower values for the studied varieties

Table 3. Statistical evaluation of *Guignardia bidwelii* foliar attack rate, Duncan grouping of varieties on average for the period 2022-2023

Variety	**Dimyat**	**Misquet Otonel**	**Pamid**	**Misquet red**	**Naslada**	**Char-donney**	**Kabernet Sauvignon**	**June Blanc**	**LSD** $_{0,005}$
V1									
Degree of attack, %	68.2	54.3	45.3	58.6	12.1	67.2	86.4	10.3	8.9
Duncan	c	d	b	cd	a	d	e	a	
V2									
Degree of attack, %	32.1	30.7	20.4	35.6	10.3	41.8	62.2	5.6	7.5
Duncan	c	c	b	cd	a	d	e	a	
V3									
Degree of attack, %	13.3	14.1	10.4	16.7	8.1	19.1	21.1	2.8	6.8
Duncan	b	b	b	bc	a	c	c	a	
V4									
Degree of attack, %	8.2	9.1	5.1	12.1	3.8	14.3	16.2	1.2	4.2
Duncan	b	b	a	c	a	d	d	a	

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The variety with the highest resistance – June Blanc and Naslada is in the first group (I) /a/, II group /b/ – Pamid, III group /c/ – Dimyat and Misquet Ottonel, IV group /d/ – Chardonnay, V group /e/ – Cabernet Sauvignon, which has the highest degree of attack and VI mixed group /cd/ – Misquet red.

Weakly sensitive to the disease /class 1/ are identified as June Blanc, Naslada and Pamid (0.1-25%). The Misquet Otonelle, Dimyat, Misquet red and Chardonnay varieties are moderately sensitive (25-50%). The wine variety Cabernet Sauvignon (62.2%) is susceptible to the disease. The difference in results between V1 and V2 can be explained by the fact that three of the downy mildew treatments used the fungicide Coprantol duo, which suppresses the development of the black rot disease on grapes.

The rate of attack observed in V3 is lower compared to V1 and V2, which is due to the inclusion in the disease control scheme of a systemic fungicide registered to control black rot. The varieties June Blanc and Naslada (2.8-8.1%) are distinguished by the proven highest resistance. The second group II b includes the varieties: Pamid, Misket Ottonel and Dimyat. Misquet red variety falls into III bc mixed group – 16.7%. The fourth group IV "c" is characterized by a high degree of attack and includes Chardonnay and Cabernet Sauvignon varieties.

The attack rate reported in variant IV compared to the other variants is the lowest. This is due to the application of green pruning operations combined with the use of chemical preparations with a proven effect against black rot, as a result of which the disease is brought under complete control. In this regard, the lowest rates of disease attack are observed in variant IV.

The results obtained for Naslada variety confirm the data of some authors [7], that the variety is characterized by increased rot resistance.

Harvesting grapes from the vine

The yield of grapes is directly affected by the number of bunches and their mass. Under the conditions of the experiment, the highest average yield from one vine was recorded for V4 in the June Blanc variety (11.2 kg). The remaining varieties of V4 significantly exceed the values of V1. The obtained results can be explained by combining the correct preparations against the disease and cultural practices as green pruning. This undoubtedly affects the better ventilation of the vines, and in combination with the application of chemical preparations, the highest yield was found at V4. In the varieties with smaller bunches, the yield is respectively the lowest - Misquet Otonel (5.3 kg), Chardonnay (3.9 kg) and Cabernet Sauvignon (3.8 kg) (Table 4).

The dynamics of differences between varieties in individual years are relatively constant values. In general, the highest values of the attribute were established in the year 2023, and comparatively lower in the year 2022.

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Table 4. Statistical processing of productivity by year

Variety	Dimyat	Misquet Otonel	Pamid	Misquet red	Naslada	Chardonnay	Cabernet Sauvignon	June Blanc	LSD $_{0,005}$
V1, 2022									
Yield, kg	4.2	3.1	3.3	2.6	7.2	1.3	1.1	7.6	2.8
Duncan	a	a	b	b	c	a	a	d	
V1, 2023									
Yield, kg	6.4	5.3	3.8	3.6	8.3	2.0	1.3	8.1	6.2
Duncan	a	a	a	a	b	a	a	b	
V2, 2022									
Yield, kg	5.5	5.8	3.0	3.8	9.1	2.6	2.1	8.3	3.8
Duncan	a	a	a	a	b	a	a	b	
V2, 2023									
Yield, kg	6.1	3.7	4.8	4.2	9.4	2.9	2.4	9.4	4.6
Duncan	b	a	a	a	b	a	a	b	
V3, 2022									
Yield, kg	6.5	4.3	5.5	4.9	9.8	3.1	2.9	9.8	5.2
Duncan	a	a	a	a	b	a	a	b	
V3, 2023									
Yield, kg	6.8	4.6	5.8	5.1	10.0	3.4	3.2	10.0	6.7
Duncan	a	a	a	a	b	a	a	b	
V4, 2022									
Yield, kg	7.1	4.7	6.0	5.8	10.2	3.6	3.4	10.5	10.4
Duncan	a	a	a	a	a	a	a	a	
V4, 2023									
Yield, kg	7.8	5.3	6.8	6.3	10.6	3.9	3.8	11.2	12.3
Duncan	a	a	a	a	a	a	a	a	

