

"THE ENVIRONMENT - RESEARCH, CHARGE, ADMINISTRATION"

Vol. III/2023

CRAIOVA
ROMÂNIA
15-16 JUNE 2023



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"THE ENVIRONMENT - RESEARCH, CHARGE, ADMINISTRATION"

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MECHANICAL ANALYSIS OF GRAPES AND BERRIES OF VARIETIES GROWN IN HILANDAR

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Abstract

The grapevine is the most important plant species on Mount Athos. The Hilandar monastery has 15 ha are under vines. The monastery vineyard was planted with vines of introduced vines produced by "Richter International" (France) varieties: Merlot (clones 181, 346, 347), Cabernet Franc (clones 210, 214), Cabernet Sauvignon (clones 15, 169, 337), Alicante Bushe (clone 95). During 2015. Cabernet Franc (clone 214) was planted and Marcellan (clone 980). The results presented in the research are part of the research conducted in 2018 on the Cabernet Sauvignon (clone 337), Cabernet Franc (clone 214), Merlot (clone 181) and Alicante bouchet (clone 95). The aim of the research was to determine the mechanical properties of grapes and berries. The research was carried out at the time of grape harvest, when 10 bunches of each variety were randomly sampled for the purposes of the experiment. In laboratory conditions, the mass of the cluster, the number of berries in the cluster, the mass of all the berries in the cluster, the length, the width of the cluster, and the weight of the berry were determined. For the berry analysis, an average sample of 100 berries was selected at random. The average weight of the bunch of the Merlot variety was 224.9 g, the width of the bunch was 12.4 cm, and the length was 20.3 cm. The average number of berries in a bunch of Cabernet Sauvignon was 217.5. The total weight of all the berries in the bunch for the Cabernet Franc variety was 275.9 g, while the weight of the rind varied from 7-23 g. The mass of 100 berries for the Cabernet Franc variety was 133.3 grams, and the mass of 100 seeds was 3.37 grams. The highest determined weight of the skin of 100 berries was measured for the Cabernet Sauvignon variety - 10.97 gr. Based on the dimensions of the berries, Alicante Bouschet was ranked as the variety with the largest berry, the length of the berry varied in the range of 11-18 mm, and the width of 12-18 mm. On the basis of the obtained values of the structural indicators, it can be concluded that the tested varieties have a pronounced oenological potential for the production of high quality wines.

Key words: mechanical analysis, grape, berrie, Hilandar, grapevine

INTRODUCTION

Kovačević M. (2015) states that Agion Oros (Greek lng.) or Mount Athos is the third branch of the Halkidiki peninsula in the Aegean Sea, Greece. It is a monastic republic that is unique in the world. It is an autonomous territory within the Republic of Greece. Despite its tumultuous history, which includes the golden age during the reign of Byzantium, the Crusades, the difficult Ottoman centuries and the World Wars, the peninsula of Athos has managed to preserve its original spiritual form until today. In the course of more than a thousand years, 20 Orthodox monasteries, countless sketches and

cells were built in a small area. Today, more than 2,000 monks guard and skits cherish and keep priceless medieval treasures in the form of icons, frescoes, crosses, holy relics, documents, books... in the treasuries of the monasteries and sketches. Today the Agion Oros represents the spiritual center of all Orthodox nations.

The grape varieties grown in the vineyards of the Hilandar monastery are world-famous and widely distributed. The Merlot variety is spread over about 115,000 ha of world vineyards, starting from France, through Italy, Algeria, some parts of the USA, and all the

way to Argentina, California, Chile. The most important variety in this vineyard is Cabernet Sauvignon. Due to the wide area of cultivation, and therefore the influence of various climatic factors, the aromas of Cabernet Sauvignon wine can vary greatly. But, there is no doubt that Cabernet Sauvignon is one of the most important varieties in the world, from which top quality wines can be expected. Also, another French variety was planted – Cabernet Franc. A variety that performed very well in blends with Cabernet Sauvignon, but also as an independent variety with top quality wines. Due to the great demand for red wines, both in the world, and especially in the area of Mount Athos, wine production is accompanied by varieties that serve to improve the color of the wines. Due to the high presence of anthocyanins in the skin, but also in the mesocarp, Alicante Bouschet has established itself as a suitable variety for the mentioned conditions.

MATERIALS AND METHODS

The research was carried out in the vineyard of Hilandar Monastery on Mount Athos. Hilandar Monastery was founded in 1198 by Saint Sava and his father, Saint Simeon (Kovačević M. 2015).

Marković et al (2007) states that in 2008, in an effort to continue the tradition from eight centuries of history, an initiative was launched and it was decided to plant a vineyard on the field of St. Sava near the port of Hilandar, 2.5 km from the monastery. The vineyard is planted on an area of 15 hectares. The rows are of the trellis type with a planting distance of 2.5 m x 1 m and Gyt training system. It is a growing form of a low tree (height 80 cm) which is adapted for trellis cultivation of vines. A typical mixed pruning is done on this form of tree. Only one bow and one cone are left (Marković 2023).

In the flawless rows of the new, modern vineyard, clones of well-known varieties were

planted – Merlot (clones 181, 346, 347), Cabernet Franc (clones 210, 214) and Cabernet Sauvignon (clones 15, 169, 337). In addition, a spicy variety was added, which proved to be good in this vineyard on Mount Athos, as well as an independent variety - Alicante bouschet (clone 95). The aim of the study was to determine the mechanical properties of grapes and berries of Cabernet Sauvignon, Cabernet Franc, Merlot and Alicante-Bouchet varieties in the vineyards of Mount Athos. The study was carried out at the time of grape harvest, when 10 bunches of grapes were taken at random from each of the mentioned varieties for the experiment. Under laboratory conditions (Marković and Pržić 2020) the mass of the bunch, the number of berries in the bunch, the mass of all berries in the bunch, the length, the width of the bunch and the weight of the berry were determined. For berry analysis, an average sample of 100 berries was randomly selected and categorized by size (small, medium, and large). Mechanical separation of seeds, skin and mesocarp was performed using jute cloth. The berry skin and seeds were air dried and then the weight of the berry skin and the number and weight of the seeds were determined. In addition, the following parameters of mechanical composition of grapes and berries were determined: mass of 100 berries, mass of berry skins of 100 berries, mass of seeds of 100 berries and mass of 100 seeds.

RESULTS AND DISCUSSIONS

Climatic conditions of microlocality

The vine is the most important plant species on Mount Athos. In this area the vines are grown under the conditions of warm and dry climate. The region is sunny, the sums of effective temperatures are satisfactory, as well as the temperature differences between day and night. There is a deficit of precipitation, as only 260 mm fall per year. The growing season lasts an average of 247 days, from the

end of March to the deep autumn, at the end of November. The average temperature during the growing season is 21.2 degrees, which is very important for obtaining high quality grapes (Marković et al 2007). The wine is produced at this climate condition are used primarily for the purposes of worship, consumption and self-sustainability of the economy of the monastery.

Table 1. – Average monthly and average annual humidity in period of 1961.-1990.

Jan	Feb	Mar	Apr	May	Jun	Annual
76	74	73	69	64	56	
Jul	Avg	Sep	Oct	Nov	Dec	
53	56	62	70	77	78	67

Characteristics of Merlot cv.

Merlot is one of the most widespread grape varieties in the world. It originates from France and can be found under various synonyms - Merlot, Plant Medoc, Merlaut. Merlot is characterized by a very high vigour of trunk, with hairy, reddish-green color of top of the young shoot and the mature shoot is also medium thick and dark red. Leaf is medium sized, 3 or 5 lobed, with shallow lower and deep upper notches and with hermaphrodite flower. Berry is small, round or slightly flattened, dark blue skin, with abundant ash. Cluster size is small to medium (80-150 g), conical-cylindrical, loose to medium. The ripening period occurs late in the epoch III. Average yield ranges from 5 to 10 t/ha; high frost resistance with freezing of winter buds at temperatures below -22 to -26°C. Medium resistance to *Plasmopara viticola* and *Uncinula necator* and good resistance to *Botrytis cinerea*. The grape juice (must) can have a sugar content of 20-24% and a total acidity of 7-9 g/l (Žunić and Garić, 2010).

Merlot clones 181 and 347

Very widely used in the world, for the extraction of high quality raw materials for the production of wines of the highest quality.

Merlot clone 181 has a higher average skin content of 8.61%. The higher content of the skin affects the greater presence of phenolic compounds responsible for the color of the wine, its astringency. Anthocyanins are phenolic compounds found in the skin of the grapes and are responsible for the color of the berries (Zivkovic et al., 2016; Menkovic et al 2017; Zdunic et al., 2019).

Table 2. Mechanical composition of berries Merlot clones 181 and 347

(%)	Mesocarp	Skin	Seeds
Clone 181	87.88	8.61	2.6
Clone 347	89.1	6.83	1.8

Characteristics of Cabernet Franc cv.

Cabernet Franc is a French grape variety also known by the synonyms Gros cabernet, Carmenet, Petite Fer. It trunk has a high vigour. Top of the young shoot is golden yellow with wine-red edges, and ripe shoot is flattened, has a thick hazel-coloured bark with short internodes and pronounced callicles. The leaf is medium sized with 5 lobes. The flowers are hermaphroditic. Berries are small, black-blue skin, covered with ash. Cabernet Franc has medium-sized clusters (110-150 g), conical, medium compact. The ripening period occurs late in the III epoch. Average yield is between 8 and 12 t/ha; high frost resistance with freezing of winter buds at temperatures below -22 to -24°C. Medium resistance to *Plasmopara viticola* and *Uncinula necator* and good resistance to *Botrytis cinerea*. The grape juice (must) can have a sugar content of 20-24% and a total acidity of 6-8.5 g/l (Žunić and Garić, 2010).

Cabernet Franc, clone 214

A French clone that blends very well with Cabernet Sauvignon and is therefore often used to accompany Sauvignon in vineyards. Cabernet Franc is rich in tannins, which are very important in the production of quality wines. "Good" tannins are mainly found in the skin, and the percentage of 5.9% shows

that clone 214 was satisfactory on this parameter.

It also had a slightly higher percentage of pulp in the berry than the norm, which is between 60 and 85%.

Table 3. Mechanical composition of berries of Cabernet franc clone 214

(%)	Mesocarp	Skin	Seeds
Clone 214	89.1	5.9	5.03

Characteristics of Cabernet Sauvignon

Cabernet Sauvignon is a cosmopolitan French grape variety also known by the synonyms Petit Cabernet and Petit Vidure (Žunić and Garić, 2010). Its trunk has a high vigor. Top of the young shoot is hairy, green or light green. The mature shoot is medium thick or thick, purple with maroon color of nodules. The leaf is medium sized with 5 lobes. The flowers are hermaphrodite. Berries are medium sized, round with dark blue skin. The cluster is

small to medium sized (80-150 g), conical-cylindrical, loose to medium compact. Ripening time occurs late in the III epoch. The average yield is between 6 and 8 t/ha. The pruning is long, arching with 10-12 buds. The grape juice (must) can contain 20-24% sugar; 6.5-8.5 g/l total acidity. High frost resistance with freezing of winter buds at temperatures below -22 to -26°C. It has medium resistance to *Plasmopara viticola* and *Uncinula necator* and good resistance to *Botrytis cinerea*. Cabernet Sauvignon produces the highest quality red wines. The yield is very low, but the wine is of high quality. Economically very important. Only clones are recommended. It is an excellent raw material for high quality colored wines. The quality of the wine is very good, with a specific smell of violets. The wines have a closed ruby color and are very suitable for cupping to improve the quality of the wine with other colored varieties. Clones 15, 169, 337 - intended for the production of wines

with intense color and specific aromatic notes that complete the general wine.

Cabernet Sauvignon clone 337

French clone, cosmopolitan character. It is used for the production of red wines of the highest quality. It goes particularly well with Cabernet Franc.

It is used to balance the tannin and acid structure in wines of other color varieties. Clone 337 in the Hilandar vineyard has a significantly higher percentage of mass in the berry compared to the standard variety. The high proportion of mesocarp, as well as the normal proportion of skin and seeds in the grape, indicates that this Cabernet Sauvignon clone also has a higher proportion of tannins and acids.

Larger amounts of tannins in the aging process give the red wines the necessary body and structure.

Table 4. Mechanical composition of berries of Cabernet sauvignon clone 337

(%)	Mesocarp	Skin	Seeds
Clone 337	87.36	8.56	4.08

Characteristics of Alicante Bouschet

Žunić and Garić (2010) state that Alicante Bouschet from Spain or Alicante Henri Bouschet (FR), Tinto Velasco (ESP), Tinto Nero (ITA). The trunk has medium vigor. Top of the young shoot is green-bronze, pale pink on one side. The mature shoot is yellow-brown, of medium thickness, the internodes are of medium length. The leaves are of medium size, with 3 or 5 lobes. The flower is hermaphrodite. The berry is small, round or slightly flattened, dark blue skin, with abundant ash. The bunch of Alicante is medium sized (110-150 g), conical, medium compact. Ripening time occurs late in the epoch III. The average yield is between 15 and 20 t/ha; the variety is very resistant to frost, with winter buds freezing at temperatures below -20 to -22°C. It shows increased resistance to *Plasmopara viticola*,

Uncinula necator and *Botrytis cinerea*. The grape juice (must) can have a sugar content of 18-20% and a total acidity of 7-10 g/l.

Alicante Bouschet clone 95

Alicante Bouschet is a variety of wine colorant or in French Teinturier.

It is used to restore the color of red wines. This variety is characterized in the Hilandar area by a very high grape weight of 537.6 grams, compared to the norm, which is between 90 and 130 grams.

The pulp content of the berries is also high, which favors a higher juice yield, which in this variety is a source of pigments (anthocyanins) to improve the color of red wines.

Table 5. Mechanical composition of berries of Alicante Bouschet

Mesocarp (%)	Skin (%)	Seeds (%)
94.53	3.83	1.64

ACKNOWLEDGEMENTS

The research was financed by the Ministry of Education, Science and Technological Development, Republic of Serbia, project ref. numbers: 451-03-47/2023-01/200116.

CONCLUSIONS

Based on the analysis of locality conditions and the agrobiological and technological characteristics of the clones of Merlot, Cabernet Sauvignon, Cabernet Franc and Alicante Boucher varieties, the following conclusions can be drawn:

- The location of the St. Sava field is suitable for growing all listed varieties. All vines of the cultivated varieties were characterized by a large grape mass, which was significantly higher than the standard variety.
- Most of the measured parameters also indicate that the grapes contain a sufficiently high percentage of skin, seeds and pulp, which are important for obtaining high-quality raw materials and substances

(anthocyanins, tannins) for the production of top quality wine.

- New vineyards should be planted exclusively with clones, as in this way the better economic and technological characteristics of the varieties come into play.
- Hilandar wines, especially Merlot wines, are characterized by a high content of anthocyanins, of which the malvidin group is the most prominent. The antioxidant, antiarterogenic, antidiabetic, anticancer, cardio-protective and anti-inflammatory effects of malvidin have been proven.
- Marković (2017) claims that the influence of the authentic climate, the physical and chemical characteristics of the soil, as well as the proximity of Mount Athos and the Aegean Sea, contribute to the specificity of the entire "terroir", which is a prerequisite for the production of wines of exceptional quality in the Saint Sava area.

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AGGREGATE COMPOSITION AND STABILITY OF SOIL STRUCTURE OF RANKERS FROM MT. MALJEN, SERBIA

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Abstract

Soil structure is the natural organization of soil particles into different forms under the influence of pedogenic processes. The aim of this work is to determine the soil structure of ranker soils on Mount Maljen by analyzing the aggregate composition and water stability of structural aggregates, and to evaluate the soil structure using various soil aggregation indices. Thirteen soil profiles were studied and classified as ranker according to the national soil classification system. The following soil structure indices were determined: dry and wet mean weight diameter (dMWD and wMWD), dry and wet geometric mean diameter (dGMD and wGMD), structural stability index (SI), and structural coefficient (Kstr). The favorable aggregate composition of the studied ranker is illustrated by the wMWD/dMWD ratio of 0.81±0.10, the values of SI > 9% and Kstr > 2 in all soil profiles. The results indicate that the studied soils have favorable structure, high water stability and low risk of structural degradation, but various linear erosion processes observed in the field indicate that the study area is degraded and that soil structure is not the only factor stabilizing soil erosion.

Key words: Soil structure, Rankers, aggregate composition, structural indices, soil degradation

INTRODUCTION

Rankers belong to the order of automorphic soils in the National Soil Classification System. They belong to the class of humus accumulating soils and are characterized by the following soil horizon sequence: A - R, A - C, or A - C - R. They often have a well-developed humus accumulation horizon and

are formed on non-calcareous parent material. These soils are usually formed on steep slopes in hilly mountainous regions. The natural vegetation on these soils consists mainly of grasses, rarely of forests, and they occur in all climatic conditions, from semi-arid to extremely humid. There are more than 400,000 ha of rankers in Serbia (Dugalić and

Gajić, 2012). Životić et al. (2021) noted that many authors in Serbia often associate rankers with the Leptosols Reference Soil Group (RSG) of the World Reference Base for Soil Resources (WRB), which is not always the case. Soil structure refers to the size, shape, and arrangement of solids and voids, their ability to store and transmit fluids and organic and inorganic matter, and their ability to support vigorous root growth and development (Lal, 1991). Soil aggregates are the basic structural elements of soil and are collections of mineral and organic soil components with microscopic and macroscopic dimensions. The presence, quantity, size, and stability of soil aggregates determine a number of soil properties (e.g., infiltration, water retention, hydraulic conductivity, etc.) and the performance of most soil functions (Pavlu et al., 2022). Soil aggregation is a complex process that results from the interaction between many different variables, including various soil properties, environmental and plant factors, and human intervention. Aggregate distribution and stability are often used as measures of soil structure (Six et al., 2000). Soil structure stability is one of the most important indicators of soil degradation, and some authors point out that it is one of the physical soil properties that can serve as an indicator of soil quality (Arshad and Coen 1992). In addition, soil structure directly affects soil erodibility and influences soil erosion. Favorable soil structure and high aggregate stability are very important because they affect many other soil properties and processes as well as plant growth. There are several indicators of soil aggregate stability, such as mean dry and wet weight diameter (dMWD and wMWD), mean dry and wet geometric diameter (dGMD and wGMD), structural stability index (SI), and structural coefficient (Kstr). Soil structure is not an easy

measure to quantify, and there are numerous methods for its determination, all of which differ significantly in terms of precision and success (Životić et al., 2019). The most commonly used method for soil structure analysis in Serbia is Savinov's method (Savinov, 1931). Soil structure of different soil types has been studied by many authors (Gajić et al., 2006, Gajić et al., 2010; Ćirić et al., 2012; Životić et al., 2019) using this method.

