

Influence of Mycorrhizae Inoculation on Grape Ripening and the Aromatic Profile of the Must of Variety Graševina (*Vitis vinifera* L.)

Utjecaj inokulacije mikorize na dozrijevanje grožđa i aromatski profil mošta kultivara Graševine (*Vitis vinifera* L.)

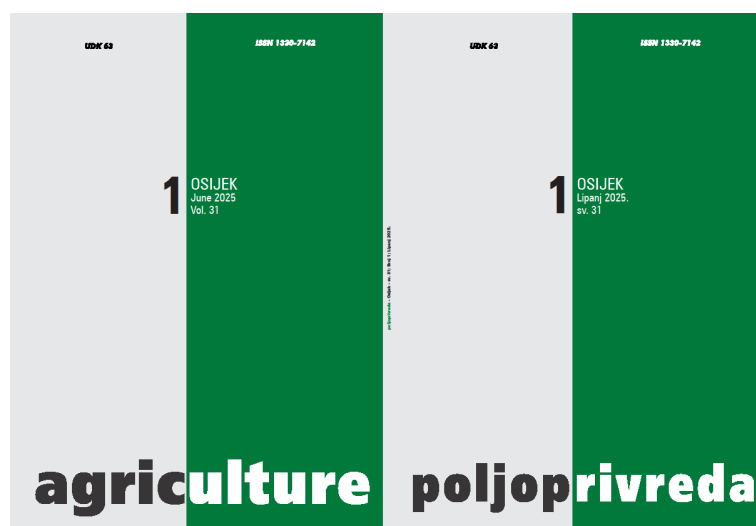
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Poljoprivreda / Agriculture

ISSN: 1848-8080 (Online)

ISSN: 1330-7142 (Print)

<https://doi.org/10.18047/poljo.31.1.3>



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THE INFLUENCE OF MYCORRHIZAE INOCULATION ON THE GRAPE RIPENING AND THE AROMATIC PROFILE OF THE GRAŠEVINA VARIETY'S (*Vitis vinifera* L.) MUST

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Original scientific paper

Izvorni znanstveni članak

SUMMARY

The research was conducted with the objective of determining the influence of inoculation with the live mycorrhizal mycelium on the grape ripening and the concentration of aromatic compounds in the Graševina variety's must in the winegrowing region of Kutjevo. Graševina was grafted onto the Vitis berlandieri x Vitis riparia SO4 vine rootstock. The vines were of the Guyot variety, pruned with up to ten buds per vine. A mycorrhizal suspension in the amount of 20 ml, with approximately two thousand propagation units of living mycorrhizal mycelium, was inoculated into the immediate root zone. Climatic conditions in the research years differed significantly, as did the harvest dates. The first year was characterized by extremely rainy conditions, with excessive precipitation. During the second research year, the average air temperature at the time of grape ripening was approximately higher by 3 °C higher than that in the first year, and the average amount of precipitation was in the optimal range. The experiment was executed in two treatments with four repetitions, according to the scheme of a random block arrangement. A statistically significant difference was detected neither in the grape-ripening dynamics of grape ripening nor in the nature, but the mycorrhizal treatment had a higher average bunch weight in 2015. In the grape must of the 2014 harvest, mycorrhiza influenced a higher concentration of 1-hexanol, whereas a lower concentration of nerol was detected in 2015.

Keywords: mycorrhiza, *Vitis vinifera* L., aromatic composition of must, grape ripening

INTRODUCTION

Mycorrhizal fungi play a vital role in the grapevine's health, growth, and environmental adaptation, and knowledge about the diversity, interaction, and role of grapevine mycorrhizae provides new opportunities in sustainable vineyard management (Viret and Gindo 2024). The term *mycorrhiza* (from the Greek words *mykes* "fungus" and *rhiza* "root") implies an association of fungi and plant roots that are involved in the absorption of nutrients from the soil (Sapp 1994; Remy et al. 1994). A primary classification of mycorrhizal symbioses according to the plants would be completely impractical due to a very large number of systematically different species.