Sugar content

It was established from the analyzes of the grape juice that the sugar content of all studied varieties at consumption maturity is within the normal values for wine grapes (Table 5). In all the years of the study, the

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Cabernet Sauvignon variety had the most intense sugar accumulation, which, despite the high yields obtained from the vine, managed to accumulate enough sugars (22.2%). The variety Pamid (19.0%) has the lowest sugar-accumulating capacity. The number of sugars in the other varieties is between 19.6% for Dimyat and 21.3% for the Misquet Otonel variety.

Table 5. Estimation of sugars from grapes by year

Variety	Dimyat	Misquet Otonel	Pamid	Misquet red	Naslada	Chardo-nnay	Cabernet Sauvignon	June Blanc	LSD $_{0,005}$
V1 2022									
Sugar content, Brix %	16.1 a	18.2 a	17.0 a	17.9 a	18.1 a	18.7 a	18.2 a	17.8 a	3.6
V1 2023									
Sugar content, Brix %	17.2 b	18.8 a	17.5 b	18.4 b	18.5 b	19.2 a	18.8 a	18.4 a	2.7
V2 2022									
Sugar content, Brix %	18.2 a	19.3 a	17.9 a	19.0 a	18.4 a	19,6 a	18,4 a	18,9 a	2.3
V2 2023									
Sugar content, Brix %	18.8 a	19.8 a	18.5 a	19.5 a	19.0 a	20.2 a	19.3 a	19.4 a	1.9
V3 2022									
Sugar content, Brix %	18.4 b	20.1 a	18.2 b	20.1 a	18.6 a	20.1 a	19.5 a	19.2 a	1.6
V3 2023									
Sugar content, Brix %	18.9 b	20.7 a	18.7 b	20.8 a	19.3 b	20.6 a	20.3 a	19.8 a	1.2
V4 2022									
Sugar content, Brix %	19.0 c	20.6 a	18.4 d	20.5 a	18.9 c	20.3 b	21.3 a	19.5 c	0.9
V4 2023									
Sugar content, Brix %	19.6 d	21.3 b	19.0 e	21.2 c	19.6 d	21.0 c	22.2 a	20.0 c	0.5

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It is indicative from the analysis of the presented data that the sugars that the studied varieties accumulate in 2022 are relatively less than in 2023, this can be explained by the climatic conditions over the years. The data obtained for V1 show that in this variant the wine varieties accumulate the least sugars, as a result of which the technological qualities of the raw material deteriorate. The best sugar accumulation is observed in V4, which is due to the cultivation method and the applied plant protection scheme.

Conclusions

According to the accepted classification, slightly sensitive are June Blanc and Naslada, moderately sensitive is the Pamid variety. The varieties Misquet Otonel, Misquet red are sensitive, and the wine variety Cabernet Sauvignon can be defined as highly sensitive.

Attack rate reported in fourth variant compared to other variants and lowest. This is due to the application of green pruning operations in combination with the use of chemical preparations with a proven effect against black rot.

The yield of grapes is directly affected by the number of bunches and their mass. Under the conditions of the experiment, the highest average vine yield was reported for fourth variant in the June Blanc variety (11.2 kg). The remaining varieties of fourth variant significantly exceed the values of first variant.

For the varieties with smaller bunches, the yield is respectively the lowest - Misquet Otonelle (5.3 kg), Chardonnay (3.9 kg) and Cabernet Sauvignon (3.8 kg)

In all the years of the study, the Cabernet Sauvignon variety had the most intense sugar accumulation, which, despite the high yields obtained from the vine, managed to accumulate enough sugars (22.2%). The variety Pamid (19.0%) has the lowest sugar-accumulating capacity. The number of sugars in the other varieties is between 19.6% for Dimyat and 21.3% for the Misquet Otonelle variety.

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