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COMPARATIVE RESEARCH ON THE INFLUENCE OF SOME TECHNOLOGICAL SEQUENCES FROM CONVENTIONAL AND ORGANIC VITICULTURE

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Abstract

Although organic viticulture has slowly developed in last decades, especially in Europe, with Italy, France, and Spain as main promoters, in Romania organic viticulture is still at the beginning. The research focused on the main technological sequences (soil management, fertilization, disease, and pest control) in conventional and organic viticulture and the influence on leaf area, yield, grape quality, management costs, and profit in 'Cabernet Sauvignon', 'Feteasca Neagra', 'Pinot Noir', 'Italian Riesling', and 'Chardonnay' wine varieties from Recas-Petrovaselo Vineyards. Variants from organic grapevine registered lower yields compared to the conventional ones, without significant differences in the grapes quality. The management and production costs were higher in the organic viticulture plots, but also the profit was higher due to demand and the higher price of wine. Organic viticulture, through the correlation of the technological sequences with the requirements of the varieties and natural resources from the growing area, has great chances to spread more and more based on the demand and the development of a stable market in Romania.

Key words: *organic viticulture, quality, cost, profit, grapevine.*

INTRODUCTION

Viticulture is an intensive sector of horticulture characterized by a high degree of land use (Roselli et al., 2020). However, in recent years, organic viticulture is beginning to spread on larger areas (Meissner et al., 2019). The organic viticulture is mostly concentrated in Europe (over 85% - OIV, 2019); among the European countries, Spain, Italy, and France encompassed the majority of organic grapevine growing areas (Mann et al., 2012). In Romania, organic viticulture is just at beginning, with very few vineyards converted from conventional viticulture (Dobrei et al. 2018). Therefore, only few studies exist concerning the research results in organic viticulture and grape yield.

Organic viticulture can be differentiated from conventional one by soil management, fertilization, disease and pest control (Merot & Wery, 2017). In addition, vineyard management, have an important share in the grape production costs, and also require the higher inputs with possible polluting effect on the soil, environment and wine–based products (Bindi & Nunes, 2016; Azorín & Garcia, 2020). By optimizing the organic vineyard management result lower pollutant emissions, without significant differences in grape production, quality and economic indicators compared to conventional viticulture (Baumgartner et al., 2007). European research in recent years has provided winegrowers with various soil management solutions with lower fuel consumption and less aggressive with the soil and the environment (Dobrei et al., 2015). Also, there are currently effective alternatives for replacing the conventional fertilizers and classic schemes for diseases and pests control, to can obtain quantitative and qualitative grape production compared to conventional viticulture, in more environmentally friendly conditions (Merot et al., 2020). However, these new solutions must be chosen carefully, according to each variety particularities, the pedo-climatic resources of each grape-growing area and the technical and financial possibilities of each vineyard (Dobrei et al., 2016).

MATERIALS AND METHODS

The research was carried out in the Recas Wine Center, Petrovaselo area, in a full maturity vineyard in expectation for conversion to organic viticulture, during 2016-2018.

The research focused on the main technological sequences which are different from conventional to organic viticulture, namely: soil management system, fertilization, diseases and pest control. Separate experiments were organized for each technological sequence, in order to observe the impact and the differences between the variants for conventional and organic viticulture. The weight and impact of the three technological sequences were also observed separately. The planting distances were 2.2 meters between rows and 1 meter between vines on row resulting 4545 vines density per hectare.

The main varieties cultivated within the vineyard ('Cabernet Sauvignon', 'Feteasca Neagra', 'Pinot Noir', 'Italian Riesling' and 'Chardonnay') were observed for suitability to the requirements of organic viticulture in the soil and climate conditions of the local grapevine growing area. Observations and determinations were made on the influence of experimental variants on physiological indicators (leaf area, photosynthetic efficiency), on grape production and quality, as well as on economic indicators (total costs, production value, production cost and profit). Leaf area was measured by LI- 3100C leaf area meter (LI-COR, Biosciences GmbH, Bad Homburg, Germany). Phothosynthetic efficiency was determined by gas exchange measurements on vine leaves with a portable steady-state gas-exchange system (Li-6200, Licor, USA).