The fungi involved in mycorrhizae mainly belong to the endophytes, with a predominantly nonseptate mycelium belonging to a subdivision of Glomeromycota and the subdivisions of Ascomycota and Basidiomycota, characterized by the formation of septa (Smith and Read, 2009). In grapevines, the arbuscular mycorrhiza (AM) and ectomycorrhiza (ECM) are of particular importance.

The name *arbuscular* comes from the characteristic structures, arbuscules, that occur in the root cortex cells of a large number of plants colonized by the AM fungi, together with reservoirs, or vesicles, located within or between the cells (Smith and Read, 2009). A low specificity of the AM fungi in the soil leads to the possibility of multiple fungal species colonizing the roots of a single plant (Wilson, 1994). The ectomycorrhizae (ECM) are characterized by three structural components: a mycelial sheath, or mantle, which covers the root, a Hartig network that forms a labyrinth of internal hyphae between the epidermal and cortical cells, and an external

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mycelium that grows toward the soil and forms a system of hyphae, which are a connection with the soil and with the sporocarp of the fungi that form the ectomycorrhiza (Smith and Read, 2009).

Mycorrhizal vine grafts demonstrate enhanced survival and improved tolerance to adverse conditions during the acclimation phase. They also enjoy an improved physiological and nutritional status and have a higher relative water content and photosynthetic intensity (Bruissson et al., 2016). According to Schellenbaum et al. (1991), a mycorrhizal symbiosis in grapevine increases the root network's branching, length, and density.

In the vineyard soils, the different groups of AM fungi are detected, depending on the depth. In the upper soil layers, the plant cover in the interrow part of the plantation affects the diversity of the AM fungal population (Schreiner 2020). The effectiveness of mycorrhizal symbiosis in grapevines depends on the strain of mycorrhizal fungus, grapevine characteristics, soil type, and their interaction (Hayman, 1982; Jackson, 2020). The differences in the colonization of mycorrhizal fungi on grapevines depend on the variety, grapevine rootstock, and the vine load (Schreiner, 2003; Aguin et al., 2004). Certain grapevine mycorrhizal fungi are tied to the specific terroirs and are one of the factors that characterize the protected designations of origin (PDO; Nanetti et al. 2023).

The mycorrhizae increased the grapevine resistance to the plant pathogens and a lack of moisture in the soil (Torres et al. 2018). Eftekhari et al. (2010) determined a positive influence of the mycorrhizal fungi *Glomus intraradices*, *G. mosseae*, *G. fasciculatus*, and their combinations on the growth and chemical composition of four grapevine cultivars ('Shahroodi,' 'Asgari,' 'Keshmeshi,' and 'Khalili'). The leaf area increased, and an increased concentration of chlorophyll, and the proportion of total phenols in the roots and leaves of the treated plants were also determined. A resistance to the negative influence of heavy metals and pathogens on the vine was increased, while the growth of saplings was simultaneously stimulated due to better vine nutrition (Franco et al. 2024). The inoculated vines significantly increased the grape yield and quality, resulting in an earlier grape ripening, and the chemical composition of berries was also changed (Karagiannidis et al. 2007; Nicolas et al. 2015). Karoglan et al. (2015) detected that the application of Mykoflor inoculant positively affected the yield and mechanical cluster composition of the Traminer variety. Given a higher yield, mycorrhizae, as expected, led to a decrease in the sugar content, as well as in the total acidity of the Traminer variety's must. Torres et al. (2019) established that an inoculation with the mycorrhizal fungi increased the content of glucose and amino acids, as well as the aromatic precursors, in the grapes of the Tempranillo variety. Mycorrhizae can be an alternative to the exogenous application of nitrogen compounds to increase the content of amino acids in grapes, which can affect the aromatic characteristics of wine.