The aim of this study is: a) to perform an analysis of the soil structure of rankers from the Maljen Mountains after dry and wet sieving, and b) to evaluate the aggregate composition and the stability of structural aggregates by different soil aggregation indices.

MATERIALS AND METHODS

Study area

The study was carried out in the eastern part of Maljen mountain, which is located in western Serbia. Maljen belongs to Dinaric Alps Mountain range and the most encountered bedrock are serpentinites and limestones. The mountain spreads about 25 km wide in western-eastern direction, and its highest peak is called Kraljev sto (1104 m a. s. l.).

The area is characterized by a mountain climate. The nearest mountain meteorological station (located on Rudnik mountain) recorded a mean annual temperature of 10.4°C and a mean annual rainfall of 965.1 mm in the period from 1997 to 2016. However, in the researched area, a lower average temperature and a higher annual amount of precipitation can be expected, given that it is located at a higher altitude. Study area is located between the municipalities of Gornji Milanovac, Mionica and Požega. The altitude of the terrain on which the soil was examined ranges between 767 and 898 m a. s. l. The relief of the study

area is mountainous with moderately high and high slope gradients, and often long slopes.

The vegetation of the study area is mostly grassy and very dense, except on very steep slopes where it is very rare or non-existent. Exposure of bedrocks and coarse surface fragments are present on the top of the surface across the slopes, and sometimes on the flat terrain. Woody vegetation is also present on the flatter parts where the soil is deeper. The dominant land use in the study area is pastures used for extensive grazing.

Soil sampling and analyses

Field research was conducted in May of 2022. A total of 13 soil profiles were opened until the appearance of solid rock. Soil was described on field. Disturbed soil samples were collected from all soil horizons in profiles and a total number of 13 samples were analysed in the laboratory.

The main physical and chemical characteristics were determined by following methods: particle-size distribution of the soils was determined by combining sieving and pipette methods (Rowell, 1997); soil texture was classified using the USDA triangle (Natural Resource Conservation Service, 2004); soil organic matter (SOM) (Dugalić and Gajić, 2005); soil organic carbon concentration (SOC) was calculated = % of humus / 1.724.

Dry ASD (aggregate-size distribution) and water stability were determined by Savvinov's method (Savinov, 1936). This method uses dry and wet sieving procedures. Soil aggregates were separated on sieves of 11.2, 5, 3, 2, 1, 0.5, and 0.25 mm into eight dry aggregate size classes. As for the wet sieving, the samples were originally sieved through a column of 3, 2, 1, 0.5 and 0.25 mm sieves, but considering the fact that the highest percentage of aggregates (on average 23.1±6.9%) retained on a 3 mm sieve, upon drying these aggregates were again sieved through 11.2, 8 and 5 mm sieves in order to

obtain more reliable results of the water resistance of the aggregates.

Structure indices and coefficients

The following soil structure indices were calculated: dMWD, wMWD, dGMD, wGMD, Kstr and SI. The weights of different aggregate size classes (ASCs) obtained after dry and wet sieving were used to calculate dMWD, wMWD, dGMD and wGMD. Both dMWD and wMWD were calculated by the following equation (Van Bavel, 1949):

$$MWD = \frac{\sum_{i=1}^n xi*mi}{\sum_{i=1}^n mi} \quad (1)$$

Where: xi is the mean diameter of each ASC (mm), mi is the weight of each ASC (g) with respect to the total sample and n is the number of separated ASCs.

Geometric mean diameter was calculated as the index of Mazurak (1950) after dry and wet sieving using the following equation:

$$GMD = \exp \left| \frac{\sum mi*\log xi}{\sum mi} \right| \quad (2)$$

Where: mi is the weight of the aggregates of each size class (g) and xi is the mean diameter of its size class (mm).

Structural stability index (SI) proposed by Pieri (1992) was determined as a way of assessing the risk of structural degradation as per the following equation:

$$SI = \frac{1.274*SOC}{(silt+clay)} * 100 \quad (3)$$

Where: SOC (%) represents soil organic carbon content and (silt + clay) (%) represents the combined silt and clay content of the soil. SI is expressed in % and a value higher than 9% indicates that the soil has a stable structure, values between 7% and 9% indicate that there's a low risk of structural degradation, values between 5% and 7% indicate a high risk of degradation and finally a value lower than, or equal to 5% indicates a structurally degraded soil (Pieri, 1992).

Another way of assessing the quality of soil structure is through the coefficient of

structure given by Shein et al. (2001) which was calculated using the formula given below:

$$Kstr = \frac{A}{B} \quad (4)$$

Where: A is the content of aggregates of size 0.25-10 mm (%) and B represents the content of aggregates <0.25 mm and >10 mm (%). Kstr is used for evaluating aggregate composition where soils have a good structure if Kstr values are > 1.5; satisfactory structure if Kstr ranges from 0.67 to 1.5; and unsatisfactory for Kstr < 0.67.

RESULTS AND DISCUSSIONS

Soil properties, aggregate-size distribution and aggregate stability. The studied soils are located at elevations between 767 and 898 m a.s.l. The soil profiles were opened at sites with varying degrees of slope (from sites with gently sloping terrain to slopes with 20-30% inclination). The micro relief around the profiles is mainly characterized by the occurrence of skeletons and rocks on the soil surface, which led to the fact that the soil profiles were opened in non-representative places. The basic characteristics of the studied

soils are listed in Table 1. It can be noted that the silt fraction dominates the grain size distribution in all samples with an average value of 63.7±7.0%. The lowest silt fraction of 45.0% was found in profile No. 8, while in the other twelve profiles the silt fraction exceeds 55%. All the studied soils have a very high percentage of particles smaller than 0.05 mm (71.5-92.8%). Twelve of the thirteen samples belong to the same texture class - silty loam, while the sample from profile 8 belongs to the loamy texture class. All the samples studied have a very high SOM content. The average SOM content is 14.19±2.29%. The soil organic carbon content is also high, varying from 5.59% in profile 6 to 10.75% in profile 12. In addition to the characteristics listed in Table 1, the studied soils have a moderately acidic to neutral response, high cation exchange capacity, and high base saturation. Twelve of the thirteen soil profiles belong to the leptosols RSG of the WRB classification. Profile 10 belongs to the leptic pheozems because its thickness is more than 25 cm.

Table 1 Particle size distribution and soil organic matter of investigated Rankers

Soil sample number	Depth (cm)	Horizon	Particle size distribution (% , mm)			Soil texture	SOM (%)	SOC (%)
			Total sand 2-0.05	silt, 0.05-0.002	clay, <0.002			
1	0-15	A	16.9	65.2	17.9	Silty loam	13.11	7.60
2	0-20	A	17.5	64.7	17.8	Silty loam	16.19	9.39
3	0-20	A	15.3	66.5	18.2	Silty loam	13.67	7.93
4	0-21	A	19.8	60.4	19.8	Silty loam	11.32	6.57
5	0-11	A	19.3	63.8	16.9	Silty loam	15.09	8.75
6	0-22	A	22.1	63.9	14.0	Silty loam	9.64	5.59
7	0-17	A	14.3	67.1	18.6	Silty loam	14.31	8.30
8	0-18	A	28.5	45.0	26.5	Loam	13.71	7.95

9	0-24	A	28.0	56.8	15.2	Silty loam	12.73	7.38
10	0-29	A	9.5	70.1	20.4	Silty loam	15.79	9.16
11	0-14	A	7.2	74.6	18.2	Silty loam	13.29	7.71
12	0-20	A	15.1	63.9	21.0	Silty loam	18.53	10.75
13	0-22	A	8.3	65.5	26.2	Silty loam	17.04	9.89

Table 2 shows the results obtained by dry sieving. The content of microaggregates is higher than 10% only in profiles 10 and 13. In the studied soils, structural aggregates with size from 3 to 5 mm are the most represented with average content of $19.2\pm 4.4\%$. Aggregates with a size of 0.5-1 mm are the least represented with an average of $5.1\pm 0.8\%$. The results of dry sieving indicate that the studied soils have a favourable aggregate composition, which is best illustrated by the fact that the content of agronomically valuable fractions (0.25 to 10 mm) in all soil samples is over 70%. Among these aggregates, fine and medium aggregates predominate. Structural aggregates with large diameters (larger than 10 mm) are not conducive to water conservation and plant growth, while aggregates with too small diameters (called microaggregates, smaller than 0.25 mm) can clog pores and affect soil permeability (Wu and Hong, 1999). Aggregate stability is defined as resistance to external destructive agents such as rain, runoff (drainage), and wind (Pavlu et al., 2022). The results of wet sieving and the

distribution of particle size classes obtained afterwards are presented in Table 3. It should be noted again that the aggregates were originally sieved through a series of 3-, 2-, 1-, 0.5-, and 0.25-mm sieves during wet sieving. However, because the highest percentage of aggregates remained on a 3-mm sieve, they were re-sieved through 11.2-, 8-, and 5-mm sieves after drying to obtain more accurate results for the indices. Thus, we obtained nine aggregate size classes, one more than with dry sieving. The content of water-stable macroaggregates (5-8 mm) ranged from 2.7% to 11.5% ($6.2\pm 3.1\%$ on average). Megaggregates (< 11.2 mm) are present in every soil sample and the average content is $7.9\pm 5.0\%$. The presence of these aggregates in wet sieving shows that the soils have high water stability. The percentage of water stable aggregates larger than 1 mm of $67.9\pm 5.3\%$ is also an indicator of high aggregate stability. Pavlu et al. (2022) state that soil structure stability is one of the most important indicators of soil degradation. The presence of water-stable aggregates plays a very important role in maintaining the stability of soil structure.

Table 2 Dry aggregate size distribution analysis

Soil sample	Depth (cm)	Dry aggregate size distribution (mm, in %)							
		>11.2	11.2-5	5-3	3-2	2-1	1-0.5	0.5-0.25	<0.25
1	0-15	12.2	20.0	22.5	12.7	10.5	5.4	7.5	9.2
2	0-20	18.8	19.7	19.6	12.5	9.8	4.3	6.7	8.6
3	0-20	5.2	8.6	20.1	23.6	19.2	5.3	9.8	8.2
4	0-21	6.2	10.1	22.5	25.0	18.3	4.2	7.6	6.1
5	0-11	14.0	15.0	21.5	15.0	11.7	4.8	8.8	9.1
6	0-22	17.6	16.6	20.0	13.8	13.0	4.7	8.0	6.3
7	0-17	16.4	9.7	26.7	9.2	15.2	5.0	9.0	8.9

8	0–18	17.6	16.4	21.8	17.9	12.8	4.3	5.5	3.6
9	0–24	22.1	14.0	16.3	11.9	13.0	4.6	9.3	8.8
10	0–29	4.2	6.5	13.9	18.5	21.5	7.4	14.5	13.5
11	0–14	8.5	20.5	20.0	13.8	13.5	5.9	10.4	7.5
12	0–20	11.5	6.3	10.3	18.6	21.3	4.9	18.7	8.5
13	0–22	20.8	12.7	14.4	12.6	14.2	4.9	9.7	10.6

Table 3 Soil aggregate stability to water analysis

Soil sample	Depth (cm)	Soil aggregate stability to water (mm, in %)								
		>11.2	11.2–8	8–5	5–3	3–2	2–1	1–0.5	0.5–0.25	<0.25
1	0-15	9.5	3.9	6.3	22.6	9.6	15.2	10.6	2.6	19.8
2	0-20	12.1	8.8	11.1	25.6	3.7	9.4	7.2	2.1	20.1
3	0-20	1.8	9.1	11.3	11.9	10.9	24.4	11.4	2.6	16.5
4	0-21	1.8	5.4	3.2	41.1	6.6	13.2	8.1	1.7	19.0
5	0-11	10.0	0.3	4.1	41.5	4.5	11.1	7.4	4.1	17.0
6	0-22	13.7	9.1	5.3	36.1	3.9	8.7	7.5	2.1	13.6
7	0-17	5.2	3.3	4.8	40.2	6.1	9.2	5.4	1.2	24.6
8	0-18	8.4	5.8	6.6	41.0	4.7	11.1	6.3	1.4	14.7
9	0-24	18.4	8.1	4.7	22.4	5.3	11.3	9.4	2.0	18.5
10	0-29	3.1	2.4	2.7	22.9	9.2	20.2	10.6	2.5	26.3
11	0-14	4.8	7.1	5.5	8.4	11.3	23.0	14.9	1.8	23.1
12	0-20	4.0	4.4	3.2	10.5	4.3	23.9	16.1	3.0	30.5
13	0-22	9.1	5.8	11.5	20.9	5.6	15.4	7.5	1.5	22.5

Soil structure indices

The values of the structural coefficient, mass weight, and mean geometric diameter, as well as the index of structural stability, are shown in Table 4. These indices, along with aggregate size distribution (ASD) and stability of soil aggregates to water (WAS), are critical to understanding the structural condition of soils. Mean weight diameters were calculated using dry (dMWD) and wet (wMWD) sieving results; the same is true for geometric mean diameters (GMD). The dry MWD of the studied soils has values ranging from 2.56 mm to 5.40 mm (average 4.36 ± 0.92 mm). Wet MWD values range from 2.21 mm to 4.77 mm (3.52 ± 0.84). In general, the higher the wMWD value, the more stable the soils and vice versa. High values mean greater aggregate stability, while high values of aggregates < 0.25 mm mean low aggregate stability (Životić et al., 2019). The ratio of wMWD and dMWD has an average value of 0.81 ± 0.10 , indicating little change in aggregate size after wet sieving. This ratio is a

good indicator of aggregate stability. The least significant change between wMWD and dMWD was observed in profile 3, while the largest difference was observed in profile 11. The stability of the soil aggregates can also be expressed by the dry and wet geometric mean diameter. The values of dry GMD range from 1.13 mm in soil profile 10 to 1.67 mm in profile 8, while wGMD has values between 0.95 mm (profile 12) and 1.49 mm (profile 6). The relationship between wGMD and dGMD indicates that the mean geometric diameters changed very little after wet sieving, with the average value of wGMD being 0.87 ± 0.06 of dGMD. All the studied soils have a structural stability index (SI) higher than 9.14%, with an average value of $12.65 \pm 1.91\%$. This means that all soil samples have a stable to very stable structure, with minimal to no risk of structural deterioration. High SI values are correlated with very high SOC values of the studied soils. The structural coefficient also shows very high values. In all 13 profiles, the

value of this parameter is greater than 2. The highest value of Kstr was measured in profile 4 (Kstr = 7.17), and the lowest in profile 13 (Kstr = 2.18). In accordance with the

classification given by Shein et al. (2001), we can conclude that the studied soils have a good structure.

Table 4 Various structural indices of Rankers from Maljen mountain

Soil sample	Depth (cm)	dMWD (mm)	wMWD (mm)	wMWD/	dGMD (mm)	wGMD (mm)	wGMD/	SI (%)	Kstr
				dMWD			dGMD		
1	0-15	4.69	3.51	0.75	1.5	1.23	0.82	11.65	3.68
2	0-20	5.4	4.47	0.83	1.6	1.37	0.85	14.5	2.65
3	0-20	3.16	3.04	0.96	1.31	1.22	0.93	11.93	6.49
4	0-21	3.51	3.04	0.86	1.41	1.25	0.89	10.44	7.17
5	0-11	4.57	3.65	0.80	1.47	1.31	0.89	13.81	3.34
6	0-22	5.09	4.74	0.93	1.58	1.49	0.95	9.14	3.18
7	0-17	4.57	3.28	0.72	1.46	1.22	0.83	12.34	2.96
8	0-18	5.23	4.06	0.78	1.67	1.42	0.85	14.17	3.71
9	0-24	5.29	4.77	0.90	1.53	1.38	0.90	13.06	2.24
10	0-29	2.56	2.39	0.93	1.13	1.05	0.93	12.89	4.67
11	0-14	4.23	2.76	0.65	1.44	1.09	0.76	10.58	5.28
12	0-20	3.35	2.21	0.66	1.23	0.95	0.78	16.13	3.99
13	0-22	4.98	3.79	0.76	1.46	1.25	0.86	13.74	2.18

CONCLUSION

After performing quantitative analyses, we can conclude that all studied rankers have favourable aggregate composition and water-stable soil structure. The values of various structural indices and coefficients indicate that the studied soils have a low risk of degradation. The favourable aggregate composition is best illustrated by the content of the most agronomically valuable aggregates (0.25-10 mm), which is 78.2±6.1% in our study. The size ratio of structural aggregates after wet sieving ranges from 0.65 to 0.96, or 0.81±0.10 on average, which is also an indicator of water-stable structural aggregates. The structural stability index (SI) has a value above 9.14% for all the soils studied, indicating that there is very little to no risk of structural deterioration, since all the samples have a very stable soil structure. The favourable structure of these soils is also reflected in the values of the structural coefficient (Kstr), which is on average above

2 in all profiles (3.96±1.55). The studied rankers are characterised by a good structure, with a high content of agronomically suitable aggregates, which are very resistant to water. The studied rankers have a favourable aggregate composition and water-stable aggregates. Therefore, various linear erosion processes, such as gullies along the entire length of the slope and soil creep on the slope shoulders, were observed during the field research. These phenomena are common in soils developed on serpentinite rocks. The study area is degraded despite the favourable soil structure, which also indicates that soil structure is not the only factor stabilising soil erosion.

ACKNOWLEDGMENT

This research is a result of Master studies of the first author and it was prepared within the framework of projects 451-03-47/2023-

01/200116 and 451-03-47/2023-01/200011 funded by the Serbian Ministry of science, technological development and innovation.

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AGROBIOLOGICAL CHARACTERISTICS OF SOME CABERNET SAUVIGNON CV CLONES GROWN IN THE CONDITIONS OF THE WINE REGION OF CENTRAL SERBIA

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Abstract

The study was conducted in 2021 in the Šumadija region. At experimental vineyard row spacing is 2.4 m and 0.9 m between vines in row. Vineyards is characterized training system with height of 90 cm on which is Roayat cordon used. The aim of this study was to determine the differences between Cabernet Sauvignon clones 191, 412, E153 and 169. The duration of phenological stages was determined by Lorenz et al. (1994). Mechanical composition of grapes and berries was determined according to the method of Marković and Pržić (2020). The sugar content of the grape must was determined by the Oechsle mostwage and the total acidity by the titration method using 0.1M NaOH. The bleeding of the grape clones was registered 24.03, budburst 13.04, flowering on 29.05, veraison on 01.08 and harvest on 01.10. Clone 169 stands out from the other clones in most of the parameters studied: the highest average bunch weight (154.0 g), average bunch length (10.65 cm), average number of berries in the bunch (140.6) and average weight of berries in the bunch (147.5 g). According to the content of total acids, clone 191 (7.50 g/l) stands out, followed by clone E 153 (7.28 g/l) and clone 412 (6.68 g/l). Based on the date and the results obtained, it can be concluded that the tested clones are suitable for growing in the wine region of Central Serbia and that, based on the parameters shown, they can be recommended for the production of high quality wine.