All data were statistically processed by using XLStat statistical software 16.0.6741.2048 version. Pearson correlation was performed to examine the relationship among measurements and yield components. PCA (Principal Component Analysis) illustrate the relationship among different variables (IR/C= 'Italian Riesling' Control; IR/H = 'Italian Riesling' Herbicides; IR/T+H = 'Italian Riesling' Tillage +Herbicides; IR/M= 'Italian Riesling' Mowing; IR/O= 'Italian Riesling' Organic; C/C= 'Chardonnay' Control; C/H = 'Chardonnay' Herbicides; C/T+H = 'Chardonnay' Tillage +Herbicides; C/M= 'Chardonnay' Mowing; C/O= 'Chardonnay' Organic; FN/C= 'Feteasca Neagra' Control; FN/H = 'Feteasca Neagra' Herbicides; FN/T+H = 'Feteasca Neagra' Tillage +Herbicides; FN/M= 'Feteasca Neagra' Mowing; FN/O= 'Feteasca Neagra' Organic; CS/C= 'Cabernet Sauvignon' Control; CS/H = 'Cabernet Sauvignon' Herbicides; CS/T+H = 'Cabernet Sauvignon' Tillage +Herbicides; CS/M= 'Cabernet Sauvignon' Mowing; CS/O= 'Cabernet Sauvignon' Organic; PN/C= 'Pinot Noir' Control; PN/H = 'Pinot Noir' Herbicides; PN/T+H = 'Pinot Noir' Tillage +Herbicides; CS/M = 'Pinot Noir' Mowing; CS/O= 'Pinot Noir' Organic).

RESULTS AND DISCUSSIONS

The PCA model was applied for leaf area and photosynthetic efficiency data for determination the relationship among variables when different soil management for 'Cabernet Sauvignon', 'Feteasca Neagra', 'Pinot Noir', 'Italian Riesling' and 'Chardonnay' varieties was applied.

Leaf area per vine highly influenced (r = 0.7570) the photosynthetic efficiency in leaf area/kg grapes, for 'Cabernet Sauvignon' and 'Feteasca Neagra' variety in all experimental variants, while for 'Italian Riesling', 'Chardonnay' and 'Pinot Noir', the correlation is negative regardless of soil management variant.

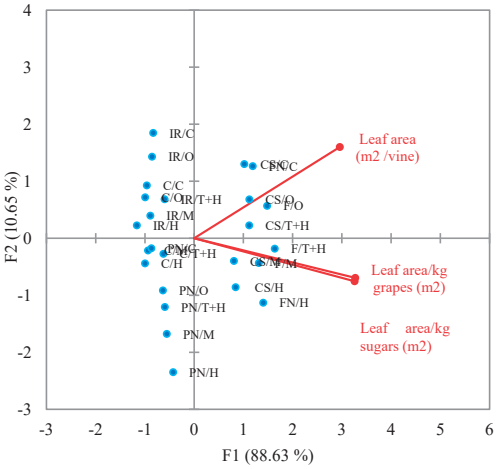

Figure 1. PCA correlation biplot for leaf area variability to soil management methods, during 2016-2018 growing seasons

The link is also strong between leaf area/vine and the leaf area/kg sugars achieved in grape berries (r = 0.7459) in 'Feteasca Neagra' and 'Cabernet Sauvignon' varieties; in 'Pinot Noir', 'Chardonnay' and 'Italian Riesling', the leaf area/vine did not influence the leaf area/sugars ratio. Factor 1 explains 88.63% of the variation of photosynthetic efficiency for both other variables (Figure 1).

The higher correlation between leaf areas per sugars yield in 'Cabernet Sauvignon' and 'Feteasca Neagra', which are more vigorous varieties, can be explained by several studies of Downton et al. (1987), Edsonet al. (1993), Nabi et al. (2000) or Petrie et al. (2000) which found that grapes are a strong sink that have the capacity to stimulates the photosynthetic rate in grapevine leaves maybe due to the demand for assimilates.

In Figure 2 it is presented the influence of different soil management methods on grape production and components during 2016-2018 growing seasons for the same five wine grape varieties. Sugars (kg/ha) content is highly correlated with the grape production (r = 0.905) in 'Cabernet Sauvignon' and especially in 'Italian Riesling' for conventional and organic soil management. Grape production explains 66.25% of data.