According to Osrečak et al. (2020), a triennial study on the Kraljevina and Portugizac varieties discovered that a mycorrhizal inoculant increased the nature, sugar content, and basic organic acids (tartaric, malic, and citric). An arbuscular mycorrhiza on the Tempranillo variety had a positive effect on drought resistance and the maintenance of an optimal ratio of sugars and organic acids at lower temperatures (Goicoechea et al. 2023). The inoculation of mycorrhizal fungi on the Tempranillo variety improved parameters related to phenolic maturity, such as anthocyanin content and increased antioxidant activity under elevated temperature conditions, demonstrating a protective role of inoculation with a positive impact on berry quality (Torres et al. 2016). In a field trial in a Sangiovese vineyard, a mycorrhizal fungal treatment increased the organic acid content, especially the malic and tartaric one, while increasing the sugar content. From an aromatic point of view, the complexity of the wine was improved, with a greater presence of fruity and citrus notes (Mercanti et al. 2024).

The grapes contained more or less aromatic compounds or their precursors, depending on the characteristics of a cultivar itself, vine metabolism, environmental conditions, or technological processes during the grape and wine production (Radovanović, 1986; Mušević, 1985; Rutan et al., 2018). The individual aromatic properties of must produced from a particular grape variety were a result of different concentrations of numerous compounds, as well as of their numerous combinations (Riberau-Gayon et al. 2006). The grapes (*Vitis vinifera* L.) generally did not have a specific aroma, except for some muscat cultivars or the Cabernet Sauvignon. However, other grape varieties also contained the compounds and aroma precursors from the groups of compounds, such as the C-6 compounds, monoterpenes, norisoprenoids, furan compounds, and lactones. The groups of compounds C13-norisoprenoids, β -ionones, and β -damascenones contributed to a more diverse range of aromas, while the lactones, alcohols, phenols, and benzenoids also significantly contributed to the aroma in several grapevine varieties (Ryona and Sacks, 2013).

Graševina is the most important Croatian wine variety, grown on 4,347 ha; what is more, Croatia is the leading country in terms of Graševina's presence in a total wine-grape varieties' assortment and is also the leader in terms of areas under Graševina (Eurostat 2022; Apprrr 2022). In their atlas, Robinson et al. (2012) list the synonym *Graševina* as the primary name of the variety due to a great importance of the variety for the Republic of Croatia. Although Croatia is recognizable by this variety, its origin has not been fully established. According to recent research, it probably originates from Italy, since it is related to the Italian variety Orsolina (Preiner et al. 2022). The Italian origin is also suggested by numerous synonyms, such as the *Italian Riesling*, *Riesling Italico* (Mirošević and Turković, 2008.; Tomašević et al. 2023), and the like. The research hypothesis was to determine the influence of grapevine mycorrhiza on the dynamics

of grape ripening and the concentration of individual aromatic compounds in the Graševina grapes.

MATERIALS AND METHODS

The research was conducted on the experimental plantation of the University of Applied Sciences in Požega, on the Vražjak location, in the territory of the village of Podgorje in the Kutjevo vineyard of the Slavonian wine-growing region. The vineyard had a southbound exposure and a very gentle terrain slope, from 250 to 270 meters above sea level.

A large part of Mount Papuk is made up of soils with the Paleozoic silicate rocks and silicate quartz metamorphic rocks. The soils are predominantly medium deep and shallow, in some places deep, loamy or sandy loamy, and skeletal (Gagro 1986). The soil reaction was acidic to strongly acidic, and in a smaller part neutral or slightly alkaline. The experimental vineyard on the Vražjak location belonged to a category of neutral soils. The humus content in the upper soil part was weakly humusy. These soils were moderately to highly permeable to water, and natural drainage was pronounced on the steep positions. In the vineyard positions, precipitation erosion was very high. The terrain configuration and a shallow vineyard-soil profile reduced the possibility of water retention in the soil (Kovačević, 1977). The soil quality on the slopes of Papuk between the villages of Podgorje and Vetovo was average low, and the soils were mostly unsuitable for cultivation due to a pronounced presence of skeletons and a shallow profile. The measures to combat erosion had to be implemented. The natural vegetation was sylvan, although the dry pastures predominated.

The vineyard was planted in 2006. The rootstock was SO4, and the grapevine clone was A 3-3. The training form was Guyot, with a load of ten buds. The planting distance was 2.1 x 0.8 m. The soil was cultivated every second row, and the rest was grassed. Soil cultivation was rotated every year. The weeds were eradicated

mechanically, and an integrated pest management was implemented. The plantation was manured and, if necessary, fertilized by foliar feeding.