Key words: Cabernet Sauvignon, clone, grape, Roayat cordon, wine region

INTRODUCTION

Cabernet Sauvignon is second in the range of grape varieties, with an area under cultivation of 341,000 hectares (4% of the world's vineyard area). It originates from the Bordeaux region of France, where it occupies 46,555 hectares of this area, followed by Chile (42,409), the United States (40,837) and China (40,300). It is also grown in EU countries, Russia, Australia, New Zealand, and South Africa (OIV, 2022). According to published genetic analyses, this French variety originated from the crossing of Cabernet Franc and Sauvignon Blanc. Its ecological geographic origin is *Proles occidentalis*. Cabernet Sauvignon is grown worldwide

and the variety is also known by the following synonyms: Budire, Breton, Vidure Sauvignon, Veron, Cabernet petit, Petit vidure (Zunić and Garic, 2017).

It is characterized by good vigor and yield. The top of the young shoot is hairy, reddish-green colour. The leaf is round with 5, 7 or 9 lobes. The flower is hermaphrodite. The berries are small, round, slightly flattened, with dark blue skin. The grape of Cabernet Sauvignon is small to medium size, conical-cylindrical, medium-pressed (80-150 g).

Careful selection of clones (Gatti et al., 2014) and the cultivation system is crucial for Cabernet Sauvignon (Przic, 2015). In southern regions, it can be pruned long or

short, considering that bud break is late and slow. Canes are pruned to 8-12 buds, while in the case of short pruning, spurs are pruned to 3-4 buds. It is important to avoid creating large wounds during pruning (Markovic et al., 2017). The variety has robust woody canes, which makes the process of cane pulling and removal time-consuming and labour-intensive. Green pruning measures play a significant role in establishing a balance between vegetative growth and crop yield and influence wine quality (Maria et al., 2011; Keller, 2020).

Ripening time is very late in the epoch III. The average yield is between 6 and 10 t/ha. Cabernet Sauvignon is among the most resistant varieties to low winter temperatures, but it can freeze at -20 to -26 °C. It is not overly susceptible to gray mold attack, but is susceptible to tree diseases such as *Eutypa dieback* and *Uncinula necator*. The grape juice (must) can have a sugar content of 20-24% and a total acidity of 6.5-8.5 g/l.

The aim of the study was to determine the differences between Cabernet Sauvignon clones: French clone 169, 191, 412 and Italian clone E 153.

MATERIALS AND METHODS

The study was conducted in 2021 in Krnjevo, on the Radovanović vineyard, in the Šumadija region of central Serbia. The vineyard is planted in 2007. The distance between rows was 2.4 m, while the distance within the trunk in row was 0.9 m. The of training system height was 90 cm, and the cordon is a Roayat cordon. The duration of the phenological stages was determined by Lorenz et al. (1994). Mechanical composition of grapes and berries was determined according to the

method of Marković and Pržić (2020) in the laboratory of the Faculty of Agriculture in Belgrade. It was performed by taking representative samples (clusters) of clones 169, 191, 412 and clone E153. The stem is the skeleton of the grape cluster or bunch. The longest part, the rachis (main axis), is branched with peduncles, and a pedicel attaches each grape berry to the stem. They underwent the following measurements such as: average bunch weight (g), average bunch length (cm), average number of the berries in the bunch and average weight of berries in the bunch (g).

The sugar content in grape juice (must) was determined using the Oechsle mostwage. The principle of operation of the Oechsle mostwage is based on the determination of must density, which is measured in Oechsle degrees (°Oe). The Oechsle degrees are the difference between the water density and the must density at 4°C. The results of the sugar content are expressed in percentages. The percentage of sugar was determined using the following formula:

$$\% \text{ of sugar} = \text{°Oe} * 0.266 - 3$$

Total acid content was determined by the titration method using 0.1M NaOH. The working principle of determination of total acid content in grape must is based on neutralization of all acids with NaOH solution. Phenolphthalein was used as a colour indicator. The must was titrated with NaOH solution until the colour changed from light red to dark green. Total acid content was then determined using the following formula:

Total acid (g/l) = NaOH used * F * 0.75
F - normality factor of the NaOH solution
The glicoacidometric index was determined as the ratio between the sugar content and the total acid content.

RESULTS AND DISCUSSIONS

By phenological observations it was found that bleeding started 24.03., budburst occurred on 13.04., flowering started 29.05., *veraison* started 01.08. and the harvest was done at 01.10. Results are shown in table 1.

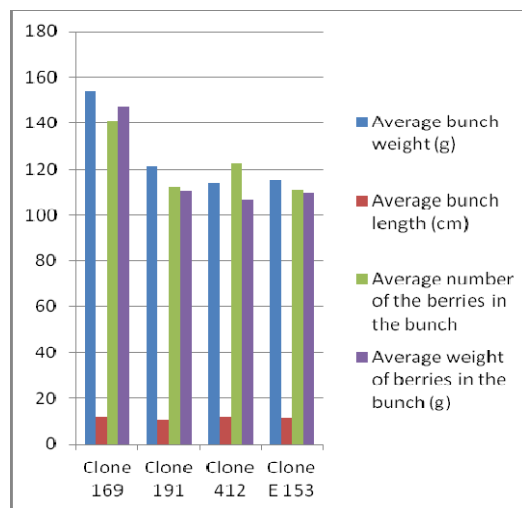
Table 1. Phenological observations of clones

Phenophase	Beginning/End
Bleeding	24.03.
Budburst	13.04
Flowering	29.05.
<i>Veraison</i>	01.08.
Harvest	01.10.

Based on the research and the results obtained, it was found that there were no differences in the duration of phenological phases between the clones.

Clone 169 stands out from the other clones in most of the parameters studied: the highest average cluster weight (154.0 g), average cluster length (10.65 cm), average number of berries in the cluster (140.6), and average weight of berries in the cluster (147.5 g). In clone 191, cluster weight ranged from 81g to 231 g, average cluster length was 10.65 cm, average number of berries in the cluster was 112.1, and average weight of berries in the cluster was 110.6 g. Clone E 153 had cluster weight of 74g to 169 g, cluster length of 10cm to 14 cm, average number of berries in cluster 111.0, and average weight of berries in cluster 109.6 g. For clone 412, average cluster weight was measured 114.1 g, average cluster length 11.5 cm, number of berries in cluster 102-150,

while average berry weight in cluster 106.4 g.



Graph 1. Mechanical composition of grapes and berries

When it comes to the mechanical composition of berries, it was also conducted in the laboratory of the Faculty of Agriculture, University of Belgrade. In table 3 are investigated various parameters related to the berries such as: % of berries in the cluster, % of skin in the cluster and % cluster of stem.

Table 3. Mechanical composition of berries

Clone	% of berries in the cluster	% of skin in the cluster	% cluster of stem
169	96.36	11.39	3.63
191	95.79	6.89	4.2
412	96.67	8.02	3.33
E153	95.75	10.83	4.24

Clone 412 stands out the most, followed by clone 169. In terms of percentage of skin in the cluster, clone 169 stands out, followed by Italian clone E153, which stands out the most of all in terms of percentage of stems in the cluster.

Wine quality depends mainly on the characteristics of the grape it is made of

(Blackford et al., 2021), and one of the attributes affecting wine composition is cluster and berry morphology (Zivkovic et al., 2016; Zdunic et al., 2019; Qian et al., 2022). Since Cabernet Sauvignon is a variety for the production of high quality red wines, parameters such as sugar content, total acidity and pH of the grape must are considered very important.

For high-quality and premium wine varieties need accumulate relatively high sugar content (20-25%), resulting in wines typically containing 12 to 14% alcohol (Brighenti et al., 2012; Morata and Loira, 2019; Cataldo et al., 2021; Markovic, 2023). Wines of those varieties generally have sufficient acidity, typically ranging from 6 to 8 g/l.

The highest sugar content was found for clone E 153 (27.59%) and the lowest for clone 169 (23.35%).

Table 3. Content of sugar and total acids in grape juice

Clones	Sugar content (%)	Total acids content (g/l)
169	23.38	6.68
191	24.66	7.50
412	20.94	6.68
E 153	27.59	7.28

According to the content of total acids, clone 191 (7.50 g/l) stands out, followed by clone E 153 (7.28 g/l) and clone 412 (6.68 g/l).

Table 4. pH and glycoacidometric index

Clones	pH	Gly
169	3.17	3,54
191	3.10	3,29
412	3.08	3,13
E153	3.10	3,79

The pH is more or less the same for all clones, and there are no significant deviations, as well as for the glycoacidometric index.

CONCLUSIONS

Based on research and obtained results it was found that:

There were no differences in the duration of phenological phenophases among clones.

For mechanical composition of grape, clone 169 stands out from the other clones in most of the parameters studied: the highest average cluster weight (154.0 g), average cluster length (10.65 cm), average number of berries in the cluster (140.6), and average weight of berries in the cluster (147.5 g).

For mechanical composition of berries clone 412 stands out the most, followed by clone 169. In terms of percentage of skin in the cluster, clone 169 stands out, followed by Italian clone E153, which stands out the most of all in terms of percentage of stems in the cluster.

The highest sugar content was observed in clone E 153 (27.59%) and the lowest in clone 169 (23.35%).

In terms of total acidity content, clone 191 (7.50 g/l) stood out, followed by clone E 153 (7.28 g/l) and clone 412 (6.68 g/l).

Based on the data and the obtained results, it can be concluded that the tested clones are suitable for cultivation in the wine region of Central Serbia and that they can be recommended for the production of quality wine based on the shown parameters.

ACKNOWLEDGEMENTS

The research was financed by the Ministry of Education, Science and Technological

Development, Republic of Serbia, project ref. numbers: 451-03-47/2023-01/200116.

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STREAMLINING SCIENTIFIC PUBLICATION WRITING: COLLABORATING WITH AI ASSISTANT CHATGPT FOR ENHANCED PRODUCTIVITY

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Abstract

Every scientist at the beginning of his professional career inevitably encounters difficulties in developing scientific publications. These difficulties are often related to the preparation of the introductory section, which relies on existing research by other authors on the topic, as well as the mastery of various statistical approaches, understanding results, and their interpretation.

The aim of this study is to assess to what extent ChatGPT can streamline the process of writing scientific publications and how it can be beneficial as an auxiliary tool. ChatGPT cannot entirely write the introductory section for you, but it can generate adequate ideas and fundamental aspects that the author can utilize and further develop for the elaboration of this part. ChatGPT can perform basic statistical analyses commonly used in such studies, which adequately align with the developments implemented in other statistical software.

Key words: ChatGPT, AI, writing scientific publication, statistical analysis.

INTRODUCTION

The rapid advancements in Artificial Intelligence (AI) have facilitated its increasing adoption across various scientific disciplines as an invaluable tool for problem-solving (Surameery & Shakor, 2022; Biswas, 2023). Among the innovative AI tools gaining popularity is ChatGPT. What is ChatGPT? ChatGPT is an AI language model developed by Open AI. It is based on the GPT (Generative Pre-trained Transformer) architecture (<https://chat.openai.com>, 2022; Sanderson, 2023). ChatGPT is designed to engage in conversation with users, providing helpful and informative responses based on the input it receives. It can understand and generate text in multiple languages and has been trained on a wide range of topics. It aims to simulate human-like conversation and provide meaningful interactions for users. OpenAI's GPT models have been widely used for various applications, including content generation,

language translation and more (Jiao et al., 2023).

Every scientist at the beginning of his professional career inevitably encounters difficulties in the developing scientific publications. These difficulties are often related to the preparation of the introductory section, which relies on existing research by other authors on the topic, as well as the mastery of various statistical approaches, understanding results, and their interpretation (Hill-Yardin et al., 2023; O'Connor, 2023). Despite the thesis presented so far, other authors present the opposite and contradictory opinion (Stokel-Walker, 2023).

ChatGPT can be a useful tool to assist in the process of writing scientific publications. Here are a few ways that it can help (<https://chat.openai.com>; Chen, 2023):

Generating ideas: ChatGPT can help brainstorm and generate ideas for your scientific publication. By providing it with

a specific prompts or questions related to your research topic, you can receive suggestions and explore different angles to approach your work (Huang & Tan, 2023).
Providing background information: If you need to gather background information on a particular topic or need a summary of existing research, you can ask ChatGPT to provide a brief overview. It can assist in finding relevant papers, explaining concepts, or summarizing key findings.
Proofreading and language support: ChatGPT can help with proofreading and language editing. It can review your draft, identify grammatical errors, suggest improvements in sentence structure, and provide general language guidance to improve the clarity and coherence of your writing (Katsnelson, 2022).
Answering a specific question: If you have a specific question or need clarification on

MATERIALS AND METHODS

What's the current the version, that we used? It's based on the GPT-3.5 architecture, which is the third iteration of the GPT series. ChatGPT data includes a vast amount of text up until September 2022 and free for use.

In the present study, I have used a sample publication as a basis for comparison, including with the regards to the statistical analyses: "Chamurliyski, P., Penchev, E., & Tsenov, N., (2015). Productivity and stability of the yield from common winter wheat cultivars developed at IPGR Sadovo under the conditions of Dobrudzha region. *Agricultural Science and Technology (AST)*, Vol. 7, № 1, 19 – 24 (ISSN 1313 – 8820)". The statistical software XLSTAT Ver. 2009.4.05 and IBM SPSS 22 was used for Two-way ANOVA and Correlation analyses.

RESULTS AND DISCUSSIONS

Let's try to write a scientific publication! As a starting point, we will attempt to create the INTRODUCTION section by posing general questions related to the subject of our study to ChatGPT.

the certain scientific concepts, methodologies, or statistical analyses, ChatGPT can provide information and explanations based on its trained knowledge. However, it's always important to fact-check and verify the information obtained from any source, including AI models.

Assisting with a formatting and referencing: ChatGPT can provide the guidance on formatting requirements for your publication, such as citation styles (e.g., APA, MLA), reference management tools, and general formatting guidelines. It can help with generating citations and references for your sources.

The aim of this study is to assess to what extent ChatGPT can streamline the process of writing scientific publications and how it can be beneficial as an auxiliary tool.

Question: Could you please, write for me an Introduction for a scientific publication with citations on the following topic: "Productivity and stability of the yield from common winter wheat cultivars developed at IPGR Sadovo under the conditions of Dobrudzha region"?

ChatGPT: "Wheat (*Triticum aestivum* L.) is one of the most widely cultivated cereal crops worldwide, providing a staple food source for a significant portion of the global population. The selection and development of high-yielding and stable cultivars are critical in meeting the increasing demand for wheat production. To evaluate the productivity and stability of the yield, a comprehensive analysis will be conducted on a representative sample of common winter wheat cultivars developed at IPGR Sadovo. This analysis will encompass various agronomic parameters, such as grain yield per unit area, biometrical indexes of the productivity, and adaptability to the Dobrudzha region's specific climatic and soil conditions. The Genotype x Environment (GxE) interaction is a key consideration in evaluating the performance of cultivars across the

different environments. Several statistical approaches have been developed to analyze GxE interactions, including the additive main effects and multiplicative interaction (AMMI) model (Dias CTS and Krzanowski WJ, 2003; Maarouf IM, 2009; Nachit MM et al., 1983). These models enable the identification of cultivars that exhibit stable performance across diverse environments. Stability analysis plays a crucial role in plant breeding and cultivar recommendations (Becker HJ and Leon, 1988; Kang M, 1993; Lin C et al., 1986). It helps breeders identify cultivars that consistently perform well across varying environmental conditions, ensuring a reliable and sustainable food supply. In the context of wheat, studies on genotype x environment interactions and stability analysis have been conducted in various regions (Hasan K and Tacettin Y, 2010; Naheif EMM, 2013; Naroui Rad MR et al., 2013; Nzuve F et al., 2013). However, specific research focusing on the productivity and stability of common winter wheat cultivars developed at IPGR Sadovo under the conditions of the Dobrudzha region is limited.”

To cite ChatGPT properly the literature used by you during the preparation of the introductory section, it is necessary to provide a list of publications upon which your research is based. ChatGPT cannot entirely write the introductory section for you, but it can generate adequate ideas and

fundamental aspects that the author can utilize and further develop for the elaboration of this part. For a more precise interpretation of the AI topic, additional clarifying questions are necessary.

The next important part of a scientific is the Aim of investigation section.

Question: Can we write an aim of investigation?

ChatGPT: “The aim of this study is into the performance of productivity and stability of the yield from these common wheat cultivars. The findings will contribute to the selection and recommendation of cultivars that exhibit favorable traits for wheat production in the Dobrudzha region.”

It's almost the same to the original text from the publication: “The aim of this investigation was to study the productivity and determine the stability of the yield from common winter wheat cultivars developed at the Institute for Plant and Genetic Resources (IPGR) Sadovo under the conditions of Dobrudzha region, Bulgaria.”

How ChatGPT would handle the results, their discussion, and basic statistical analyses?

EXAMPLE 1: Grain yield two-way ANOVA analysis.

Question: We directly enter a database from MS Excel.

ChatGPT:

Table 1. Wheat grain yield two-way ANOVA analysis generated by ChatGPT.

Source of Variation	SS	df	MS	F	P-value	F crit
Genotype	49.285	19	2.594	28.912	0.00000	2.33 - Significant
Environment	87.279	2	43.639	486.106	0.00000	3.25 - Significant
GxE	19.811	38	0.521	5.800	0.30752	1.89 – Not Significant
Error	22.812	120	0.190			
Total	179.187	179				

Table 2. Wheat grain yield two-way ANOVA analysis from the publication.

Source of Variation	SS	df	MS	F	P-value	F crit
Genotype	49.002	19	2.653	28.563	0.00000	2.33 - Significant
Environment	87.532	2	43.236	486.166	0.00000	3.25 - Significant
GxE	19.776	38	0.421	5.203	0.02752	1.89 – Not Significant
Error	22.201	120	0.120			
Total	179.323	179				

ChatGPT: “The genotype factor accounts for the significant variation in the data. The observed differences in the measured variables can be attributed to the different genotypes tested. The environment factor also has a highly significant impact on the observed variations. The differences in the measured variables can be attributed to the varying environmental conditions. The

interaction between genotype and environment shows a not significant effect on the observed cultivars. In summary, both genotype and environment have significant effects on the investigated wheats. There is also a not significant impact in the overall interaction by regarding genotype and environment.”