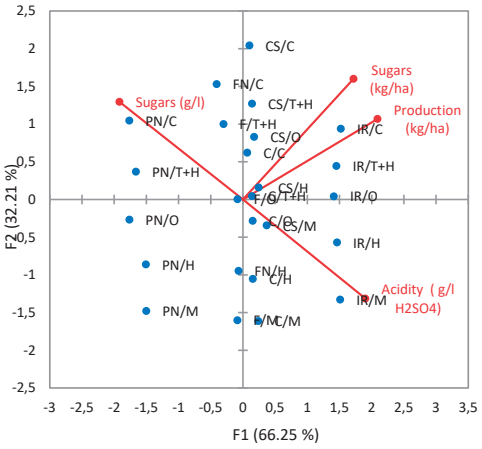

Figure 2. PCA correlation biplot for yield variables (reaction to soil management methods) during 2016-2018 growing seasons

Variables with the highest contribution were sugars content in all grape berries (kg/ha), grape production and sugars in must (g/l). Grape production and sugars yield (kg/ha) in 'Pinot noir' variety were negatively influenced in organic plots and those with herbicides and mowing soil management; the experimental plot with 'Pinot noir' and soil management by vegetation mowing has the lowest score. 'Chardonnay' variety reaction to soil management shows the higher variability. Factor 2 separated the soil management in the experimental plots and explains only 32.21% of the results; sugars yield (kg/ha) contributed the most.

Grape production had positive influence on sugar yield (kg/ha) (r = 0.9605) but the sugars (g/l) in the grape must had negative relationship with grape production and was also highly negative influenced by acidity (r = -0.9397).

Negative results for organic plots are contrary to the findings of Susaj et al. (2013) in Albanian variety 'Kallmet', comparing the organic and conventional soil management, and recorded higher yield in organic practices thanks to the improved soil properties

The behaviour of the wine grape varieties concerning the photosynthetic efficiency when different fertilizers (green manure, Fertilpolina, Humus Vita Stallatico and Fertilpolina + Cropmax) were used during 2016-2018 growing season is presented in Figure 3.

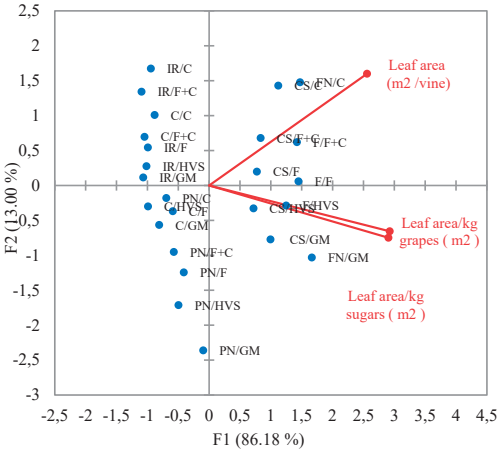

Figure 3. PCA correlation biplot for wine grape varieties (reaction to fertilization) during 2016-2018 growing seasons

PCA diagram show that leaf area per vine influence in acceptable limits the leaf area/kg grapes (0.7062) and leaf area/kg sugars (0.6852), mainly in 'Cabernet Sauvignon' and 'Feteasca Neagra' varieties. 'Chardonnay',

'Italian Riesling' and 'Pinot Noir' varieties had very low or no reaction to different methods of fertilization. There is a very strong correlation between leaf area/kg grapes and leaf area/kg sugars (r = 0.9749) in 'Cabernet Sauvignon' and 'Feteasca Neagra' varieties in all experimental plots (Figure 4).

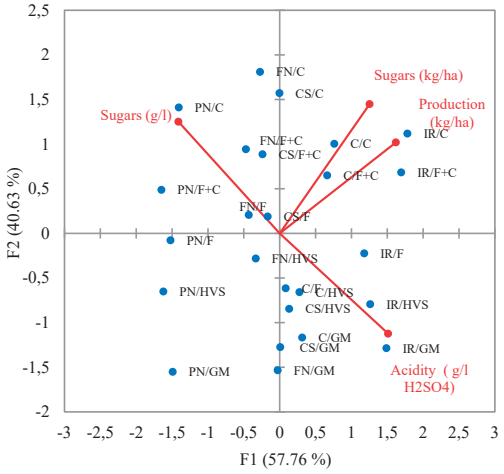

Figure 4. PCA correlation biplot for grape yield quality (reaction to fertilizers) during 2016-2018 growing seasons