The experiment was conducted in two treatments with four replications, according to a randomized block design. The first treatment was a control one, without an inoculation of the vines with mycorrhiza (NOMYC), and the second one consisted of the vines inoculated with a mixture of mycorrhizal fungi (MYC). Each replication consisted of eighteen vines. The distance between the treatments was about 50 m to avoid a possible contamination of the control vines (NOMYC). In 2013, the mycorrhizal inoculant Mykoflor was applied to the main root area at a depth of about 30 to 50 cm prior to flowering.

When conducting the viticultural experiments, it was necessary to interpret the obtained results while considering the climatic conditions, and the grapevine mycorrhizae had a direct positive impact on the accessibility of water in dry conditions. Although the average annual climate parameters might be within an optimal range, the periodically adverse and extreme climate factors, such as the long dry periods with the high temperatures or short intense showers, became more frequent. The data on the values of individual climate factors for 2014 and 2015 were collected at the Vidim Meteorological Station in Kutjevo, located at the same altitude as the experimental plantation, from which it was about 5 km distant.

Table 1 shows an average monthly temperature and monthly precipitation during the years of the study. According to the literature, the average annual air temperature in the Kutjevo vineyard ranges from 10.5 to 11.8 °C (Mirošević et al. 2008; Maletić et al. 2008; Sijerković 2014). It is clear that the average annual temperatures in both years of the study were higher than the multiannual average. Over the course of the study, a difference in the average monthly air temperature during the grape-ripening phase in August amounted to 6.9 °C.

Table 1. Air temperature (°C), rainfall (mm / m²) in 2014 and 2015, Kutjevo – Vidim Meteorological Station

Tablica 1. Temperatura zraka (°C) i oborine (mm/m²) u 2014. i 2015. godina, Meteorološka postaja Kutjevo – Vidim

Month / Mjesec	Air temperature (°C) / Temperatura zraka (°C)		Rainfall (mm/m ²) / Oborine (mm/m ²)	
	2014	2015	2014	2015
January	4.8	3.6	27.6	63.8
February	5.6	2.6	47.8	36.3
March	10.2	7.4	49.9	62.1
April	12.7	11.2	94.0	20.7
May	14.9	17.0	257.3	184.1
June	19.8	20.4	112.6	30.2
July	21.1	24.5	110.3	40.2
August	19.6	26.5	84.4	3.3
September	16.4	18.2	85.1	42.0
October	13.2	10.3	136.1	154.9
November	8.8	8.8	33.1	52.8
December	4.0	4.0	63.0	6.1
Annual average / sum	12.6	12.9	1101.2	696.5

During 2014, the amount of precipitation was 1101.2 mm/m², and in 2015 it was 696.5 mm/m². According to the presented data, the amount of precipitation in 2015 was within an optimal range of 600 to 800 mm/m² (Mirošević et al. 2009), while in 2014 there was an excessive precipitation.

During the harvests of 2014 and 2015, the following data were collected: the number of clusters per vine, nature per vine, and an average cluster mass. Each vine was separately picked and weighed, and the clusters on each vine were individually counted. The data on the nature excluded the Martin's grapes. The cluster mass was calculated based on a ratio of nature per vine and the number of clusters per vine. The nature of grapes per hectare was calculated based on the yield per vine and the number of vines per unit area. The harvest date was determined by a combined monitoring of sugar content and total acidity. The samples were taken from the part of the experimental plantation, which did not include the marked treatment replicates.

The average sugar content was determined using a refractometer and an Oechsle must balance and was expressed in Oechsle degrees (°Oe). A total must and wine acidity was determined in accordance with the OIV standards (2007) by neutralizing the must and wine with 0.1 M NaOH using the bromothymol blue indicator. The must's and wine's pH values were determined using the Beckman expandomatic pH meter, type SS2.