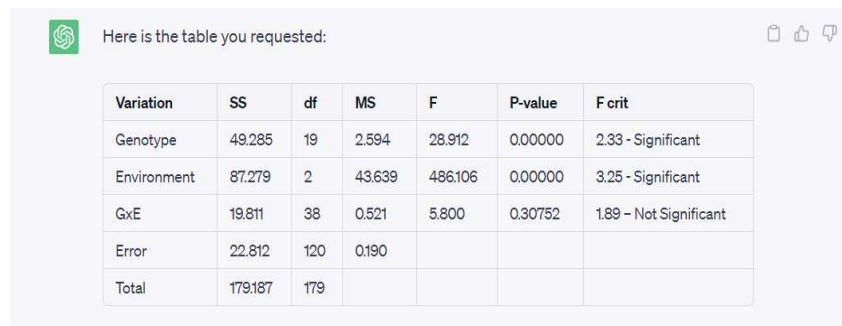


Figure 1. How ChatGPT generated wheat grain yield two-way ANOVA analysis.

1. Define the Null and Alternative Hypotheses: Determine the null hypothesis (H0) and alternative hypothesis (Ha) for each factor and their interaction. Typically, the null hypothesis assumes that there is no significant difference between the factor levels or their interaction, while the alternative hypothesis assumes the presence of a significant difference.
2. Calculate the Sum of Squares (SS): Calculate the sum of squares for each factor and their interaction using the formula: $SS = \sum (X_i - \bar{X})^2$, where X_i represents each individual value and \bar{X} is the overall mean.
3. Calculate the Degrees of Freedom (df): Determine the degrees of freedom for each factor and their interaction. The degrees of freedom are calculated as the number of levels minus 1.
4. Calculate the Mean Squares (MS): Compute the mean squares for each factor and their interaction by dividing the sum of squares by the respective degrees of freedom: $MS = SS / df$.
5. Calculate the F-statistic: Compute the F-statistic for each factor and their interaction using the formula: $F = MS(\text{factor}) / MS(\text{error})$. The F-statistic represents the ratio of variability between groups to the variability within groups.

Figure 2. How ChatGPT describe theoretically two-way ANOVA analysis (just part).

EXAMPLE 1: Correlation analysis to wheat grain yield and elements of productivity.

Question: We directly enter a database from MS Excel.

ChatGPT:

Table 3. Correlation analysis to wheat grain yield and elements of productivity generated by ChatGPT.

	NPT	TKW	WGS	NGS	GY
NPT	1				
TKW	0,13	1			
WGS	-0,55**	0,18	1		
NGS	-0,47**	-0,69**	0,57**	1	
GY	0,27*	0,27*	0,63**	0,26*	1

Table 4. Correlation analysis to wheat grain yield and elements of productivity from publication.

	NPT	TKW	WGS	NGS	GY
NPT	1				
TKW	0,13	1			
WGS	-0,50**	0,12	1		
NGS	-0,41**	-0,63**	0,55**	1	
GY	0,29*	0,30*	0,66**	0,20*	1

* is placed next to the coefficients that are statistically significant at the significance level of 0.05 (5% significance). ** is placed next to the coefficients that are statistically significant at the significance level of 0.01 (1% significance).

ChatGPT: “Overall, the results indicate that TKW and GY have the strongest and most statistically significant correlations. This suggests that the thousand kernel weight and weight of grain per single class are important factors influencing the yield of common wheat varieties. However, further analysis and interpretation are required to determine the precise nature and the direction of these relationships.” ChatGPT can perform basic statistical analyses commonly used in such studies, which adequately align with the developments implemented in other

statistical software. The initial data can be directly provided from an Excel sheet within the chat. The AI could explain step-by-step the methods by which it generates the results of the analysis, allowing the author to grasp the essence of the specific statistical approach. ChatGPT presents the obtained dependencies from the statistical analyses in a user-friendly manner. Additionally, it interprets and comments on the results, which can serve as a basis for understanding the processes related to the specific research topic and further development of the author's thesis.

CONCLUSIONS

Benefits:

Fast, intuitive, and easy-to-use with ChatGPT.

Available in a wide range of languages, enabling direct text generation in specific language without the need for an additional translator.

Offers a broad range of capabilities for mathematical and statistical processing.

Demonstrates good analytical skills when providing commentary on specific issues.

Free to use, unlike expensive statistical packages.

Drawbacks:

Sometimes there is a misinterpretation of the given question, which requires to additional clarifying questions.

It is unable to generate graphs directly but can provide Python code (<https://www.python.org/>) for that purpose. This necessitates the author to have basic IT knowledge and install PyCharm (<https://www.jetbrains.com/pycharm/>) as an additional tool.

In some cases, there may be inaccuracies in the interpretation of the results, which requires careful review of the information provided by the Chatbot.

ChatGPT cannot fully replace a researcher in writing a scientific article, but it can be a valuable assistant throughout the creative process, contributing to its improvement and efficiency.

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RESEARCH ON THE PRODUCTION CAPACITY OF TWO VARIETIES OF ALFALFA AT S.C.D.A. CARACAL

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Abstract

In recent years, after an alarming decrease in livestock numbers, which led to a significant reduction in the areas cultivated with fodder plants, in the coming years we expect a spectacular recovery of these aspects.

The superiority of alfalfa compared to other fodder crops is primarily explained by the high fodder productions, by the superior quality of the fodder produced and by the ability to produce several years in a row without being reseeded.

Key words: alfalfa, biodiversity, fodder crops

INTRODUCTION

Alfalfa has several cultivation advantages, namely:

- very high tolerance to low winter temperatures (-25⁰C);
- good drought tolerance, with a favorable response to irrigation;
- it is a great fixer of atmospheric nitrogen, from which the following crops in the rotation benefit;
- it has a very high degree of regeneration, obtaining between 4-6 mows/year;
- it is a component in the establishment of meadows, along with grasses;
- it is a good entomophilous plant which contributes to the biodiversity of useful entomofauna

Through the research theme, the following objectives were pursued:

- the effect of organic and chemical fertilization on the productivity and quality of alfalfa in pure culture under irrigation, on clay-illuvial from S.C.D.A. Caracal;
- the performance of some alfalfa varieties (Ileana and Catinca) in pure culture under irrigation on clay-illuvial from S.C.D.A. Caracal;
- the effect of some mechanical maintenance works of alfalfa under irrigation conditions on clay-illuvial from S.C.D.A. Caracal;
- chemical control of weeds in alfalfa culture on clay-illuvial from S.C.D.A. Caracal.

Some of the pursued objectives are unique on a national level, and others only for the hilly area of Oltenia.

MATERIALS AND METHODS

In the 2020 agricultural year, at S.C.D.A. Caracal an experience with alfalfa varieties and lines belonging to I.N.C.D.A. Fundulea.

The aim was to test new alfalfa genotypes, under irrigation conditions, in the area of influence of S.C.D.A. Caracal.

The experiment was laid out according to the method of randomized blocks, with 10 variants in 3 replications. The area of an experimental plot was 10 m² (10 m long and 1 m wide).

RESULTS AND DISCUSSIONS

Experiment outline:

P	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	P
Alee											
P	V5	V8	V10	V7	V3	V4	V9	V2	V6	V1	P
Alee											
P	V3	V2	V5	V6	V8	V7	V4	V1	V9	V10	P

During the vegetation period, observations and determinations were made. 4 mows were harvested, the production of green

mass and dry substance being presented in the following tables. Thus, during the year

2022, determinations were made on April 17, June 15 and July 13. On all these 3 dates, determinations were made regarding:

- Number of internodes;

- The length of the shoots;
- Production of 10 shoots without leaves;
- Production of 10 shoots with leaves;
- Production of dry matter;
- Green mass production.

Table 1

The influence of the variety on the no. of internodes in the alfalfa culture in an experiment carried out at SCDA Caracal on April 17, 2022

Variant	Nr. of internods	%	Difference	Sign
V1-Catinca	9	100%	ctrl	
V2-Ileana	8.133333	90.37037	-0.86667	
V3-2020	9.066667	100.7407	0.066667	
V4-2905	8.8	97.77778	-0.2	
V5-2906	8.8	97.77778	-0.2	
V6-2907	8.366667	92.96296	-0.63333	
V7-2908	8.333333	92.59259	-0.66667	
V8-2909-1	8.333333	92.59259	-0.66667	
V9-2909-2	8.2	91.11111	-0.8	
V10-2910	8.733333	97.03704	-0.26667	
DL5%	2.41			
DL1%	3.31			
DL0.1%	4.51			

Table 2

The influence of the variety on the length of the shoots in the alfalfa crop in an experiment carried out at SCDA Caracal on April 17, 2022

Variant	Shoot lenght, cm	%	Difference	Sign
V1-Catinca	38.6	100%	ctrl	
V2-Ileana	35.76667	92.65976	-2.83333	
V3-2020	33.76667	87.47841	-4.83333	
V4-2905	37.8	97.92746	-0.8	
V5-2906	34.66667	89.81002	-3.93333	
V6-2907	31.73333	82.21071	-6.86667	0
V7-2908	37.06667	96.02763	-1.53333	
V8-2909-1	34.76667	90.06908	-3.83333	
V9-2909-2	35.33333	91.53713	-3.26667	
V10-2910	37.23333	96.45941	-1.36667	
DL5%	6.18			
DL1%	8.47			
DL0.1%	11.53			

Table 3.

The influence of the variety on the production of 10 leafless shoots in the alfalfa crop in an experiment carried out at SCDA Caracal on April 17, 2022

Variant	Prod. Of 10 shoots without leaves	%	Diferența	Sign
V1-Catinca	7.666667	100%	mt	
V2-Ileana	8.333333	108.6957	0.666667	
V3-2020	8.666667	113.0435	1	

V4-2905	9.666667	126.087	2	
V5-2906	10.66667	139.1304	3	
V6-2907	8.666667	113.0435	1	
V7-2908	8	104.3478	0.333333	
V8-2909-1	9.333333	121.7391	1.666667	
V9-2909-2	8.333333	108.6957	0.666667	
V10-2910	7	91.30435	-0.66667	
DL5%	2.23			
DL1%	3.05			
DL0.1%	4.16			

Table 4

The influence of the variety on the production of 10 shoots with leaves in the alfalfa crop in an experiment carried out at SCDA Caracal on April 17, 2022

Varianta	Prod. 10 lastari cu frunze	Producția relativă, %	Diferența	Semnificația
V1-Catinca	17.33333	100%	mt	
V2-Ileana	17.33333	100	0	
V3-2020	17.33333	100	0	
V4-2905	19.66667	113.4615	2.333333	
V5-2906	20	115.3846	2.666667	
V6-2907	19.33333	111.5385	2	
V7-2908	16	92.30769	-1.33333	
V8-2909-1	20	115.3846	2.666667	
V9-2909-2	17.66667	101.9231	0.333333	

V10-2910	15.66667	90.38462	-1.66667	
DL5%	4.58			
DL1%	6.28			
DL0.1%	8.55			

Table 5

The influence of the variety on the production of dry matter in the alfalfa crop in an experiment carried out at SCDA Caracal on April 17, 2022

Variant	Dry matter	%	Difference	Sign
V1-Catinca	102.3333	100%	mt	
V2-Ileana	98	95.76547	-4.33333	0
V3-2020	100.3333	98.0456	-2	
V4-2905	99	96.74267	-3.33333	
V5-2906	98.33333	96.09121	-4	0
V6-2907	98.66667	96.41694	-3.66667	
V7-2908	101.3333	99.0228	-1	
V8-2909-1	100	97.71987	-2.33333	
V9-2909-2	99	96.74267	-3.33333	
V10-2910	101.3333	99.0228	-1	
DL5%	3.94			
DL1%	5.40			
DL0.1%	7.35			

Table 6

The influence of the variety on the production of green mass in the alfalfa crop in an experiment carried out at SCDA Caracal on April 17, 2022

Variant	Yield, kg/plot	%	Difference, kg	Sign
V1-Catinca	18.33333	100%	mt	
V2-Ileana	21	114.5455	2.666667	
V3-2020	20	109.0909	1.666667	
V4-2905	18.33333	100	0	
V5-2906	18.33333	100	0	
V6-2907	18.5	100.9091	0.166667	
V7-2908	19.66667	107.2727	1.333333	
V8-2909-1	17	92.72727	-1.33333	
V9-2909-2	17	92.72727	-1.33333	
V10-2910	18	98.18182	-0.33333	
DL5%	3.10			
DL1%	4.25			
DL0.1%	5.78			

CONCLUSIONS

Green mass productions were between 63.5 at the F 2020 line and 72.2 t/ha at the F 2910 line, and the U.S. productions being between 12.01 t/ha s.u at line F2909-2 and 14.20 t/ha s.u. at F2910 t/ha s.u.

The highest production is realized at the F 2910 line of 72.2 t/ha. The control variety Catinca was surpassed by the variety Ileana and the lines F2906, F2907, F2909-1, F2910 with increases in green mass production between 1-12%, the largest increase being achieved by F2910, while

the lines F2020, F2905, F2908, F2909-2 recorded production of green mass below the level of the Catinca control by up to 2%. Regarding the production of dry matter, it was observed that compared to the Catinca control, only the F Ileana variety and the F2907, F2909-1, F2910 lines recorded production increases between 3-11%, while the F2020, F2905, F2908 lines, F2909-2 recorded decreases in dry matter production compared to the control. It is noteworthy that the F2906 line, compared to the control, although it

obtained a 1% increase in green mass production, in terms of dry mass production, it was placed below its level

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COMPARATIVE STUDIES OF BLAUFRÄNKISCH VARIETY IN SERBIA AND AUSTRIA

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Abstract

Blaufrankisch is a red wine grape variety widely grown in Austria, Hungary, Serbia, Slovakia, etc. The aim of the study was to determine the influence of ecological factors that two different locations have on the grape characteristics of Blaufrankisch variety, such as: the mechanical composition of the grape berries and the chemical characteristics of grape juice. For this study, 10 vines from microlocality of Pavlovci in the Srem region, Serbia, and the Agneshof and Gotzhof microsites in Klosterneuburg, Lower Austria. The ampelographic composition of the grapes and berries showed the following comparison: the grapes from the two Austrian sites (Agneshof and Götzhof) had a greater average cluster mass (356.96 g and 302.95 g, respectively), while Blaufrankisch grapes from Serbia had an average cluster mass of 170.6 g. The difference in the weight of seeds in 100 berries is small in Serbian grapes (5.48 g) compared to Austrian (7.2 g and 5.6 g). Where Austrian berries have major variation in skin percentage (6,7% and 7,2%) which is more than double the value of Serbian

skin percentage in berries (3,3%). The values of sugar content in grape must showed slight differences in Austrian grapes (22.4%) and Serbian grapes (23.6%). Overall, the research results show that Austrian grapes grown in Klosterneuburg achieved more favorable results in most of the measured parameters.

Key words: *Blaufränkisch, mechanical composition, grape juice, Serbia, Austria*

INTRODUCTION

Blaufränkisch is a red wine grape variety widely grown in Austria, Hungary, Serbia, Slovakia, etc. It is also known under the synonyms Limberger, Frankovka, Modra Frankinja. It is known for its high acidity and tannin content and produces wines with a range of aromas from dark fruits and spices to earthy and mineral notes. This grape variety was originally introduced to Austria in the 18th century. In the 19th century, it appeared in Germany under the names Lemberger or Limberger, which originated in the town of Limberg in Lower Austria. Blaufränkisch (Frankovka) was brought to Serbia in the 19th century and is grown mainly in the Srem region.

It is described as a grape variety with a vigorous trunk. The tip of a young shoot is brown-red. The mature shoot is medium or thick, with medium-length internodes, the nodes are darker in colour. The leaf is large, usually entire, dark green. In autumn, it turns shades of red (Nakalamic, 1998).

The flower is morphologically and functionally hermaphrodite. The bunch is medium sized, cylindrical or cylindrical-conical, medium compact. The berry is medium-sized, round, dark blue with a thick skin, abundantly sprinkled with ash. The grapes ripen in the III epoch and the yield of the grapes can vary between 12-20 t/ha.

As for disease resistance, it is moderately resistant to powdery mildew and downy

mildew (*Plasmopara viticola* and *Uncinula necator*). It is relatively resistant to gray mold (*Botrytis cinerea*). It has good resistance to low winter temperatures up to 20 to -22 °C.

The qualitative characteristics of the grape must are usually between 18-24% sugar and 6-9g/l total acids (Žunić and Garić, 2017).

The Srem region is an important part of Serbia for grape growing and production of high quality wines. According to historical information, one of the first vineyards in ancient Serbia was planted in the Srem region (Markovic, 2023).

According to a 2012 agricultural census, there were 2142 hectares of vineyards in the Srem region, of which 1812 hectares were planted with grape varieties for wine production (Table 1). There are 2170 individual grape growers, which accounts for 5.7% of agricultural activity in this region.

Table 1. Area under vineyards in Serbia and in Srem region

	Total (ha)	Wine varieties (ha)	Table varieties (ha)
Serbia	22.150	17.483	4.667
Srem	2.142	1.812	330
%	100	78.92	21.08

Niederösterreich (Lower Austria) is Austria's largest wine growing region, that

produces high quality wines. This region is associated with different origins and styles of wine produced from domestic and international grape varieties. Lower Austria can be divided into three rough climatic zones: the Weinviertel in the north, the Danube region and its side valleys west of Vienna, and Niederösterreich (Lower Austria) with its Pannonian climate in the southeast.

Austria has a vineyard area of about 44,728 hectares, with Lower Austria occupying the largest part of this area with 27,074 hectares. The Weinviertel is the sub-region belonging to Lower Austria, covering about 14,000 ha and producing a remarkable variety of wines.

MATERIALS AND METHODS

The research was conducted in both Serbia and Austria. The part of the study which was done in Serbia took place in an experimental vineyard of the winery "Komuna", located on the southern slopes of the mountain Fruška Gora (45.05°N 19.82°E). The vineyard consists of a large number of wine and table varieties and clones. Spacing between rows is 1.5 m and between vines 0.9 m. The trellises were constructed from wooden poles and wire to allow optimal distribution of shoots, leaves and grapes in the space, while ensuring good exposure to sunlight. The training system was the Guyot pruning. In Austria, the examination took place at the Hoehere Bundeslehranstalt und Institut fuer Obst- und Weinbau in Klosterneuburg. Grape samples were taken at two locations. An experimental vineyard in Klosterneuburg (Lower Austria) called "Agneshof" (48.31°N 16.33°E). Another experimental vineyard on the other side of the Danube is located near the town of Korneuburg and is called "Götzhof"

(48.32°N 16.37°E). It is located in the sub-region of Lower Austria - Weinviertel. Both vineyards belong to the institute. The distance between rows is 2.5 m between rows and 0.8 m between vines.

For this study, 10 grapevines from the Pavlovci microlocation in the Srem region, Serbia, and the Agneshof and Gotzhof microlocations in Klosterneuburg, Lower Austria, were examined separately.

Mechanical composition of grapes and berries was determined in both countries according to the method of Marković and Pržić (2020). The weight, length, and width of each cluster were measured, and the rachis (pedicel) of each berry was carefully removed with scissors, taking care to leave as little mesocarp on the stem as possible. The number of berries per cluster was also recorded, and the mass of the berries and the mass of the stems were measured with an analytical balance.