Variables variability is explained in 57.76% by F1. The higher acidity was registered in 'Italian Riesling' variety (fertilized with green manure) and the lowest in the 'Pinot Noir' control plot (with highest concentration of sugar in the must). 'Italian Riesling' registered the highest grape production in the control and Fertilpolina+Cropmax plots; the grape production in the same plots was highly correlated with the sugar yield (kg/ha). Very close results for the same variables and fertilizers show the 'Chardonnay' variety. 'Pinot Noir' variety did not register positive reaction for fertilization with Fertilpolina, green manure or Humus Vita Stallatico for none of the variables.

The influence of the diseases and pest control system on the leaf area and the photosynthesis efficiency during 2016-2018 growing seasons is shown in Figure 5.

F1 explained 88.92% of the variability in PCA for the wine grape varieties leaf area after treatments (conventional, organic, and mixed) for diseases and pest control were applied. The highest leaf area per vine was registered in 'Cabernet Sauvignon' and 'Feteasca Neagra' varieties in all three treatments. Moderate leaf area shown 'Chardonnay' and 'Italian Riesling' varieties and the lowest leaf area was observed in 'Pinot Noir' variety.

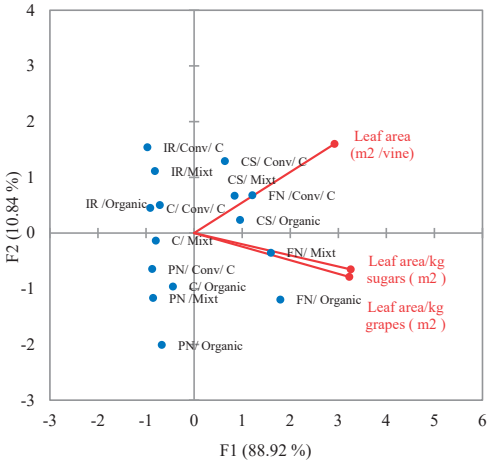

Figure 5. PCA correlation biplot for leaf area performance after diseases and pest control treatments during 2016-2018 growing seasons

The PCA for the grape yield quality variables during 2016-2018 growing season after diseases and pest control treatments accounted for 61.49% of the variability in the dataset (Figure 6).

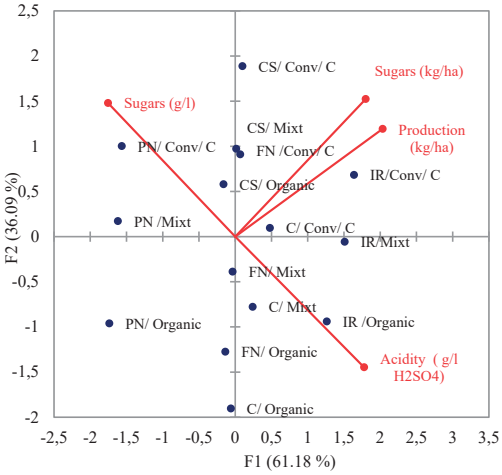

Figure 6. PCA correlation biplot for grape yield quality after diseases and pest control treatments during 2016-2018 growing seasons)

The PCA for the grape yield quality variables during 2016-2018 growing season after

diseases and pest control treatments accounted for 61.49% of the variability in the dataset (Figure 6). 'Cabernet Sauvignon' variety registered the highest results for sugar yield (kg/ha) and grape production (kg/ha), regardless of treatment, but 'Italian Riesling' shown the highest results for the same variables. Except for 'Cabernet Sauvignon' variety, in the other four varieties was found the highest acidity in organic and mixed treatments plots. In the grape must from conventional plot of 'Pinot Noir', it was observed the highest content of sugars (h/l); however, the 'Pinot Noir' grapes from the organic plot do not show any positive influence for quality variables after treatments application.

Organic grapevine growing create the microclimate that positively influence the vine development, grape yield and quality according to Klimenko et al. (2021) research in 'Chardonnay' grapes from Crimea on the background of natural grass strip middle rows.