The analysis of aromatic compounds in grapes was conducted while applying a solid-phase extraction (SPE) and gas chromatography. The grape skin was manually separated and homogenized in a homogenizer. From the obtained homogenate, 4 g was weighed and mixed with 100 mL of β -glycosidase (endozym β -split) prepared in a citrate buffer at pH = 5.0. A mixture of grapes and the enzyme preparation of beta-glucosidase was incubated for 12 hours at 40°C. Subsequent to the incubation, the

mixture was centrifuged for 20 minutes at 3600 rpm. The hydrolysates were filtered and subsequently subjected to a solid-phase extraction. The aromatic compounds from the resulting solution were extracted onto a solid phase using the ethylvinyl-benzene-divinylbenzene copolymer (Lichrolut EN, Merck, Germany) as a sorbent. A procedure for the extraction of grape-released aromatic compounds included the following: a) concentrating the column by washing it with 3 mL of dichloromethane and 3 mL of methanol, and b) applying the sample and washing the eluate with 2 mL of dichloromethane. The eluate was then evaporated to dryness under a stream of nitrogen, redissolved in 750 μ L, and injected into a gas-chromatography system.

An analysis of variance (ANOVA) was performed to process the results, and the differences between significant factor levels were tested while administering Fisher's LSD test. The SAS System for Windows 9.3 (2012) was used to analyze the data.

RESULTS AND DISCUSSION

The average bunch weight and yield per vine during the two years of study are shown in Table 2. In the 2014 treatment without mycorrhiza, a higher yield per vine was recorded, but without a statistical difference, and the average bunch weight was only 3 grams higher. In 2015, the mycorrhiza influenced a higher average bunch weight and was statistically justified. In the mycorrhized vines, the yield was higher but without a statistically significant difference.

The grape-ripening dynamics, with the changes in sugar and acid content per treatment, were observed in both years of the study. Regarding the different climatic conditions in the research years and the grapevine-development dynamic during a growing season, the initial dates for the collection of data on sugar content and total grape acids were also different.

Table 2. The mass of bunches (g) and the yield per vine (g), Graševina, 2014 and 2015

Tablica 2. Masa grozda (g) i prirod po trsu (g), graševina, 2014. i 2015. godine

Harvest	Cluster mass (g) / Masa grozda (g)		Yield per vine (g) / prirod po trsu (g)	
	NOMYC	MYC	NOMYC	MYC
2014	133	130	2906	2732
2015	65 ^b	70 ^a	1314	1552

#a, b – the different letters mark a statistically significant difference at $P < 0.05$, based on Fisher's LSD test

#a,b – različita slova označuju statistički signifikantne razlike između prosjeka okolina, odnosno kultivara kod $P < 0.05$ na osnovi Fisherova LSD testa

In 2014, which was extremely rainy, the yield was almost twice as large as in 2015. Thus, the differences in a grape maturity degree between the seasons were

expected. The detected differences in sugar content and total acidity between the treatments were not statistically justified either in the year of research or in any sampling.

Table 3. A sugar-content dynamic (°Oe) and a dynamic of total grape acidity (g/L), Graševina, 2014 and 2015.

Tablica 3. Dinamika sadržaja šećera (°Oe) i dinamika ukupne kiselosti (g/L) u grožđu, graševina, 2014. i 2015. godine.

Harvest / Berba	2014			
	Sugar content / Sadržaj šećera (°Oe)		Titratable acidity / Ukupna kiselost (g/L)	
Date	NOMYC	MYC	NOMYC	MYC
26 Aug.	58	54	13.1	14.8
19 Sept.	63	64	8.1	8.3
25 Sept.	70	72	7.5	7.7
7 Oct.	79	82	7.0	7.1
Year	2015			
	Sugar content / Sadržaj šećera (°Oe)		Titratable acidity / Ukupna kiselost (g/L)	
Date	NOMYC	MYC	NOMYC	MYC
4 Aug.	23	22	35.1	31.1
19 Aug.	69	75	9.6	9.2
26 Aug.	83	87	8.3	8.1
3 Sept.	98	97	7.2	7.6

In 2014, the highest values of all C-6 compounds were recorded in the MYC treatment. However, only in the case of the 1-Hexanol, there was a statistical justification for the influence of mycorrhizal fungi inoculation on a higher concentration of this compound in the Graševina grapes. During 2015, the values of the C-6 compounds varied between the treatments, depending

on the time of grape sampling, and the differences were not statistically significant. The values of all specific C-6 compounds were higher in 2015 in both treatments when compared to those in 2014. The content of the (E)-2- hexenal stood out in particular, having been several dozen times higher when compared to the values in 2014.