A total of 10 clusters were randomly selected at each location for the experiment. Various measurements were made in a controlled laboratory environment, including cluster mass, number of berries in the cluster, mass of all berries in the cluster, and length and width of the cluster. The weight of each berry was also determined.

A random sample of 100 berries was taken for berry analysis. The seeds, skin, and mesocarp were mechanically separated using jute cloth. The berry skin and seeds were air dried and their weight was measured. The number and weight of seeds were also recorded. In addition, the mechanical composition of the berries was determined by determining the mass of 100 berries, the mass of the berry skin of 100 berries, the mass of the seeds of 100 berries, and the mass of 100 seeds.

The sugar content of the grape must was determined by the Oechsle mostwage (Oe) and the total acidity by the titration method using 0.1M NaOH. In Austria, on the other hand, the Klosterneuburger mostwage (KMW) was used to analyze the sugar content of the grape must with the Oenofoss analyzer together with the total acidity.

The working principle of Oechsle mostwage is based on determining grape must density which is measured in Oechsle degrees (°Oe). Degrees Oechsle represent the difference between water density and must density on 4°C. The results of the sugar content are typically presented as a percentage.

The following formula is used to determine the sugar content:

$$\% \text{ of sugar} = (\text{°Oe} * 0.266) - 3$$

The total acidity was determined by a titration method using 0.1 NaOH. The working principle of determination of total acidity in grape must is based on neutralisation of all acids with NaOH solution. Phenolphthalein was used as a colour indicator. The must was titrated with NaOH solution until the colour changed from light red to dark green. The total acidity was then determined using the following formula:

$$\text{Total acidity (g/l)} = \text{NaOH used} * F * 0.75$$

F - normality factor of the NaOH solution

In Austria, the qualitative specifications of grape must were analysed using the Oenofoss instrument for measuring various parameters. It was specifically designed for the analysis of wine and grape must at different stages of production. The Oenofoss wine analyzer uses near-infrared spectroscopy (NIR) technology for rapid and non-destructive

analysis of key parameters in wine and grape must. The key parameters such as sugar, total acidity and pH were analysed.

RESULTS AND DISCUSSIONS

Climate conditions

Grapevine ecology encompasses the combined effects of external factors on vine growth and productivity. It includes the study of climatic and soil conditions specific to the area where the vine is grown. These environmental factors directly affect various aspects of grapevine development and yield. Climate, including temperature, precipitation, solar radiation, humidity and wind conditions, has a significant impact on the life cycle of grapevines. The climate factors of the Srem region and the Lower Austria region have been measured over the last 20 years and can be considered representative for this study. The climatic factors considered in this study are: temperature, humidity, and precipitation. The Srem region is classified as temperate-continental, as is Lower Austria. These regions have four distinct seasons with temperate to cold winters and warm to hot summers.

Climate in Srem region and Lower Austria

Temperature data for the last two decades are as follows: average annual temperature was 16.8°C, while in Lower Austria it was 14.6°C. The average coldest month for both countries was January (average minimum temperature of -3.6°C for the Srem region and -3°C for Lower Austria), and the warmest months were also July and August for both (average monthly maximum temperatures of 27.8°C and 27.9°C for Srem and 25.5°C and 25.2°C for L.A.).

The temperature results show that both regions are suitable for grape growing since the coldest period of the year is the time when grapevine is in dormancy and the resistance to low temperatures is the highest, so there is no greater risk of frost damage.

During the studied period, the average annual humidity in the Srem region was 76%. Conversely, the data show that humidity in Lower Austria is constantly high from May to September, averaging 76%, which has a significant impact on the development of grapes. In the Srem region, however, humidity is highest in December and January, at 88% and 87%, respectively.

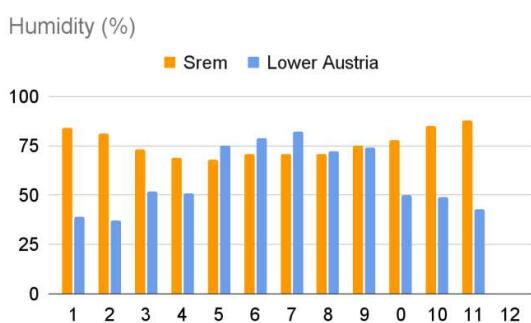


Figure 1. Average monthly humidity for the period of the past 20 years.

Vine water balance depends on soil texture, stone content, rooting depth, rainfall, reference evapotranspiration (ET₀), and leaf area. Water deficit affects photosynthesis and shoot growth and reduces berry size (van Leeuwen et al., 1994, Van Leeuwen and Darriet, 2016). It increases the content of tannin and anthocyanins in grapes. The average annual precipitation for the period studied was about 58 mm in Lower Austria. In particular, from May to September, the precipitation amounts are constantly above 72 mm, indicating a relatively high precipitation amount during this period. In

contrast, the average annual precipitation in the Srem region is 51 mm, with the highest value being reached in June.

The Srem wine region is generally favourable for precipitation. High rainfall in June has a positive effect on the phenophase of the berries (Lorenz et al, 1994), as the berries need a lot of water during this period. Low rainfall in late summer and early fall is also important as it affects the ripening of the berries and results in higher concentrations of sugars, acids and other aromatics in the grapes, which can improve the overall flavour profile of the resulting wine. Excessive rainfall in August and September, as occurred in Lower Austria, can lead to an enlargement of the berries and a dilution of the aroma compounds in the grapes. This can result in less concentrated and less flavorful wines.

Due to favourable climatic and soil conditions, all three microsites are suitable for growing a wide range of grape varieties, including Blaufränkisch. A common factor of these microsites is their proximity to the Danube.

Mechanical composition of cluster and berries

The ampelographic composition of the grapes and berries showed the following comparison: the grapes from the two Austrian sites (Agneshof and Götzhof) had a greater average cluster mass (356.96 g and 302.95 g, respectively), while the Blaufränkisch grapes from Serbia had an average cluster mass of 170.6 g. The grapes from the two Austrian sites (Agneshof and Goetzhof) had a greater average grape mass (356.96 g and 302.95 g, respectively). The average number of berries in a cluster was (99.0) for the

Serbian grapes, while grapes from Austria had significantly more berries per cluster (153.0 and 161.6). The average cluster mass for Austrian grapes was (339.18 g and 271.56 g), which is almost twice the mass of the Serbian grapes (164.2 g). The average skin mass in 100 berries was also higher in Austrian grapes (14.7 g and 14.2 g). The number of seeds in 100 berries was significantly higher in Austrian grapes (243.0 and 225.0). The difference in the weight of seeds in 100 berries is small in Serbian grapes (5.48 g) compared to Austrian (7.2 g and 5.6 g).

The percentage of mesocarp in berries is slightly higher for Serbian grapes (93.6%) than for Austrian grapes (just under 90% for both locations). The biggest difference is in the percentage of berry skin, which is twice as high in Austrian grapes (6.7% and 7.2%) than in Serbian grapes (3.3%). Higher skin content in berries may contribute to more intense color, flavor, and tannic characteristics in the resulting wine, as well as more aromatic and phenolic compounds. The results of seed content were different for all three sites, with Serbian grapes (3%) reaching the medium value and Austrian grapes (3.3% and 2.8%).

Table 2. Mechanical composition of berries

%	Komuna	Agneshof	Götzhof
Mesocarp	93,6	89,9	89,8
Skin	3,3	6,7	7,2
Seeds	3,0	3,3	2,8

The berry skin is an important structural element as it contains phenolic compounds that are extracted from the wine, giving it

colour and odour (Zivkovic et al., 2006; Zdunic et al., 2019).

The values of sugar content in grape must showed slight differences between Austrian (22.4%) and Serbian grapes (23.6%). Total acidity was lower in Austrian grapes (7.8 g/l and 7.0 g/l) than in Serbian grapes (8.4 g/l). Overall, the test results show that Austrian grapes from Klosterneuburg achieved more favourable results in most of the measured parameters.

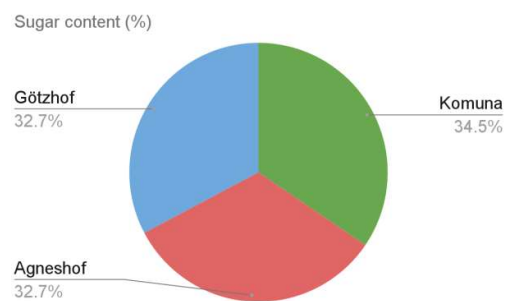


Figure 1. Chemical composition of grape must (sugar content)

CONCLUSIONS

Considering the ecological and agrobiological factors, the observations lead to the following conclusions:

- Based on the climatic data analysis conducted over the past two decades, it can be inferred that Lower Austria has experienced a higher cumulative precipitation compared to the Srem region.
- The Srem region tends to have higher overall moisture, with a pronounced peak during the winter period, while Lower Austria experiences its moisture peaks during the summer period.
- There is a significant difference in grape mass for grapes grown at two locations in Lower Austria compared to grapes grown in the Srem region.
- the percentage of berry skins is significantly higher in Austrian grapes.

-the sugar and acidity content of the grapes from all sites suggests that all sites meet the standards for the production of high quality red wines.

-the microclimatic conditions played an important role in the final results of the qualitative parameters of grapes and berries in both countries.

ACKNOWLEDGEMENTS

The research was financed by the Ministry of Education, Science and Technological Development, Republic of Serbia, project ref. numbers: 451-03-47/2023-01/200116.

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THE INFLUENCE OF YOUNG CANES REMOVAL ON FIELD PERFORMANCE AND FRUIT QUALITY OF "WILLAMETTE" RASPBERRY (*Rubus idaeus* L.)

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Abstract

The objective of this study was to evaluate the effects of different young cane removal treatments on yield components, fruit quality characteristics, and vegetative growth of the raspberry cultivar 'Willamette'. The trial was conducted in a commercial raspberry orchard in the village of Ušće (the municipality of Kraljevo, central Serbia). The orchard was established in 2014 in the form of a vertical trellis system with pillars and 2 lines of single wire. The planting distance was 0.25 m in the row and 3.0 m between rows. The experimental design was completely randomized and studied the influence of the following treatments: I) single removal of young canes (R); II) twice removal of young canes (2R); III) three-time removal of young canes (3R); IV) control treatment (without removing the first series of young canes). The applied treatments resulted in changes in the parameters of generative and vegetative potential, as well as in the characteristics of fruit quality of the tested cultivar. The highest number of fruiting branches, inflorescences, and fruits on the floricanes was recorded in 3R treatment (32.7, 89.0, and 272, respectively), as well as the highest yield per cane and linear meter (697 g and 4.1 kg, respectively). In contrast, the lowest values of generative parameters were obtained in the control treatment.

The 3R treatment resulted in a significant increase in the fruit weight (5.1 g) and soluble solids content (10.5%). Total acids content reached the highest value in the control treatment (0.70%), while vitamin C content was slightly higher in R treatment (27.03 mg/100 g fresh weight). The highest number of primocanes per linear meter was found in the control treatment (34.0), where canes were tallest and had the most nodes (260 cm and 50.0, respectively). This comprehensive study found that 3R treatment increased yield and fruit quality characteristics of the raspberry cultivar tested in current season, but vegetative growth and yield potential of canes left for the following season are reduced.

Key words: *raspberry, pruning, yield components, fruit quality, vegetative traits*

INTRODUCTION

The Republic of Serbia is one of the world's leading producers and exporters of raspberries, with an average annual production of 117,214 tons in the last five years. More than 90% of raspberries produced are exported frozen to foreign markets, while the export of fresh raspberries is almost negligible. Although the total area under raspberry cultivation has increased to 20,807 ha, the average yield per hectare has steadily decreased and in 2021 was 5.3 tons (FAOSTAT, 2023). Therefore, continuous improvement and intensification of agricultural practices in raspberry orchards is necessary. One of the main elements of improving the cultivation technology is the careful balancing of the vegetative and generative growth of raspberry plants.

Raspberries form biennial canes that are vegetative the first year (primocanes) and fruitful the second (floricanes). The primocanes, arising in the spring from the basal buds of old canes, have intensive growth during the spring and the first half of summer. The following year, these canes produce fruiting laterals and become floricanes, which die soon after fruiting and should be removed at any time before the following spring. As both types of cane simultaneously exist in the trellis, there is a large competition between the vegetative growth of primocanes and the reproductive phase of floricanes (Poledica et al., 2012).

This unique growth habit makes pruning raspberry plants somewhat challenging, as primocanes begin to grow first and can become too vigorous by the end of the growing season; therefore removing them in the spring is a traditional method of controlling raspberry growth, providing adequate space, light, and nutrients for later-developing canes. This management practice can be performed several times in the spring. As reported before (Waister and Cormack, 1977), the removal of young raspberry canes increased the yield of the floricanes. Nenadić (1986) confirmed that completely removing the first series of primocanes until flowering starts on the floricanes has a positive influence on yield, fruit quality, and disease prevention. Therefore, the aim of this study was to evaluate the effect of young canes removal treatments on yield components, fruit quality traits, and vegetative growth of the raspberry cultivar 'Willamette'.

MATERIALS AND METHODS

The experiment was conducted during 2020 in a commercial raspberry orchard of cultivar "Willamette" in the village of Ušće (the municipality of Kraljevo, central Serbia). The orchard was established in 2014 in the form of a vertical trellis system with pillars and 2 lines of single wire. The planting distance was 0.25 m in the row and 3.0 m between rows. The experimental design was completely randomized and the following treatments were applied: I) single removal of young canes (R); II) twice removal of young canes (2R); III) three-time removal of young canes (3R);

IV) control treatment (without removing the first series of young canes).

The first series of young canes were removed once in the middle of April, the second time at the beginning of May, and the third time in the middle of May. In each treatment, all young canes were cut at ground level when they were 30 cm tall. The experimental design was completely randomized with 3 replications per treatment. Each treatment was applied in 3 rows, where each row represents 1 replication covering a 10-m length of trellis. Five randomly selected canes per replication were investigated (15 canes per treatment).

Beginning of ripening (10% of fruits are ripe and can be easily removed from the plant) and end of ripening (date of the last harvest) were registered. Generative characteristics were studied by counting the number of fruiting laterals, inflorescences, and fruits per floricanes and weighing the harvested fruit to determine yield per cane (g). Yield per linear meter (kg) was calculated as a product of cane number per meter and yield obtained per cane for each harvest date. Investigation of vegetative characteristics (length of canes (cm), cane diameter (mm), number of nodes per meter of cane, and total number of nodes per cane) was carried out on primocanes in autumn of 2020.

To assess fruit quality, fruits were picked at the commercial maturity stage in the second harvest. A sample of 50 fruits per replication (10 fruits per cane) was used for the fruit quality assessment. The fruit fresh weight was measured by technical scale with a sensitivity of ± 0.01 g (Acom JW-1, Korea). Two linear dimensions, height and width (in mm) of each fruit were measured using a digital caliper Prowin (China), while the ratio of the

maximum height and width was presented as an index of fruit shape. A previously frozen fruits from each replication were homogenized by liquid nitrogen to analyze soluble solids content (SSC), total acids (TA), and vitamin C content. SSC was determined using a digital refractometer (Pocket PAL-1, Atago, Japan). TA was measured using a digital burette and 0.1 M NaOH to titrate samples to an endpoint of 8.1. Acidity was based as a percentage of malic acid equivalent. Vitamin C was quantified using a reflectometer set (Merck RQflex, Merck KGaA, Germany) as described by Pantelidis et al. (2007). Results were expressed as mg ascorbic acid 100 g^{-1} of fresh weight (FW).

A statistical analysis was performed by ANOVA using software Statistica 8.0 for Windows (StatSoft Inc., USA). Significant differences among the means were determined by a least significant difference (LSD) test at a level of $P \leq 0.05$.

RESULTS AND DISCUSSION

The fruit ripening of "Willamette" cultivar started on June 19th and ended on July 16th (data not shown). The harvest lasted 27 days, which is 10 days shorter compared to duration of the harvest under ecological conditions of the municipality of Krupanj (Poledica, 2014). Milivojević et al. (2012) reported that the ripening of the "Willamette" cultivar begins on June 6th and ends on July 4th, while the duration of this phenophase in the conditions of the Belgrade region was 29 days.

The highest number of fruiting branches on floricanes was observed in the 3R treatment (32.7), in which young canes were pruned three times (Table 1). The control treatment, in which no pruning of young canes was performed, had the lowest number of fruiting branches on

floricanes (21.3). According to Poledica (2014), the combined foliar application of the gibberellin synthesis inhibitor prohexadione-Ca and pruning of young canes significantly increased the number of fruiting branches per floricane (14.3), but is still two-fold lower than the results obtained in this study. The number of inflorescences per floricane also varied by the treatment, ranging from 41.7 (control

treatment) to 89.0 (3R). Treatments 2R and 3R significantly increased the number of fruits (267; 272) and yield per floricane (621 g; 687 g), respectively. The lowest values for these parameters were found in the control treatment (180 and 424 g, respectively). Yield per linear meter was also highest in the 3R treatment (4.13 kg).

Table 1. The effects of young cane removal treatments on yield components of raspberry cultivar "Willamette"

Treatment	Number of fruiting branches per floricane	Number of inflorescences per floricane	Number of fruits per floricane	Yield per floricane (g)	Yield per linear meter (kg)
Control	21.3±1.20b	41.7±2.60c	180±5.29c	424±37.2b	2.53±0.15b
R	28.3±2.03a	53.3±3.76bc	212±4.16b	462±30.3b	2.67±0.18b
2R	29.3±1.45a	57.3±3.18b	267±8.96a	621±50.2a	3.70±0.12a
3R	32.7±1.45a	89.0±5.69a	272±8.39a	687±65.2a	4.13±0.24a
F-test	**	**	**	*	**

Data are the means of three replications ± standard error. Values within column followed by the same letter are not significantly different at $P \leq 0.05$ (LSD test). ** $P < 0.01$; * $P < 0.05$. R) single removal; 2R) twice removal; 3R) three-time removal; control (no removing the first series of young canes).

Table 2. The effects of young cane removal treatments on vegetative potential of raspberry cultivar "Willamette"

Treatment	Number of primocanes per linear meter	Primocane length (cm)	Primocane diameter (mm)	Number of nodes per primocane	Internode length on primocane (cm)
Control	34.0±0.58a	260±5.77a	9.00±0.58a	50.0±1.53a	5.17±0.03a
R	32.0±2.08a	250±5.77b	8.00±0.58ab	48.0±1.15ab	5.17±0.03a
2R	27.0±0.58b	230±5.77c	7.00±0.58bc	46.0±0.58b	5.00±0.06a
3R	24.0±0.58b	180±5.77d	6.00±0.58c	40.0±1.15c	4.50±0.29b
F-test	**	**	*	**	*

Data are the means of three replications ± standard error. Values within column followed by the same letter are not significantly different at $P \leq 0.05$ (LSD test). ** $P < 0.01$; * $P < 0.05$. R) single removal; 2R) twice removal; 3R) three-time removal; control (no removing the first series of young canes).