Soil management systems, besides being expensive, pollute the soil and environment especially if they are not performed with enough caution (Bindi et al., 2016). Until few decades, bare soil middle rows were very common in vineyards, but for economic and environmental performance, many alternative possibilities of soil management have emerged; some, like mowing or cover crops are more environmentally friendly, while other like herbicides require less labour despite being polluting (Dobrei et al., 2015). The influence of soil management on some economic indicators, have different impact (Table 1). The highest production cost of all wine grape varieties was found for bold soil plot and the lowest production cost was found in the organic plot.

Concerning the influence of soil management on the grape production value, the highest value was obtained for the grapes from the organic plots, but this value is decisively influenced by the higher price of organic grapes. The lowest value of production was registered for the grapes harvested from plots maintained by mowing and herbicide application, mainly due to the lower grape yield.

Table 1. The influence of the soil management system on the economic indicators in 2018

Variant Soil management	Total costs (lei/ha)	Varieties	Production costs (lei/ton of grapes)	Production value (lei/ha)	Profit (lei/ha)	Difference to control (lei/ha)
Bare soil (C)	9200	Italian Riesling	1230	22700	13500	-
		Chardonnay	1300	19650	10450	-
		Feteasca Neagra	1270	29340	20140	-
		Cabernet Sauvignon	1310	31575	22375	-
		Pinot Noir	1270	25119	15919	-
Herbicides	8120	Italian Riesling	1070	21080	12960	-540
		Chardonnay	1120	18264	10144	-306
		Feteasca Neagra	1110	26760	18640	-1500
		Cabernet Sauvignon	1150	29535	21415	-960
		Pinot Noir	1110	23175	15055	-864
Tillage + Herbicides	8660	Italian Riesling	1060	22040	13380	-120
		Chardonnay	1100	19240	10580	130
		Feteasca Neagra	1110	28863	20203	63
		Cabernet Sauvignon	1110	30687	22027	-348
		Pinot Noir	1100	24360	15700	-219
Mowing	7800	Italian Riesling	1140	20466	12666	-834
		Chardonnay	1210	17900	10100	-350
		Feteasca Neagra	1180	25950	18150	-1990
		Cabernet Sauvignon	1240	29130	21330	-1045
		Pinot Noir	1180	22350	14550	-1369
Organic	8500	Italian Riesling	910	32340	23840	10340
		Chardonnay	950	28410	19910	9460
		Feteasca Neagra	940	37500	29000	8860
		Cabernet Sauvignon	960	40048	31548	9173
		Pinot Noir	940	31880	23380	7461

The most important indicator, profit, also differs depending on the soil management system; for all varieties, the maximum profit was realised on the organic plots, although, it did not yield the highest grape production, had the lowest production cost per plot and the

highest value of grape production. In the organic plots, the differences from the control vary between 10340 lei per hectare for the 'Italian Riesling' variety and 7461 lei per hectare for the 'Pinot Noir' variety. In the plots maintained by mowing and herbicide application, lower profit values were recorded, compared to the control for all wine grape varieties. Grapevine fertilization has been intensively studied, but due to the climate changes and variability, to the soil and fertilizers diversity, can be further improved, because there is not a perfect solution for universal fertilization recipes. Fertilization must be approached differently from one area to another, from grape variety to variety and from one year to another, because there is a large possibility to find new fertilizers and formulas to combine them to be more efficient. The conventional fertilization, generally based on complex chemical fertilizers, has been replaced in organic viticulture with other types of fertilizers, more environmentally friendly, with a higher recovery rate and with a less harmful impact on wine products and implicitly on humans (Table 2).

Table 2. The influence of the fertilization treatments on the economic indicators in 2018