Table 4. A concentration of the C-6 compounds (µg/kg), monoterpenes (µg/kg), norisoprenoids (µg/kg), furan compounds, and lactones (µg/kg) in grapes, Graševina, 2014 and 2015

Tablica 4. Koncentracija C-6 spojeva (µg/kg), monoterpena (µg/kg), norizoprenoida (µg/kg), furanskih spojeva i laktona (µg/kg) u grožđu, graševina, 2014. i 2015. godine

Harvest / Berba	2014		2015	
Treatment / Tretman	NOMYC	MYC	NOMYC	MYC
C-6 compounds				
(E)-2- hexenal	0	1.36	31.19	26.58
(E)-2- Hexen-1-ol	4.82	5.28	6.35	8.45
1- Hexanol	0.37 ^b	0.91 ^a	1.02	0.98
In total	5.19	7.55	38.56	36.01
Monoterpenes				
Trans-Rose oxide	0.41	0.75	1.64	2.08
Linalool	0.68	0.69	2.15	5.63
α-Terpineol	2.50	3.52	5.63	5.60
Citronellol	1.31	0.92	6.99	7.78
Nerol	0.37	1.20	11.57 ^a	6.52 ^b
Geraniol	0.62	0.94	21.08	21.53
In total	5.87	8.05	49.05	49.16
Norisoprenoids				
β- Damascenone	1.80	3.71	3.5	7.3
α-Ionone	0.98	0	4.31	0
β-Ionone	8.48	9.49	4.33	8.27
In total	10.37	13.2	12.91	15.59
Furan compounds and lactones				
Furfural	0.17 ^a	0.12 ^b	0.05	0.04
Furfuryl alcohol	0	0	0.25	0
In total	0.17 ^a	0.12 ^b	0.3	0
γ-Nonalactone	4.32	4.93	3.65	4.58

^{#a, b} – the different letters mark a statistically significant difference at $P < 0.05$, based on Fisher's LSD test

^{#a, b} – različita slova označuju statistički signifikantne razlike između prosjeka okolina, odnosno kultivara kod $P < 0.05$ na osnovi Fisherova LSD testa

The terpenes in grapes were synthesized during ripening, and their content and ratio depended on a number of factors, such as a variety, soil, climate, and ampelotechnical interventions in the vineyard; moreover, they exerted a significant influence on the grape and wine aroma (Vilanova and Sieiro, 2006). In the first year of study, no statistically significant differences were discovered in the concentration of either individual or total monoterpenes.

In 2015, a concentration of almost all individual monoterpenes was higher in the MYC treatment, and the differences were not statistically significant, with the exception of nerol. A concentration of nerol was significantly higher in the treatment without mycorrhiza and amounted to 11.57 $\mu\text{g/kg}$, if compared to the treatment with mycorrhiza, which amounted to 6.52 $\mu\text{g/kg}$. The concentration of α -Terpineol and geraniol was the same in both treatments. The compounds associated with roses—that is, geraniol, linalool, and nerol—were represented by the higher values than those of the detection threshold: linalool in the 2014 MYC treatment and nerol in the 2015 NOMYC treatment. The results of a positive influence of mycorrhiza on the concentration of aromatic compounds in grapes were also reported by other authors (Bruissson et al. 2016; Torres et al. 2016; Torres et al. 2019).

The several times higher monerpene values were detected in the second year of study, regardless of the treatment. Although Velasquez et al. (2020) established that the arbuscular mycorrhizal fungi *Funneliformis mosseae* negatively affected the accumulation of the C13 norisoprenoids in the plant tissue of the 'Sangiovese' cultivar. In this study, however, the total concentration of this group of compounds was higher in the treatment with a mycorrhizal inoculum, although no statistically significant differences were detected. A statistical data analysis did not reveal any significant differences between the average values of norisoprenoids in the must. The concentrations of β -Damascenone and β -Ionone were higher in the MYC treatment, in both study years.