The number of primocanes per linear meter and primocane length increased significantly in the control treatment (34.0 and 260 cm, respectively), whereas the lowest primocane diameter, number of nodes, and internode length of primocane

were observed in the 3R treatment (Table 2). Poledica (2014) reported that the first and second removal of young canes had no significant effect on the primocane height, diameter, and number of nodes compared to the control treatment. Removal of young

canes should be performed depending on the vigor of the cultivar and climatic conditions in the growing area. This measure is less necessary for the cultivars with lower cane production ("Tulameen," "Mekeer") than for cultivars where high cane production leads to lower yield and fruit quality ("Willamette"). Since the main objective in raspberry production is to obtain the highest possible yield per unit area, it is essential to balance the generative and vegetative potential to ensure a high yield the following year.

In addition to the agronomic performance of raspberries, the biometric and chemical characteristics of the fruit are also considered important factors, generally related to consumer perception of the fruit quality. The physical characteristics of raspberry fruit are an important quality attribute that can be used to assess the suitability of the fruit for specific purposes. In our research (Table 3), the 3R

treatment resulted in a significant increase in fruit weight (5.1 g), while the smallest fruits were found in the control and R treatments (3.6 g). Fruit height and width were also highest in the 3R treatment (21.3 mm and 22.5 mm, respectively), while the lowest values were recorded in the R treatment (17.8 mm and 18.6 mm, respectively). The main reason that the physical fruit parameters are highest in the 3R treatment, in which the young canes are cut three-times, is that the plant directs more nutrients to fruit development. However, such an approach to raspberry cultivation can lead to weak growth of the later developed canes, which does not ensure a high yield in the following season. Fruit shape index ranged from 0.94 (2R treatment) to 0.99 (control treatment), corresponding to predominantly angular-round to round fruit shapes.

Table 3. The effects of young cane removal treatments on physical fruit traits of raspberry cultivar "Willamette"

Treatment	Fruit weight (g)	Fruit length (mm)	Fruit width (mm)	Index of fruit shape
Control	3.57±0.12b	18.7±0.40b	18.9±0.09b	0.99±0.025
R	3.57±0.12b	17.8±0.45b	18.6±0.56b	0.96±0.006
2R	3.80±0.26b	18.7±0.48b	20.0±0.53b	0.94±0.018
3R	5.07±0.24a	21.4±0.66a	22.5±0.58a	0.95±0.023
F-test	**	**	**	ns

Data are the means of three replications ± standard error. Values within column followed by the same letter are not significantly different at $P \leq 0.05$ (LSD test). ** $P < 0.01$; ns – not significant. R) single removal; 2R) twice removal; 3R) three-time removal; control (no removing the first series of young canes).

Raspberry fruits are one of the most popular fruits because of their pleasant flavor which is the result of the biosynthesis of phytochemicals, such as sugars and acids. The ratio of sugars to organic acids determines the balance between soluble solids and titratable acidity, which in turn influences fruit flavor and taste (Papaioanou et al., 2018).

In our study, no significant effects of the applied treatments on chemical fruit characteristics were observed (Table 4). Values of SSC obtained in our experiment showed lower levels in all treatments, ranging from 10.2% to 10.5%, than the value of 11.7% previously reported for the "Willamette" cultivar grown at "Radmilovac" experimental station of the

Faculty of Agriculture, University of Belgrade (Milivojević et al., 2012). Poledica (2014) reported that the content of soluble solids increases with the combined foliar application of the gibberellin synthesis inhibitor prohexadione-Ca and pruning of young canes. Total acids content was also found to be similar among the examined

treatments, but a slightly higher value was achieved in the control treatment (0.70%), accompanied by low SSC.

Table 4. The effects of young cane removal treatments on chemical fruit traits of raspberry cultivar "Willamette"

Treatment	Soluble solids content (%)	Total acids (%)	Vitamin C content (mg/100 g FW)
Control	10.2±0.21	0.70±0.009	26.8±0.27
R	10.3±0.15	0.67±0.015	27.0±0.22
2R	10.2±0.07	0.68±0.009	26.7±0.18
3R	10.5±0.15	0.66±0.010	25.5±0.90
F-test	ns	ns	ns

Data are the means of three replications ± standard error. Values within column followed by the same letter are not significantly different at $P \leq 0.05$ (LSD test). ** $P < 0.01$; ns – not significant. R) single removal; 2R) twice removal; 3R) three-time removal; control (no removing the first series of young canes).

Milinković et al. (2021) reported 2.5 fold higher TA content in conventionally grown "Willamette" cultivar (1.78%), which could be explained as a consequence of diverse environmental conditions and cultivation methods between the studies.

Vitamin C has been shown to play an important role in controlling oxidative reactions in the human body and it exhibits anticarcinogenic activities (Sun et al. 2002). Content of vitamin C in raspberry fruit was previously reported to be between 17 and 37 mg 100⁻¹ g FW (Pantelidis et al., 2007). In our study, levels of vitamin C in raspberry fruit were consistent (25.5 to 27.0 mg 100⁻¹ g FW),

and no significant differences were expressed among the treatments.

CONCLUSIONS

Removing young canes at ground level in the spring is one of the most important practices that affect the growth, productivity and fruit quality of "Willamette" raspberry. How often the young canes are removed depends on the climatic conditions in the raspberry plantation, as well as the agricultural practices used. In this study, the 3R treatment was effective in increasing yield components. However, this approach can result in lower vegetative growth of later developed primocanes, which in this case cannot ensure adequate yield potential the next year. Therefore, it is preferable to

remove young canes twice; the first should be made in late April and the second cut in mid-May.

ACKNOWLEDGEMENTS

This work was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia according to the Agreement on the realization of scientific research work in 2023 with the Faculty of Agriculture of the University of Belgrade (Contract No. 451-03-47/2023-01/200116)

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DISEASES IN BARLEY (*HORDEUM VULGARE* L.) IN THE REGION OF SHUMEN, BULGARIA

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Abstract

Barley is the third most widespread cereal crop after wheat and corn in Bulgaria. Barley yields are controlled by many factors, among which diseases are of equal importance. The purpose of the present study is to determine the occurrence and spread of barley diseases in the Shumen region. The investigation was carrying out during 2022/2023. During the growing season, the following diseases have been detected: powdery mildew (*Blumeria graminis* f.sp. *hordei*), Barley yellow dwarf virus, yellow rust (*Puccinia striiformis*) and loose smut (*Ustilago nuda*). During the vegetation period two fungicide treatments were applied with tebuconazole (Plant protection product Tesoro) against powdery mildew and propiconazole + tebuconazole against yellow rust.

Key words: Barley, *Hordeum vulgare*, Diseases

INTRODUCTION

Barley is the third most widespread cereal crop after wheat and corn in Bulgaria. In recent years, there has been a tendency to increase the areas with barley, and in 2023 the crop occupies 158.5 thousand ha. Yields vary in different years from 3.9 to 4.4 t/ha. In the Official Variety List of the Republic of Bulgaria for 2023 are included 49 winter and spring barley varieties (EATFISC, 2023). Barley yields are controlled by many abiotic and biotic factors, among which diseases are of equal importance.

The following barley diseases are described in Bulgaria: Barley yellow dwarf virus, Powdery mildew (*Blumeria graminis* f.sp. *hordei*), Covered smut (*Ustilago hordei*), Loose smut (*Ustilago nuda*), False loose smut (*Ustilago nigra*), Leaf rust (*Puccinia hordei*), Yellow rust (*Puccinia striiformis* f.sp. *hordei*), Net blotch (*Pyrenophora teres* /*Drechslera teres*/), Leaf blotch (*Rhynchosporium secalis*), Barley stripe (*Pyrenophora graminea* /*Drechslera graminea*/),

Fusarium disease (*Fusarium* sp.), Septoria leaf blotch (*Zymoseptoria tritici*/*Septoria tritici*). (Atanasova et al., 2010; Nakova et al., 2015).

Some of them occur annually and are of economic importance and others have sporadic occurrence but in years with favorable conditions can compromised the yield.

The purpose of the present study is to determine the occurrence and spread of barley diseases in the Shumen region, Bulgaria (Figure 1).



Figure 1. Location of Shumen region, Bulgaria

MATERIALS AND METHODS

The investigation was carrying out during 2022/2023, on an area of 50 ha, sown with the barley cultivar Tangra. The plants were

sown and cultivated according to standard agricultural practices and technologies.

During the vegetation period the plants were observed to determine the occurrence and development of diseases. Disease incidence (DI) was estimated on 100 plants located on the diagonals of the field.

Disease incidence (DI) was calculated according to the McKinney index (McKinney, 1923):

$DI = \frac{\sum(ab)}{100NK}$, where:

a - infection class frequencies;

b - number of plants of each class;

N - total of observed plants;

K - highest value of the evaluation scale.

RESULTS AND DISCUSSIONS

During the growing season the following diseases have been detected: Powdery mildew (*Blumeria graminis* f.sp. *hordei*), Barley yellow dwarf virus, yellow rust (*Puccinia striiformis*) and loose smut (*Ustilago nuda*) (Table 1).

The first symptoms of powdery mildew were observed in the stem elongation stage - 2nd node with DI= 10%. Symptoms are expressed in the development of a white, floury coating on the surface of the leaves, leaf sheaths and stems. When the flag leaf appeared, the DI reached 30%. This is a result of favourable conditions for pathogen development expressed in temperature 10-22°C and humidity above 95% (Stanoeva and Iliev, 2014). According to the concept of Integrated pest management (IPM) this stage is critical for disease development especially when DI = 30%. For preventing yield reduction tebuconazole-based fungicide (Plant protection product Tesoro) was applied.

Symptoms of barley yellow dwarf virus are observed during tillering and stem

elongation stage. They are expressed in suppressed growth and development, stronger tillering and yellowing of the upper part of the leaves. Symptoms were observed on about 1% of plants (DI=1%). The appearance of the disease is most likely related to aphids observed in the field in the autumn. They were treated with an insecticide.

Table 1. Barley diseases detected in cultivar Tangra in Shumen region during 2022/2023

Growth stage	BBCH	Expected Disease	Appearance
Emergence – Second node	09-32	Fusarium root rot, Fusarium stem rot	No No
aLeaf development – Flag leaf	10-39	Septoria leaf blotch	No
Tillering	20-29	Leaf rust	No
Tillering – Heading	21-59	Powdery mildew	Yes
Tillering – Stem elongation	20-39	Barley stripe Barley yellow dwarf virus	No Yes
Stem elongation – Heading	30-59	Yellow rust Net blotch Leaf blotch	Yes No No
Heading	51-59	Covered smut Loose smut False loose smut	No Yes No

Symptoms of yellow rust were observed at the beginning of heading. They are expressed in the appearance of yellow orange postules along the length of the

leaves, arranged in lines. Temperatures of 10–15°C and a relative humidity of 100% are optimal for spore germination, penetration and production of new spores. These are spread by wind or leaf-to-leaf contact. Cool, damp weather in the spring, with overnight dew or rain, provides optimum conditions for disease development (AHDB, 2023). An interesting fact is that the pathogen cannot overwinter in Bulgaria and is carried by air through urediniospores. Due to the presence of favorable conditions for the development of the disease and the short incubation period, when the presence of the disease is established, treatment with a fungicide based on prothioconazole and tebuconazole (Plant protection product Prozaro), which is also effective against powdery mildew, was carried out.

Loose smut is observed after heading stage and damaged 10% of plants (Figure 2). The appearance of the disease is related to the fact that the barley seeds were systemically infected with the pathogen and were not treated before sowing with fungicide against this disease.



Figure 2. Symptoms on loose smut (*Ustilago nuda*) on barley cultivar Tangra

At this point, barley is in the ripening stage. Due to the way *U. nuda* is seed transmitted pathogen, the grain obtained from this field will not be used as seed material.

During the vegetation period two fungicide treatments were applied in the field with barley cultivar Tangra. The first was with tebuconazole (Plant protection product Tesoro) against powdery mildew (*Blumeria graminis* f.sp. *hordei*) and the second was with propioconazole + tebuconazole (Prozaro) against yellow rust (*Puccinia striiformis*) (Table 2). These treatments were dictated by the disease incidence in specific phenophase of barley development.

Table 2. Fungicide application in barley cultivar Tangra in 2022-2023

Disease	Growth stage	BBCH	DI, %	Fungicide application
Powdery mildew	Stem elongation – Second node	30-32	10	No
	Flag leaf just visible	37	30	Yes Tebuconazole
Barley yellow dwarf virus	Second node – Third node	32-33	1	Insecticide in the autumn
Yellow rust	Beginning of heading	51	10	Yes Prothioconazole+tebuconazole
Loose smut	Heading	51-59	10	No

CONCLUSIONS

In 2023 in the field with barley variety Tangra, in Shumen region, Bulgaria is detected the occurrence and distribution of four diseases: powdery mildew (DI=30%), Barley yellow dwarf virus (DI=1%), loose smut (DI=10%) and yellow rust (DI=10%).

Two fungicides were applied against powdery mildew when DI=30% with tebuconazole and against yellow rust with prothioconazole+tebuconazole when DI=10%.

ACKNOWLEDGEMENTS

This research work was carried out with the support of Project “Agroecological and biological research on natural and artificial communities — phase I”, RD-08-140/24.02.2023.

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PHYTOREMEDIATION ABILITIES OF SPECIES FROM THE *FESTUCA* GENUS

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Abstract

The term phytoremediation refers to the sowing of plants that have the ability to grow in devastated areas. The aim of growing these plants on such substrates is to remove or stabilize pollutants in the ecosystem. Phytoremediation is a method of removing various pollutants, both organic and inorganic in origin. It offers a significant advantage over other remediation methods due to its relatively low investment requirements. *Festuca* species, with their strong fibrous root system and rapid growth of aboveground biomass, are ideal candidates for phytoremediation. The aim of this paper is to review the available literature and summarize the results of our research on the uptake of heavy metals in the organs of plants of the genus *Festuca*. The study focused on 3 species of the genus *Festuca*: red fescue (*Festuca rubra*), tall fescue (*Festuca arundinacea*) and meadow fescue

(*Festuca pratensis*). Our studies, conducted in pots in 2021 and 2022, found that *Festuca arundinacea* had the highest initial growth and the best above-ground biomass yield on substrates such as flotation tailings compared to the other two species. It was also concluded from these studies that the addition of organic fertilizer to the substrate contributed to increased growth performance in all three species tested, while plants fertilized with mineral NPK fertilizer and a combination of mineral and organic fertilizers showed significantly lower biomass yields. Therefore, the addition of organic material is recommended to improve the physical properties of tailings. The largest part of the heavy metals taken up by the substrate plants accumulates in the roots, while a significantly smaller part is transported to the above-ground organs. Therefore, these plants can be classified as heavy metal excluders.

Key words: *Phytoremediation, excluders, pollutants, heavy metal, Festuca species*

INTRODUCTION

The increase in world population has led to an increase in individual wants and needs, resulting in increased industrialization and increased agricultural production. Many human activities have a negative impact on the quality of the environment. These include, above all, large industrial complexes such as mines or power plants, as well as traffic, the irrational use of chemical substances for fertilization and plant protection in agriculture, etc (He et al., 2015). Soils near mines and similar industrial complexes often have a completely altered physical and chemical composition because large amounts of waste material have been deposited on the surface. This waste material is rich in heavy metals, which remain after ore mining, and poor in essential plant nutrients. Heavy metals are not biodegradable, remain in the soil for a long time and have potentially toxic effects on humans and animals when plants growing on such substrates enter the food chain (Sarwar et al., 2010).

In view of all this, it is important to pay close attention to restoring physical and chemical properties of degraded land. Such measures are called soil remediation. One particular method of soil remediation, known as phytoremediation, involves the cultivation of plants capable of growing in such areas and reducing the levels of

heavy metals in the substrate by their uptake and accumulation in below- and above-ground plant organs (Greipsson, 2011; Sarwar et al., 2017). Plants with well-developed root systems, rapid growth, and the ability to produce a large amount of aboveground biomass are used for phytoremediation, such as plants from the *Poaceae* family (Kumar-Patra et al., 2021). Species belonging to the genus *Festuca* are able to grow in degraded areas and, thanks to their highly developed fibrous root system, help stabilize of degraded areas and prevent the spread of fine particles over long distances. In addition, these plants help to reduce the content of heavy metals in the substrate through their uptake and accumulation (Hu et al., 2015; Galende et al., 2014; Prasad, 2005).

The aim of this study was to investigate the growth potential of *Festuca* species on soils with altered physical and chemical properties that are enriched with heavy metals.

MATERIALS AND METHODS

In 2021 and 2022, a greenhouse experiment was conducted at the Faculty of Agriculture, University of Belgrade, to study the phytoremediation abilities of *Festuca* species. The study focused on three species of the genus *Festuca*: tall fescue (*Festuca arundinacea* Schreb.), red

fescue (*Festuca rubra* L.) and meadow fescue (*Festuca pratensis*). The experiment was carried out in pots with three different types of fertilizers and two levels of irrigation. Seeds of the above species, obtained from the Institute of Forage Crops in Kruševac, were sown in pots with a diameter of 12 cm and a depth of 10 cm. Immediately before sowing, the pots were filled with a substrate taken from the flotation tailings dump of a lead, copper, and zinc mine (Table 1). Fertilizer was applied with organic NPK fertilizer obtained by pelleting chicken manure (NPK 4:4:4), with mineral NPK fertilizer (NPK 16:16:16) and a with combination of these two fertilizers. Two different irrigation rates were applied: 50%, of the field water capacity (FWC) and 75% of the FWC. The amount of water used was replenished every 2-3 days by measuring the pot mass and above-ground biomass was harvested when the plants had reached a height of about 20 cm. Plant height was measured once a week and the yield of fresh above-ground biomass was determined immediately after harvest. The data obtained were processed using ANOVA in Statistica 10 software. The results are displayed cumulatively as the sum of the plant heights and biomass achieved.

RESULTS AND DISCUSSION

Based on our investigations, we can conclude that all three *Festuca* species

Table 2. The influence of fertilization and irrigation on the yield of festuca species grown on flotation tailings

Fertilizer (A)	Tall fescue		Red fescue		Meadow fescue	
	Plant height (cm)	Biomass (g)	Plant height (cm)	Biomass (g)	Plant height (cm)	Biomass (g)
O.	56.3	6.1	24.7	1.9	42.2	4.7
M.	16.3	1.0	11.7	1.2	18.7	0.9
O.+M.	18.8	0.5	11.3	0.8	35.5	3.4

tested are able to grow on substrates with unfavourable physicochemical properties, such as flotation tailings. Flotation tailings are characterized by a very poor nutrient capacity, with a very low content of essential plant nutrients. The concentration of heavy metal residues in the tailings is very high and exceeds the maximum permissible concentrations for agricultural soils.