Variety	Fertilizers	Total costs (lei/ha)	Production costs (lei/ton grapes)	Production value (lei/ha)	Profit (lei/ha)	Difference to control (lei/ha)
Italian Riesling	Conventional (C)	8850	818	21648	12798	-
	Green manure	9400	1039	27147	17747	4949
	Fertilpolina	9200	974	28344	19144	6346
	Humus Vita Stallatico	7950	863	27642	19692	6894
	Fertilpolina+Cropmax	9800	937	31380	21580	8782
Chardonnay	Conventional (C)	8850	908	19486	10636	-
	Green manure	9400	1160	24306	14906	4270
	Fertilpolina	9200	1116	24738	15538	4902
	Humus Vita Stallatico	7950	948	25167	17217	6581
	Fertilpolina+Cropmax	9800	1032	28488	18688	8052
Feteasca Neagra	Conventional (C)	8850	961	27621	18771	-
	Green manure	9400	1235	30444	21044	2273
	Fertilpolina	9200	1117	32936	23736	4965
	Humus Vita Stallatico	7950	995	31964	24014	5243
	Fertilpolina+Cropmax	9800	1139	34432	24632	5861
Cabernet Sauvignon	Conventional (C)	8850	942	28197	19347	-
	Green manure	9400	1197	31408	22008	2661
	Fertilpolina	9200	1081	34024	24824	5477
	Humus Vita Stallatico	7950	966	32920	24970	5623
	Fertilpolina+Cropmax	9800	1112	35260	25460	6113
Pinot Noir	Conventional (C)	8850	1097	24195	15345	-
	Green manure	9400	1485	25316	15916	571
	Fertilpolina	9200	1291	28496	19296	3951
	Humus Vita Stallatico	7950	1177	27024	19074	3729
	Fertilpolina+Cropmax	9800	1332	29428	19628	4283

Regarding the influence of fertilization on economic indicators, issues are different for each indicator analyzed. The impact of fertilization on total expenditure per hectare is different; mixed and organic fertilization options have led to an increase in total costs for all grape varieties. The less expensive fertilization option was when the organic Humus Vita Stallatico was applied. The lowest cost per ton of grapes production was registered in the conventional fertilization, and the highest production cost was found in the plot with green manure fertilization. Among the alternative fertilization options, the closest value to the control for the production cost was in the plots fertilized with Humus Vita Stallatico. Although the organic fertilization plots recorded higher costs per ton of grapes, due to the higher price of organic grapes, the same plots registered the higher values of production and profit per hectare for all wine grape varieties. The highest profit were recorded in organic plots fertilized with the combination of Fertilpolina + Cropmax, ranging between 25460 lei per hectare for 'Cabernet Sauvignon' and 18688 lei per hectare

for 'Chardonnay'. The profit differences registered compared to the control were higher in all experimental plots; the maximum difference was found when fertilization with Fertilpolina + Cropmax was applied. With all of the sustainable advantages of organic viticulture, Weeler and Crisp (2009) mentioned that organic grapevine growing suppose significant increases in input costs driven especially by the labour costs.

Diseases and pests control is another technological sequence that involves a completely different approach between conventional and organic viticulture. Due to climate change and variability, the diseases and pests prevention and control is increasingly difficult and with an increasing impact on the grape production level (Nistor et al., 2018). The necessity for carbon mitigation and pesticides application imposed new strategies and products for diseases and pests control in both conventional and organic viticulture. Therefore, hazardous products with high remnant effect are less and less used in crops. The conventional, organic, and mixed fertilization treatments had different influence on economic indicators. For all grape varieties, the highest total costs were recorded in the plots with conventional diseases and pest control, and the lowest - in the plots with organic control (Table 3). Instead, the cost of production differs from grape variety to another, depending on the amount of production and the grape variety sensitivity to diseases and pests. The highest cost per ton of grapes was recorded in the plots with organic control, except for 'Cabernet Sauvignon' variety, which, being more tolerant to diseases, had similar production costs. Without costs for pesticides, and higher price for grapes, in the organic control plots was recorded higher grape yield and profit than the control plots. The profit was in favour of organic plots, with differences per hectare between 8509 lei in the case of the 'Italian Riesling' variety and 4240 lei per hectare in the case of the 'Pinot Noir' variety. The mixed treatment for diseases and pest control, by alternating organic products with conventional ones, although it ensures higher grape production compared to the organic plots, because grapes are sold at lower price, registered the lowest values of production and profit. Results are confirmed by the opinion of Borca et al. (2019) which found that the treatments for diseases and pest control in the conventional grapevine growing had the highest inputs and impact on the grape production costs, grape yield and quality.