In 2014, the presence of furfural alcohol from the group of furan compounds was not determined in the berries of the Graševina grape variety. The value of the NOMYC treatment, amounting to 0.17 $\mu\text{g/kg}$, as shown in Table 4, was significantly different from the MYC treatment, which implies that the mycorrhizal fungus had a negative impact. The content of the γ -Nonalactone was higher in the treatment with mycorrhizal symbiosis, but the differences illustrated were not statistically justified.

In 2015, the values of the furan compounds in the Graševina berries were higher in the control treatment (NOMYC), while the content of γ -Nonalactone was higher in the MYC treatment. A statistical data analysis did not determine any justified differences between the 2015 treatments.

CONCLUSION

Based on a biennial study of the influence of mycorrhizal preparation Mykoflor on the Graševina grape variety

(*Vitis vinifera* L.), no positive effect on the increase of the grape yield was determined. A higher average mass of mycorrhizal clusters was determined in 2015. The influence of mycorrhiza on the grape-ripening dynamic—that is, on the movement of average sugar content and total acids during the grape-ripening phenophase—was not confirmed. In 2014, the influence of mycorrhiza on the grapevine grapes' total aromatic potential was reflected in an increase in the concentration of 1-Hexanol and a significantly lower furfural content. In 2015, a significantly lower nerol content was determined in the grapes treated with mycorrhiza. The influence of mycorrhiza on the concentration of monoterpenes, furan compounds, and lactones in the grapevine was not discovered.

On the basis of conducted research and current knowledge, it is likely that a very strong influence of environmental factors reduced the influence of mycorrhiza on the grape-ripening dynamic and the concentration of aroma precursors in the Graševina must.

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UTJECAJ INOKULACIJE MIKORIZE NA DOZRIJEVANJE GROŽĐA I AROMATSKI PROFIL MOŠTA KULTIVARA GRAŠEVINE (*Vitis vinifera* L.)

SAŽETAK

Istraživanje je provedeno s ciljem utvrđivanja utjecaja inokulacije živoga mikoriznog micelija na dozrijevanje grožđa i koncentraciju aromatskih spojeva mošta sorte graševina u vinogorju Kutjevo. Graševina je cijepljena na loznu podlogu Vitis berlandieri x Vitis riparia SO4. Rez je bio mješovit, s jednim reznikom i jednim lucnjem, a opterećenje trsa iznosilo je oko deset pupova. U neposredno područje korijena inokulirano je 20 ml mikorizne suspenzije s oko dvije tisuće propagacijskih jedinica živoga mikoriznog micelija. Različiti klimatski čimbenici tijekom vegetacije utjecali su na dinamiku dozrijevanja i termin berbe. Prvu godinu istraživanja karakterizirali su izrazito kišni uvjeti s prekomjernim oborinama. Tijekom druge godine istraživanja prosječna temperatura zraka u vrijeme dozrijevanja grožđa bila je veća za oko 3 °C u odnosu na prvu godinu, a prosječna količina oborina bila je u optimalnome rasponu. Pokus je proveden u dvama tretmanima s četiri ponavljanja prema shemi slučajnoga bločnog rasporeda. Nije utvrđena statistički opravdana razlika u dinamici dozrijevanja grožđa kao ni u prirodi, ali je u 2015. godini tretman s mikorizom imao veću prosječnu masu grozda. U moštu grožđa ubranoga tijekom berbe 2014. godine mikoriza je utjecala na veću koncentraciju 1-heksanola, a u 2015. na manju koncentraciju nerola.

Ključne riječi: mikoriza, *Vitis vinifera* L., aromatski sastav mošta, dozrijevanje grožđa

(Received on February 2, 2025; accepted on April 14, 2025 – Primljeno 2. veljače 2025.; prihvaćeno 14. travnja 2025.)