Table 1. Chemical properties of tailings that was used as substrate in the experiment and the maximum permissible amounts of heavy metals for arable land (Official Gazette of RS, No 30/2018)

Parameter	Concentration	MPA (mg kg ⁻¹)
pH (in H ₂ O)	6.85	/
pH (in KCl)	6.59	/
N (%)	0.005 ± 0.001	/
P ₂ O ₅ (mg/100 g soil)	1.08 ± 0.006	/
K ₂ O (mg/100 g soil)	8.49 ± 0.04	/
Organic C (%)	3.71 ± 0.25	/
Pb (mg kg ⁻¹)	655.3 ± 0.86	85
Zn (mg kg ⁻¹)	1217 ± 49.3	140
Ni (mg kg ⁻¹)	217.2 ± 8.47	35
Cu (mg kg ⁻¹)	443.4 ± 2.30	36
Cd (mg kg ⁻¹)	7.33 ± 0.63	0.8
Mn (mg kg ⁻¹)	884.6 ± 50.9	2000

The high concentration of organic carbon in the tailings is not due to the presence of organic material, but to the addition of the organic compound xanthate, which promotes ore decomposition (Table 1).

Irrigation (B)						
50% FWC	29.1	2.6	16.3	1.2	31.7	2.8
75% FWC	31.9	2.5	17.2	1.5	32.5	3.1
ANOVA						
A	**	**	**	**	**	**
B	NS	NS	*	NS	NS	NS
A×B	NS	NS	*	NS	*	*

NS - non significant; * significant influence; ** very significant; O - organic fertilizer; M - mineral fertilizer; O+M mixture of organic and mineral fertilizers; FWC - field water capacity

Fertilization had a statistically significant effect on plant growth and aboveground biomass yield. Based on the data in Table 2, it can be seen that the addition of organic fertilizer significantly improved the growth of above-ground biomass in all three plant species tested.

The highest plant height of 56 cm was found in tall fescue plants treated with organic fertilizer, followed by meadow fescue with the same fertilizer treatment (42 cm), while red fescue reached a height of about 25 cm.

Meadow fescue plants treated with a combination of the two fertilizers reached a slightly lower height than a the treatment with pure organic fertilizer (35 cm), while the other two species showed significantly lower heights, about 19 cm for tall fescue and 11 cm for red fescue.

The weakest results were obtained in the treatment with pure mineral fertilizer. Similar results were obtained for the yield of fresh above-ground biomass, with tall fescue treated with organic fertilizer giving the highest yield, followed by meadow fescue with the same treatment, while red fescue gave lower results (Table 2).

These results are consistent with studies by numerous authors reporting that plant growth on such substrates is limited by a lack of nutrients and organic matter

(Fontaine et al., 2003; Wei et al., 2011).

The addition of organic fertilizers improves the microbiological activity of the substrate, promotes plant growth and thus enhances the effect of phytoremediation (Pillai et al., 2013).

Statistically significant differences between the applied irrigation levels were only observed for red fescue height, while in other cases different irrigation levels had no significant effect on plant height and yield.

CONCLUSION

Many human activities, especially those related to mining and coal burning, have a significant impact on the environment. The dumping of a large amount of waste materials on the adjacent land leads to changes in the physicochemical properties of the soil.

These waste materials are rich in heavy metals, which can have toxic effects if they enter the food chain. It is therefore crucial to pay attention to the remediation of such soils.

One possible method is phytoremediation, which involves growing plants capable of growing on substrates with unfavourable characteristics.

Species from the genus *Festuca* are suitable candidates for this purpose due to

their rapid growth and the formation of a large amount of above-ground biomass. The addition of organic fertilizer promotes plant growth on substrates such as flotation residues and thus improves the effectiveness of phytoremediation.

ACKNOWLEDGEMENTS

The paper is the result of research carried out within the framework of the "Agreement on the Implementation and Financing of Scientific Research in 2023" between the Ministry of Science, Technological Development and Innovation of the Republic of Serbia and the Faculty of Agriculture of the University of Belgrade under contract number 451-03-47/2023-01/200116 I 451-03-47/2023-01/200119

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THE INFLUENCE OF YOUNG CANES REMOVAL ON FIELD PERFORMANCE AND FRUIT QUALITY OF "WILLAMETTE" RASPBERRY (*Rubus idaeus* L.)

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Abstract

The objective of this study was to evaluate the effects of different young cane removal treatments on yield components, fruit quality characteristics, and vegetative growth of the raspberry cultivar 'Willamette'. The trial was conducted in a commercial raspberry orchard in the village of Ušće (the municipality of Kraljevo, central Serbia). The orchard was established in 2014 in the form of a vertical trellis system with pillars and 2 lines of single wire. The planting distance was 0.25 m in the row and 3.0 m between rows. The experimental design was completely randomized and studied the influence of the following treatments: I) single removal of young canes (R); II) twice removal of young canes (2R); III) three-time removal of young canes (3R); IV) control treatment (without removing the first series of young canes). The applied treatments resulted in changes in the parameters of generative and vegetative potential, as well as in the characteristics of fruit quality of the tested cultivar. The highest number of fruiting branches, inflorescences, and fruits on the floricanes was recorded in 3R treatment (32.7, 89.0, and 272, respectively), as well as the highest yield per cane and linear meter (697 g and 4.1 kg, respectively). In contrast, the lowest values of generative parameters were obtained in the control treatment. The 3R treatment resulted in a significant increase in the fruit weight (5.1 g) and soluble solids content (10.5%). Total acids content reached the highest value in the control treatment (0.70%), while vitamin C content was slightly higher in R treatment (27.03 mg/100 g fresh weight). The highest number of primocanes per linear meter was found in the control treatment (34.0), where canes were tallest and had the most nodes (260 cm and 50.0, respectively). This comprehensive study found that 3R treatment increased yield and fruit quality characteristics of the raspberry cultivar tested in current season, but vegetative growth and yield potential of canes left for the following season are reduced.

Key words: raspberry, pruning, yield components, fruit quality, vegetative traits

INTRODUCTION

The Republic of Serbia is one of the world's leading producers and exporters of raspberries, with an average annual production of 117,214 tons in the last five years. More than 90% of raspberries produced are exported frozen to foreign markets, while the export of fresh raspberries is almost negligible. Although the total area under raspberry cultivation has increased to 20,807 ha, the average yield per hectare has steadily decreased and in 2021 was 5.3 tons (FAOSTAT, 2023). Therefore, continuous improvement and intensification of agricultural practices in raspberry orchards is necessary. One of

the main elements of improving the cultivation technology is the careful balancing of the vegetative and generative growth of raspberry plants.

Raspberries form biennial canes that are vegetative the first year (primocanes) and fruitful the second (floricanes). The primocanes, arising in the spring from the basal buds of old canes, have intensive growth during the spring and the first half of summer. The following year, these canes produce fruiting laterals and become floricanes, which die soon after fruiting and should be removed at any time before the following spring. As both types of cane simultaneously exist in the trellis, there is a large competition between the vegetative

growth of primocanes and the reproductive phase of floricanes (Poledica et al., 2012). This unique growth habit makes pruning raspberry plants somewhat challenging, as primocanes begin to grow first and can become too vigorous by the end of the growing season; therefore removing them in the spring is a traditional method of controlling raspberry growth, providing adequate space, light, and nutrients for later-developing canes. This management practice can be performed several times in the spring. As reported before (Waister and Cormack, 1977), the removal of young raspberry canes increased the yield of the floricanes. Nenadić (1986) confirmed that completely removing the first series of primocanes until flowering starts on the floricanes has a positive influence on yield, fruit quality, and disease prevention. Therefore, the aim of this study was to evaluate the effect of young canes removal treatments on yield components, fruit quality traits, and vegetative growth of the raspberry cultivar 'Willamette'.

MATERIALS AND METHODS

The experiment was conducted during 2020 in a commercial raspberry orchard of cultivar "Willamette" in the village of Ušće (the municipality of Kraljevo, central Serbia). The orchard was established in 2014 in the form of a vertical trellis system with pillars and 2 lines of single wire. The planting distance was 0.25 m in the row and 3.0 m between rows. The experimental design was completely randomized and the following treatments were applied: I) single removal of young canes (R); II) twice removal of young canes (2R); III) three-time removal of young canes (3R); IV) control treatment (without removing the first series of young canes).

The first series of young canes were removed once in the middle of April, the second time at the beginning of May, and the third time in the middle of May. In

each treatment, all young canes were cut at ground level when they were 30 cm tall. The experimental design was completely randomized with 3 replications per treatment. Each treatment was applied in 3 rows, where each row represents 1 replication covering a 10-m length of trellis. Five randomly selected canes per replication were investigated (15 canes per treatment).

Beginning of ripening (10% of fruits are ripe and can be easily removed from the plant) and end of ripening (date of the last harvest) were registered. Generative characteristics were studied by counting the number of fruiting laterals, inflorescences, and fruits per floricanes and weighing the harvested fruit to determine yield per cane (g). Yield per linear meter (kg) was calculated as a product of cane number per meter and yield obtained per cane for each harvest date. Investigation of vegetative characteristics (length of canes (cm), cane diameter (mm), number of nodes per meter of cane, and total number of nodes per cane) was carried out on primocanes in autumn of 2020.

To assess fruit quality, fruits were picked at the commercial maturity stage in the second harvest. A sample of 50 fruits per replication (10 fruits per cane) was used for the fruit quality assessment. The fruit fresh weight was measured by technical scale with a sensitivity of ± 0.01 g (Acom JW-1, Korea). Two linear dimensions, height and width (in mm) of each fruit were measured using a digital caliper Prowin (China), while the ratio of the maximum height and width was presented as an index of fruit shape. A previously frozen fruits from each replication were homogenized by liquid nitrogen to analyze soluble solids content (SSC), total acids

(TA), and vitamin C content. SSC was determined using a digital refractometer (Pocket PAL-1, Atago, Japan). TA was measured using a digital burette and 0.1 M NaOH to titrate samples to an endpoint of 8.1. Acidity was based as a percentage of malic acid equivalent. Vitamin C was quantified using a reflectometer set (Merck RQflex, Merck KGaA, Germany) as described by Pantelidis et al. (2007). Results were expressed as mg ascorbic acid 100 g⁻¹ of fresh weight (FW).

A statistical analysis was performed by ANOVA using software Statistica 8.0 for Windows (StatSoft Inc., USA). Significant differences among the means were determined by a least significant difference (LSD) test at a level of $P \leq 0.05$.

RESULTS AND DISCUSSION

The fruit ripening of "Willamette" cultivar started on June 19th and ended on July 16th (data not shown). The harvest lasted 27 days, which is 10 days shorter compared to duration of the harvest under ecological conditions of the municipality of Krupanj (Poledica, 2014). Milivojević et al. (2012) reported that the ripening of the "Willamette" cultivar begins on June 6th

and ends on July 4th, while the duration of this phenophase in the conditions of the Belgrade region was 29 days.

The highest number of fruiting branches on floricanes was observed in the 3R treatment (32.7), in which young canes were pruned three times (Table 1). The control treatment, in which no pruning of young canes was performed, had the lowest number of fruiting branches on floricanes (21.3). According to Poledica (2014), the combined foliar application of the gibberellin synthesis inhibitor prohexadione-Ca and pruning of young canes significantly increased the number of fruiting branches per floricanes (14.3), but is still two-fold lower than the results obtained in this study. The number of inflorescences per floricanes also varied by the treatment, ranging from 41.7 (control treatment) to 89.0 (3R). Treatments 2R and 3R significantly increased the number of fruits (267; 272) and yield per floricanes (621 g; 687 g), respectively. The lowest values for these parameters were found in the control treatment (180 and 424 g, respectively). Yield per linear meter was also highest in the 3R treatment (4.13 kg).

Table 1. The effects of young cane removal treatments on yield components of raspberry cultivar "Willamette"

Treatment	Number of fruiting branches per floricanes	Number of inflorescences per floricanes	Number of fruits per floricanes	Yield per floricanes (g)	Yield per linear meter (kg)
Control	21.3±1.20b	41.7±2.60c	180±5.29c	424±37.2b	2.53±0.15b
R	28.3±2.03a	53.3±3.76bc	212±4.16b	462±30.3b	2.67±0.18b
2R	29.3±1.45a	57.3±3.18b	267±8.96a	621±50.2a	3.70±0.12a
3R	32.7±1.45a	89.0±5.69a	272±8.39a	687±65.2a	4.13±0.24a
F-test	**	**	**	*	**

Data are the means of three replications ± standard error. Values within column followed by the same letter are not significantly different at $P \leq 0.05$ (LSD test). ** $P < 0.01$; * $P < 0.05$. R) single removal; 2R) twice removal; 3R) three-time removal; control (no removing the first series of young canes).

Table 2. The effects of young cane removal treatments on vegetative potential of raspberry cultivar "Willamette"

Treatment	Number of primocanes per linear meter	Primocane length (cm)	Primocane diameter (mm)	Number of nodes per primocane	Internode length on primocane (cm)
Control	34.0±0.58a	260±5.77a	9.00±0.58a	50.0±1.53a	5.17±0.03a
R	32.0±2.08a	250±5.77b	8.00±0.58ab	48.0±1.15ab	5.17±0.03a
2R	27.0±0.58b	230±5.77c	7.00±0.58bc	46.0±0.58b	5.00±0.06a
3R	24.0±0.58b	180±5.77d	6.00±0.58c	40.0±1.15c	4.50±0.29b
F-test	**	**	*	**	*

Data are the means of three replications ± standard error. Values within column followed by the same letter are not significantly different at $P \leq 0.05$ (LSD test). ** $P < 0.01$; * $P < 0.05$. R) single removal; 2R) twice removal; 3R) three-time removal; control (no removing the first series of young canes).

The number of primocanes per linear meter and primocane length increased significantly in the control treatment (34.0 and 260 cm, respectively), whereas the lowest primocane diameter, number of nodes, and internode length of primocane were observed in the 3R treatment (Table 2).

Poledica (2014) reported that the first and second removal of young canes had no significant effect on the primocane height, diameter, and number of nodes compared to the control treatment. Removal of young canes should be performed depending on the vigor of the cultivar and climatic conditions in the growing area. This measure is less necessary for the cultivars with lower cane production ("Tulameen," "Mekeer") than for cultivars where high cane production leads to lower yield and fruit quality ("Willamette"). Since the main objective in raspberry production is to obtain the highest possible yield per unit area, it is essential to balance the generative and vegetative potential to ensure a high yield the following year.

In addition to the agronomic performance of raspberries, the biometric and chemical characteristics of the fruit are also considered important factors, generally

related to consumer perception of the fruit quality. The physical characteristics of raspberry fruit are an important quality attribute that can be used to assess the suitability of the fruit for specific purposes. In our research (Table 3), the 3R treatment resulted in a significant increase in fruit weight (5.1 g), while the smallest fruits were found in the control and R treatments (3.6 g). Fruit height and width were also highest in the 3R treatment (21.3 mm and 22.5 mm, respectively), while the lowest values were recorded in the R treatment (17.8 mm and 18.6 mm, respectively).

The main reason that the physical fruit parameters are highest in the 3R treatment, in which the young canes are cut three-times, is that the plant directs more nutrients to fruit development. However, such an approach to raspberry cultivation can lead to weak growth of the later developed canes, which does not ensure a high yield in the following season.

Fruit shape index ranged from 0.94 (2R treatment) to 0.99 (control treatment), corresponding to predominantly angular-round to round fruit shapes.

Table 3. The effects of young cane removal treatments on physical fruit traits of raspberry cultivar "Willamette"

Treatment	Fruit weight (g)	Fruit length (mm)	Fruit width (mm)	Index of fruit shape
Control	3.57±0.12b	18.7±0.40b	18.9±0.09b	0.99±0.025
R	3.57±0.12b	17.8±0.45b	18.6±0.56b	0.96±0.006
2R	3.80±0.26b	18.7±0.48b	20.0±0.53b	0.94±0.018
3R	5.07±0.24a	21.4±0.66a	22.5±0.58a	0.95±0.023
F-test	**	**	**	ns

Data are the means of three replications ± standard error. Values within column followed by the same letter are not significantly different at $P \leq 0.05$ (LSD test). ** $P < 0.01$; ns – not significant. R) single removal; 2R) twice removal; 3R) three-time removal; control (no removing the first series of young canes).

Raspberry fruits are one of the most popular fruits because of their pleasant flavor which is the result of the biosynthesis of phytochemicals, such as sugars and acids. The ratio of sugars to organic acids determines the balance between soluble solids and titratable acidity, which in turn influences fruit flavor and taste (Papaioanou et al., 2018).

In our study, no significant effects of the applied treatments on chemical fruit characteristics were observed (Table 4). Values of SSC obtained in our experiment showed lower levels in all treatments, ranging from 10.2% to 10.5%, than the value of 11.7% previously reported for the "Willamette" cultivar grown at "Radmilovac" experimental station of the

Faculty of Agriculture, University of Belgrade (Milivojević et al., 2012). Poledica (2014) reported that the content of soluble solids increases with the combined foliar application of the gibberellin synthesis inhibitor prohexadione-Ca and pruning of young canes. Total acids content was also found to be similar among the examined treatments, but a slightly higher value was achieved in the control treatment (0.70%), accompanied by low SSC.

Table 4. The effects of young cane removal treatments on chemical fruit traits of raspberry cultivar "Willamette"

Treatment	Soluble solids content (%)	Total acids (%)	Vitamin C content (mg/100 g FW)
Control	10.2±0.21	0.70±0.009	26.8±0.27
R	10.3±0.15	0.67±0.015	27.0±0.22
2R	10.2±0.07	0.68±0.009	26.7±0.18
3R	10.5±0.15	0.66±0.010	25.5±0.90
F-test	ns	ns	ns

Data are the means of three replications ± standard error. Values within column followed by the same letter are not significantly different at $P \leq 0.05$ (LSD test). ** $P < 0.01$; ns – not significant. R) single removal; 2R) twice removal; 3R) three-time removal; control (no removing the first series of young canes).

Milinković et al. (2021) reported 2.5 fold higher TA content in conventionally grown "Willamette" cultivar (1.78%), which could be explained as a consequence of diverse environmental conditions and cultivation methods between the studies.

Vitamin C has been shown to play an important role in controlling oxidative reactions in the human body and it exhibits anticarcinogenic activities (Sun et al. 2002). Content of vitamin C in raspberry fruit was previously reported to be between 17 and 37 mg 100⁻¹ g FW (Pantelidis et al., 2007). In our study, levels of vitamin C in raspberry fruit were consistent (25.5 to 27.0 mg 100⁻¹ g FW), and no significant differences were expressed among the treatments.