Table 3. The influence of the disease and pest control treatments on the economic indicators in 2018

Variety	Diseases and pest control	Total costs (lei/ha)	Production costs (lei/ton grapes)	Production costs (lei/ha)	Profit (lei/ha)	Difference to control (lei/ha)
Italian Riesling	Conventional (C)	9500	832	22842	13342	-
	Organic	8500	840	30351	21851	8509
	Mixed	8900	818	21750	12850	-492
Chardonnay	Conventional (C)	9500	958	19830	10330	-
	Organic	8500	1033	24669	16169	5839
	Mixed	8900	970	18348	9448	-882
Feteasca Neagra	Conventional (C)	9500	958	29736	20236	-
	Organic	8500	1002	33900	25400	5164
	Mixed	8900	981	27225	18325	1911
Cabernet Sauvignon	Conventional (C)	9500	895	31809	22309	-
	Organic	8500	885	38388	29888	7579
	Mixed	8900	891	29952	21052	-1257
Pinot Noir	Conventional (C)	9500	1129	25236	15736	-
	Organic	8500	1193	28476	19976	4240
	Mixed	8900	1127	23691	14791	-945

CONCLUSIONS

The main technological sequences that require different approach in conventional and organic viticulture are: tillage, fertilization, and disease and pest control. These management practices have major importance in the structure of total expenditures and with a high impact on grape production, quality, and economic indicators. Soil management and fertilization influence the health of plants, with direct influence on photo-synthetic rate. Conventional soil management

offer the best conditions for higher photosynthetic rate, but have the most aggressive impact on the soil and the environment due to much higher carbon emissions compared to the mowing or organic soil management. Although soil management by mowing or organic did not confirm the parameters of the control plot (bold soil), are achievable and necessary alternatives in order to mitigate carbon emissions, soil and water protection, and last but not least to offer the consumer wine products as healthy as possible. The conventional fertilization provides the highest increase in production, while is the most energy-intensive consumer, with the highest degree of soil and water pollution. For many reasons, chemical fertilizers must be increasingly replaced partially or even completely with organic fertilizers or other useful nutrients less harmful for environment and groundwater. Although the alternative options for soil management, fertilization and disease and pest control could not exceed the control plots with conventional viticulture, as regards the production rate, thanks to the availability of many consumers willingness to offer higher prices to benefit from healthy wine products, these variants have led to increased production value and profit rate. 'Cabernet Sauvignon' was the variety with the best results for leaf area, grape production, and sugars yield/ha for all soil management, fertilizers applied and diseases and pest control treatments. With close results ranked 'Feteasca Neagra' variety. 'Italian Riesling' and 'Chardonnay' were versatile registering positive and negative reactions to conventional and organic practices. In most experimental plots regardless organic or conventional practices, recorded negative results, excepting the high sugars concentration in grape must. The main technological sequences that require a totally different approach in conventional and organic viticulture are tillage, fertilization, and disease and pest control, which have a major importance in the structure of total expenditures and with a high impact on grape production, quality and economic indicators.

REFERENCES

Azorín, P.R., & García, G.J. (2020). The productive, economic, and social efficiency of vineyards using combined drought-tolerant rootstocks and efficient low water volume deficit irrigation techniques under mediterranean semiarid conditions, *Sustainability, 12,* 1930; doi:10.3390/su12051930.

Baumgartner, K., Steenwerth, K.L., & Veilleux, L. (2007). Effects of organic and conventional practices on weed control in a perennial cropping system, *Weed Science, 55*:352-358.

Bindi, M., & Nunes, P. (2016). Vineyards and vineyard management related to ecosystem services: experiences from a wide range of enological regions in the context of global climate change. *Journal of wine economics, 11*(1), 66-68. doi:10.1017/jwe.2016.2.

Borca, F., Nan R.D., Nistor E., & Dobrei A. (2019). Effect of different phytosanitary treatment schemes on the yield and quality of some wine grape varieties, *Journal of Horticulture, Forestry and Biotechnology, 23*(4), 8-13.

Dobrei, A., Dobrei, A.G., Nistor, E., Posta, G., Malaescu, M., & Balint, M. (2018). Characterization of grape and wine quality influenced by terroir in different ecosystems from Romania cultivated with Feteasca neagra, *Scientific Papers, Series B, Horticulture, 62*, pp. 247-253, ISSN: 2285-5653.

Dobrei, A., Nistor, E., Sala, F., & Dobrei, A. (2015). Tillage practices in the context of climate change and a sustainable viticulture. *Notulae Sciencia Biologicae, 7*(4):500-504. doi: 10.15835/nsb.7.4.9724.

Dobrei, A.G., Dobrei, A., Nistor, E., Camen, D., & Chisaliță, I. (2016). Research on farm size and economic potential of the vine-growing farms in the western of Romania, *SGEM 2016, Book 2, vol.5* pp. 555-562, ISBN 978-619-7105- 76-6.

Dobrei, A.G., Dobrei, A., Nistor, E., Sala, F., Mălăescu, M., Drăgunescu, A., & Camen, D. (2015). Research concerning the qualitative potential of the wines obtained from different grape-growing ecosystems. *Journal of horticulture, forestry and biotechnology*, *19*(1), 103-107, ISSN 2066-1797.

Downton, W.J.S. & Grant, W.J.R. (1992). Photosynthetic physiology of spur pruned and minimal pruned grapevines. *Aust. J. Plant Physiol., 19*, 309-316.

Edson, C.E., Howell, G.S. & Flore, J.A. (1993). Influence of crop load on photosynthesis and dry matter partitioning of Seyval grapevines. I. Single leaf and whole vine response pre- and post-harvest. *Am. J. Enol. Vitic. 44*, 39-146.

Klimenko, O.E., Klimenko, N.I., & Klimenko N.N. (2021). Organic viticulture elements development, *IOP Conf. Ser.: Earth Environ. Sci*. 659 012004.

Mann, S, Ferjani, A, & Reissig, L. (2012). What matters to consumers of organic wine? *British Food Journal, 114*(2), 272-284.

Meissner, G., Athmann, M. E., Fritz, J., Kauer, R., Stoll, M., & Schultz, H. R. (2019). Conversion to organic and biodynamic viticultural practices: impact on soil, grapevine development and grape quality. *Oeno One*, *53*(4). https://doi.org/10.20870/oeno-one.

Merot, A., Fermaud, M., Gosme, M., & Smits, N. (2020). Effect of Conversion to Organic Farming on Pest and Disease Control in French Vineyards. *Agronomy, 20, 2010*, 1047. https://doi.org/10.3390/agronomy

Merot, A., Wery, J. (2017). Converting to organic viticulture increases cropping system structure and management complexity, *Agron. Sustain. Dev., 37*:19, doi: 10.1007/s13593-017-0427-9.

Nabi, G., Trought, M.C.T., & Whitehead, D. (2000).

Nistor, E., Dobrei, Alina, Dobrei, A., Camen, D., & Matti, G.B. (2018). Temperature and rainfall influence on shoot length in Pinot Noir, Merlot and Cabernet Sauvignon varieties, *Scientific Papers, Series B, Horticulture, 62*, pp. 267-274.

OIV (2019). Statistical Report on World Vitiviniculture; International Organisation of Vine and Wine: Paris, France.

Petrie, P.R., Trought, M.C.T. & Howell, G.S. (2000). Influence of leaf ageing, leaf area and crop load on photosynthesis, stomatal conductance and senescence of grapevine (*Vitis vinifera* L. cv. Pinot noir) leaves. *Vitis, 39,* 31-36.

Roselli, L., Casieri, A., de Gennaro, B.C., Sardaro, R., & Russo, G. (2020). Environmental and economic sustainability of table grape production in Italy, *Sustainability, 12*3670; pp.1-24. doi:10.3390/ su12093670

Susaj, L., Susaj, E., Melegu, M., Mustafa, S., Dervischi, V. & Ferraj B. (2013). Effects of different weed management practices on production and quality of wine grape cultivar Kallmet in North-Western Albania, *Journal of Food Agriculture and Environment, 11*(1)):379-382.

The influence of short-term partial shading on photosynthesis and stomatal conductance in relations to crop load of grapevines (*Vitis vinifera* L.). *Paki. J. Biol. Sci., 3*, 279-283.

Wheeler, S.A. & Crisp, P. (2009). Evaluating a range of the benefits and costs of organic and conventional production in a Clare Valley vineyard in South Australia, *AARES conference workshop on The World's Wine Markets by 2030*: Terroir, Climate Change, R&D and Globalization, Adelaide Convention Centre, Adelaide, South Australia.