CONCLUSIONS

Removing young canes at ground level in the spring is one of the most important practices that affect the growth, productivity and fruit quality of "Willamette" raspberry. How often the young canes are removed depends on the climatic conditions in the raspberry plantation, as well as the agricultural practices used. In this study, the 3R treatment was effective in increasing yield components. However, this approach can result in lower vegetative growth of later developed primocanes, which in this case cannot ensure adequate yield potential the next year. Therefore, it is preferable to remove young canes twice; the first should be made in late April and the second cut in mid-May.

ACKNOWLEDGEMENTS

This work was funded by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia according to the Agreement on the realization of scientific research work in 2023 with the Faculty of Agriculture of the University of

Belgrade (Contract No. 451-03-47/2023-01/200116)

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DIVERSITY OF MACROMYCETES AND BRYOPHYTES IN THE VALLEY OTĂȘĂU– VÎLCEA COUNTY

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Abstract

The territory under study is located along the Otăsău stream and covers an area of about 300 km². The Otăsău valley, as mentioned in the previous subchapter, includes two relief steps: the mountain step and the subcarpathian area of Oltenia. All the studies carried out in the area of the Otăsău basin, an integral part of the Buila-Vânturarița National Park, and reflected the wealth of flora and fauna species, supporting the need to protect and protect this complex of forms, associations and landscapes. The landscapes offered by this corner of the country: bare rocks and impressive steeps next to smooth plateaus, winding paths and shady forests, glades full of light delight the eyes of nature lovers. The overview of macromycetes in the researched territory was developed based on own research, carried out between 2021-2022. The mycological flora of this territory is particularly rich and diverse in composition, most cryptogams find in this area the most favorable conditions for their development. Following the analyzes carried out on the macromycetes encountered in the Otăsău valley, 82 species of macromycetes were identified, belonging to a number of 56 genera and 24 families. Bryophytes are small autotrophic plants commonly known as mosses. Most mosses prefer moist biotopes: forests, meadows, swampy areas, etc. According to the substrate on which mosses live, they can be: tericoli (on the ground), saxicol (on rocks) and corticoli (on the bark of trees). The vegetative body is thalloid or cormoid. From the Otăsău Valley, 24 species of bryophytes were also identified in Vâlcea. The overview of bryophytes from the researched territory was made based on own research, but also on bibliographical data. The 24 species of bryophytes identified in the Otăsău valley belong to 24 families and 2 classes: Hepaticae and Musci. Of the total bryophyte species identified in the Otăsău valley, 5 species are found in the lists of rare, endangered or vulnerable species. Special attention must be paid to the protection and conservation of biodiversity, because the researched territory is located in an area where forests are overexploited.

Key words: macromycetes bryophytes, Otăsău Valley, biodiversity

INTRODUCTION

All the studies carried out in the area of the Otăsău basin, respectively of the Buila-Vânturarița Massif, reflected the richness of the flora and fauna species, supporting the need to protect and protect this complex of forms, associations and landscapes. The landscapes offered by this corner of the country and never found elsewhere: bare rocks and impressive steeps next to smooth plateaus, winding paths and shady forests, glades full of light enchant the eyes of nature lovers. The floristic diversity of the ecosystems in the Otăsău basin is very high, due to a complex of factors, among which are:

- the mountainous relief that occupies a significant part of the territory, favoring the maintenance of natural vegetation which, in these areas, could not be replaced by agricultural crops due to the rugged relief of the calcareous ridge;
- the high frequency of limestones, marked in relief by sectors of gorges and small isolated massifs with steep slopes, chimneys, fissures, cracks, dry valleys, hollows that harbor a particularly interesting flora;
- the relatively mild climate, with sub-Mediterranean influences, which favored

the spread of relatively thermophilic species;

- within the mountainous relief there is a great diversity of habitat types (ecological entity that indicates the living environment of the species, at the same time abiotic, but also biotic). This complex of factors correlated with the position in relation to the genetic centers and migration paths of flora and fauna, determined the existence of very different elements: Eurasian, European and Central-European, Alpine-Carpathian, Sub-Mediterranean, Carpatho-Balkan as well as a series of endemic or subendemic species.

The diversity of the landforms, the geological structure, the altitude, offer particularly varied conditions that allowed the establishment of an equally rich and varied flora, including all large groups of plants.

In the Otăsău basin, the vegetation in the forest area is divided into two sub-areas, namely:

- the beech subzone;

- the spruce subzone;

The dominant species being: beech (*Fagus sylvatica*), fir (*Abies alba*), spruce (*Picea abies*) and larch or larch (*Larix decidua*).

According to the specific composition of the forests and the altitudinal succession of species in the case of these subzones, the following vegetation layers were distinguished:

- lower mountain;

- middle mountain;

- upper mountain;

Above the forests stretches a transition strip to the alpine gap, which on the southern slope has a large expanse in some places (Mountain Piatra, Văleanu, Cacova). The stands and rare trees in this area are made of spruce or fir, among

which juniper and mountain anin bushes are often installed.

Macromycetes, also known as large fungi or higher fungi, are a category of fungal organisms with conspicuous and large fruiting bodies, such as cap and foot. These fungi are part of the kingdom Fungi and are distinct from micromycetes such as molds and yeasts, which do not produce large, visible fruiting structures.

Macromycetes include a wide variety of species, from edible fungi such as champignons to toxic or even deadly species. They are ecologically important because they are involved in essential processes such as the decomposition of organic matter and the formation of symbiosis with plant roots (mycorrhizae).

There are numerous families, genera, and species of macromycetes, and their study is an important branch of mycology, which is the science that deals with the study of fungi. It is important to note that not all macromycetes are edible, and correct species recognition is essential to avoid consuming toxic or dangerous mushrooms.

Different species of macromycetes prefer certain types of habitat. For example, forest mushrooms can be found in wet or dry forests, while certain species prefer to grow on dead wood and others on soil. Some macromycetes can form close symbiotic relationships with tree roots, as in the case of mycorrhizae.

There are also species adapted to the specific climate of some regions, and the diversity of macromycetes varies according to geography, altitude and local environmental conditions. For example, certain regions with temperate or tropical climates may host a greater variety of fungal species than regions with arid climates.

Usually, macromycetes are highly diverse organisms and adapt to a wide variety of environments, making them globally distributed.

Bryophytes are small autotrophic plants commonly known as mosses. Most mosses prefer moist biotopes: forests, meadows, swampy areas, etc. According to the substrate on which mosses live, they can be: tericoli (on the ground), saxicol (on rocks) and corticoli (on the bark of trees). The vegetative body is thalloid or cormoid.

MATERIALS AND METHODS

The territory under study is located along the Otăsău stream and covers an area of about 300 km². The Otăsău valley, as mentioned in the previous subchapter, includes two relief steps: the mountain step and the subcarpathian area of Oltenia (fig. 1, fig. 2, fig. 3).



Fig. 1. Vegetation aspect of the researched territory



Fig.2. Otăsău Basin: delimitation, geomorphology, hydrography (source: Buila-Vânturarița National Park Administration)

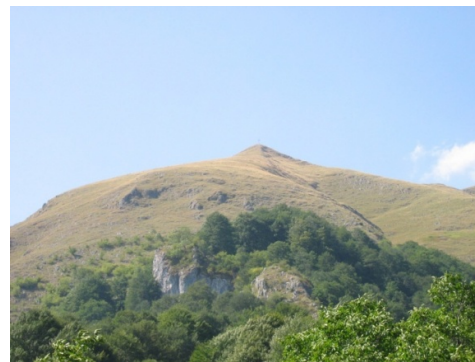


Fig. 3. Aspect from the researched territory – Mount Piatra

All the studies carried out in the area of the Otăsău basin, an integral part of the Buila-Vânturarița National Park, and reflected the wealth of flora and fauna species, supporting the need to protect and protect this complex of forms, associations and landscapes. The landscapes offered by this corner of the country: bare rocks and impressive steps next to smooth plateaus, winding paths and shady forests, glades full of light delight the eyes of nature lovers.

The hydrographic network of the researched territory is represented by the Otăsăului Valley together with its

numerous tributaries. Otăsău, a left-hand tributary of the Bistrița, which originates in Curmătura Builei and collects the waters from the southern slopes of the Piatra and Albu Mountains (Valea Bulzului, Valea Pătrunsa). The most important tributaries are: Bulzu Stream and Tisa Stream, which it receives near the town of Bărbăți. In general, the valleys have a balanced hydrographic regime, but due to the long slopes during the rains, most of them become torrential. Seen from the aspect of their origin, evolution and distribution, the soils found in the upper basin of Otăsău can be grouped into: zonal and azonal soils. From a systematic point of view, they fall into: argiloiluviosols, cambisols, spodosols and umbrisols. In the hilly floor, the most widespread soils are the eumesobic brown soils known in the specialized literature and as forest brown soils, eutrophic brown soils, are the soils occupied by beech trees and mesophilic meadows. The gleic alluvial soils found under the *Alnus glutinosa* stands and the colluvial soils under the *Alnus incana* stands. They are part of the class of undeveloped soils. In the mountain floor, under the mountain beech trees, mixed forests of coniferous and beech, spruce, the most common zonal soils are brown acid soils.

The overview of macromycetes and bryophytes in the researched territory was developed based on own research, carried out between 2021-2022. Field research was done in all seasons and on scheduled itineraries.

For the identification of macromycete species, the following works were mainly used: Determinator for the recognition of edible, inedible and poisonous mushrooms from Romania (G. Sălăgeanu, 1985) and Atlas de champignons d'Europe (E.

Romagnesi, 1995). For each macromycete species, the ecological group, the biological form, the substrate, the collection period, the locality and whether the respective species is edible, inedible or poisonous are indicated.

For the identification of bryophyte species, the following works were mainly used: Bryophytes from Romania (G. Mohan, 2004) and Unsere Moos und Farnpflanzen (D. Aichele und H. W. Schwegler, 1991).

RESULTS AND DISCUSSIONS

The overview of macromycetes in the researched territory was developed based on own research, carried out between 2021-2022. The mycological flora of this territory is particularly rich and diverse in composition, most cryptogams find in this area the most favorable conditions for their development. Following the analyzes carried out on the macromycetes encountered in the Otăsău valley, 82 species of macromycetes were identified, belonging to a number of 56 genera and 24 families.

În teritoriul cercetat se întâlnesc următoarele specii: *Hypoxylon rutilu* Tul., *Xylaria hypoxylon* (L. ex.Fr.) Grev., *X. polymorpha* (Scop.) Grev., *Aleuria aurantia* (Pers. ex.Fr.) Fuck (syn. *Peziza aurantia*(Fers.) Fr), *Auricularia auricula – judae* L.ex.Fr. (Syn *Auricularia auricula* Hook.), *A. mesenterica* (Dicks. ex S.F. Gray) Pers., *Dacrymyces palmatus* Schw., *Calocera cornea* (Batsch ex Fr.) Fr., *C. viscosa* (Pers. ex Fr.) Fr., *Ramaria botrytis* (Pers. ex Fr.) Rick. M., *Exidia glandulosa* (Bull. ex St. Am.). Fr., *Tremella mesenterica* Retz. ex Hook. Sl, *Mitrula abietis* Fr. (Syn. *Mitrula cuculata* Batsch. ex Fr.), *M. sphaerocephala* Bres.; Sf, *Stereum hirsutum* (Willd. ex Fr.) S. F. Gray. Sl, *Ramaria aurea* (Schff. ex Fr.)

Quel., *R. botrytis* (Pers. ex Fr.) Rick, *Abortiporus bienis* (Bull.ex.Fr) Sing., *Daedalea quercina* L. ex. Fr. (Syn. *Trametes quercina*), *Ganoderma applanatum* (Pers. Ex Wallr.) Pat. (Syn. *Fomes applanatus* (Pers.) Gill.). SPI,

Fomes fomentarius (L. ex Fr.) Gill, *Phellinus igniarius* (L. ex Fr.) Qué!, *Pitosporus betulinus* (Bull. Ex Fr.) Karst. SPI, *Trametes hirsuta* (Wulf.ex. Fr.) Pil (Syn.*Coriolus hirsutus*) (Wulf ex.Fr.) Quel. Sl, *T. versicolor* (L. ex. Fr.) Fr. (Syn *Coryolus versicolor* (L. ex. Fr.) Quel. Sl, *Bjerkandera adusta* (Willd. ex Fr.) Karst. Sl, *Coriolus versicolor* (L. ex Fr.) Quel. Sl, *Polyporus ovinus* (Schaeff.) Fr. (Syn. *Albatrellus ovinus* (Schff.: Fr.) Kotl. & Pouz.). M, *Fistulina hepatica* Schaeff. ex. Fr. Sl, MycEpx, *Macrolepiota gracilentata* (Fr.) Mos. Sh, *Agaricus silvaticus* Schff. ex Secr. Sh, . *Cystoderma cinnabarinum* (A. et S. ex Secr.) Fay. Sh, *Macrolepiota procera* (Scop. ex Fr.) Sing. Sh, *Coprinus atramentarius* (Bull. ex Fr.), . *Panaeolus papilionaceae* (Bull. ex Fr.) Quel. SPI, *P. sphinctrinus* (Fr.) Quel. SPI, . *Inocybe fasticiada* (Schff. ex Fr.) Quel. Sh, *Cortinarius delibutus* Fr. Sh, *C. purpurascens* Fr. Sh, *Inocybe fasticiada* (Schff. ex Fr.) Quel. Sh., *Craterellus cornucopioides* (L. ex Fr.) Pers., *Cantharellus cibarius* Fr., *Panus rudis* Fr. Sl, *Schizophyllum commune* Fr. (Syn. *S. alneum* (L.) Schroet.) Sl, *Pleurotus cornucopiae* Paul. ex Fr. Sl, *P. ostreatus* (Jacq. ex Fr.) Kumm. Sl, *Lactarius piperatus* (L. Ex Fr.) S.F. Gray. M, *L. pergamenus* (Swartz. ex Fr.) Fr., *Russula cyanoxantha* (Seff. ex Schw.) Fr., M, . *R. rosea* Qué!, *R. vesca* Quel. M., *R. virescens* (Schff. ex Zant.)Fr. M, *Armillariella mellea* (Vahl in Fl. Dan. ex Fr.) Karst. SPI, *A. tabescens* (Scopex.Fr.) Sing. SPI, *Laccaria amethystina* (Bolt. ex

Hoaker) Murr. Sh, *Marasmius alliaceus* (Jacq. ex Fr.) Fr. Sf., *M. oreades* (Bolt. ex Fr.) Fr. M, *M. rotula* (Fr. ex Scop.) Fr. Sl,

Bryophytes are small autotrophic plants commonly known as mosses. Most mosses prefer moist biotopes: forests, meadows, swampy areas, etc. According to the substrate on which mosses live, they can be: tericoli (on the ground), saxicol (on rocks) and corticoli (on the bark of trees). The tight body is thalloid or cormoid.

The study of bryophytes from the Otăsău basin, respectively from the Buila-Vânturarița Massif, began and gradually evolved in parallel with the study of macromycetes from the researched territory.

The overview of bryophytes from the researched territory was made based on own research, but also on bibliographical data.

Gh. Popescu cited a number of 34 species from the Bistriței-Vâlcii basin, among which:

Hylocomium splendens, *Marchantia polymorpha*, *Polytrichum commune*, *Ptilium crista-castrensis*, *Dicranum scoparium*, *Fumaria hygrometrica*.

Absorbing large amounts of water, mosses or bryophytes play an important role in reducing the action of torrents on slopes from the mountain floor to the alpine one.

Growing on rocks, together with lichens, they thicken, through the death of their gametophyte and sporophyte, the humus blanket, making it possible for other plant species to grow on these rocks.

Moss can be used as bedding for cattle, to fill mattresses in mountain areas, as a thermal insulating layer between greenhouse windows or to wrap plants whose moisture must be preserved during transport.

The genus *Sphagnum* plays an important role in the formation of peat, and when dried and sterilized it successfully replaces cotton wool.

Some species, developing in large quantities in mountain and lowland hay, prevent the development of other plants. In this case the muscles must be removed by raking.

The 24 species of bryophytes identified in the Otăsău basin belong to 24 families and 2 classes: Hepaticae and Musci.

Bryophyte species are: *Blasia pusilla* L., *Concepalus conicus* (L.), *Marchantia polymorpha* L., *Metzgeria furcata* (L.), *Blepharostoma trichophyllum* (L.), *Cephalozia connivens* (Dicks.), *Frullania dilatata* (L.), *Hylocomium splendens* (Hedw.), *Plagiothecium undulatum* (L.ap.Hedw.), *Platygyrium repens* (Brid.), *Pleurozium schreberi* (Wild.), *Polytrichum commune* L., *Rhytidiadelphus squarrosus* (L.), *Rhytidiadelphus triquetrus* (L.), *Ptilium crista-castrensis* (L. ap. Hedw.), *Neckera crispa* (L.), *Isothecium myurum* (Polich.), *Funaria hygrometrica* L. ap. Hedw., *Eurhynchium striatum* (Schreber), *Drepanocladus aduncus* (Hedw.), *Diphyscium foliosum* Mohr., *Dicranum scoparium* (L.) Hedw., *Climacium dendroides* (Hedw.), *Sphagnum cuspidatum* Ehrh. em. Warnst.

Of the total species identified in the Otăsău basin, 5 species are found in the lists of rare, endangered or vulnerable species (S. Ștefănuț, 2009).

The bryophytes identified are present in all vegetation layers, as well as in all vegetation formations, even if they show great qualitative and quantitative variations depending on local conditions. From the total of bryophyte species identified in the Otăsău basin, 5 species are found in the

lists of rare, endangered or vulnerable species:

Rare or vulnerable species of bryophytes found in the basin Otăsău- Vâlcea are:

Climacium dendroides (Hedw.) Web. et Mohr., *Dicranum scoparium* Hedw., *Pleurozium schreberi* (Bird.) Lindb., *Hylocomium splendens* B.s.G. și *Rhytidiadelphus triquetrus* (Hedw.) Warnst.

Special attention must be paid to the protection and conservation of biodiversity, because the researched territory is located in an area where forests are overexploited.

Regarding the protection and preservation of biodiversity, special attention must also be paid to tourism and overgrazing.

CONCLUSIONS

The mycological flora of this territory is particularly rich and diverse in composition, most cryptogams find in this area the most favorable conditions for their development.

Of the total bryophyte species identified in the Otăsău valley, 5 species are found in the lists of rare, endangered or vulnerable species. Special attention must be paid to the protection and conservation of biodiversity, because the researched territory is located in an area where forests are overexploited. Most mosses prefer moist biotopes: forests, meadows, swampy areas, etc. According to the substrate on which mosses live, they can be: tericoli (on the ground), saxicol (on rocks) and corticoli (on the bark of trees).

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