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RESEARCH CONCERNING THE ECONOMIC EFFICIENCY OF STIMULANTS AND FOLIAR FERTILIZERS IN TABLE GRAPE VARIETIES

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Abstract

The research was carried out during 2019-2020 growing seasons in the Buzias-Silagiu vineyards. The aim of the study was to establish the efficiency of stimulants, biostimulants and foliar fertilizers, in two table grape varieties. In the experimental plots design with three replications, were studied eight treatments which were compared with the control plot in which was applied the conventional fertilization treatment with N_{80} P_{80} and K_{80}. The main investigation was focused on best inputs for increase the expenditure efficiency; stimulants, bio-stimulants and foliar fertilizers were tested in comparison with the chemical treatments applied in the vineyard in order to decrease the chemicals impact on the grapevine by-products and environment pollution. In the all experimental plots were recorded significant positive results compared with the control plot for grape yield, grape production, market value and income respectively. However, experimental plots (V_4 and V_8) had higher spending compared to the control plot. The most profitable experimental plots were V_7 and V_3 while V_8 provide the highest grape yields and market value. For higher profit and less environment and grape yield pollution, climate, soil and treatments must be carefully correlated in the future.

Key words: *grapes, foliar fertilizers, stimulants, yield, profit.*

INTRODUCTION

Current issues in viticulture like climate change, pollution, lack of labour force or costs, require continuous adjustment of crop technologies to improve mechanization, for complete wood-ripening, for better grapevine adaptation to climate variability, to reduce the number and the amount of chemical treatments, but without influence on the quality of grapevine by-products and economic performance (Dobrei et al., 2015; Vallad and Goodman, 2004). However, it is necessary to use more effective the inputs that represent most of the production costs (Dobrei et al, 2009; Sala and Dobrei, 2015). Depending the environment from each area and the grape variety, the farmers must found viable solutions to preserve the grape yield quality, typicity and the authenticity of wine and grapevine by-products (Nistor et al., 2018a). Vineyards managers have to decrease the useless fertilizers for the vine, which are a financial loss and, in the same time these chemicals are increasing the groundwater pollution and environment degradation (Nistor et al., 2018b).

Therefore, is advisable to decrease the conventional chemical fertilizers amounts, and conventional fertilizers to be replaced with small amounts of natural fertilizers, a also a different and gradual application of fertilizers in correlation with the plant growing stage (Ghiță et al., 2009).

Using stimulants and bio-stimulants can enable the release and better use of macro and microelements in the soil by increasing their accessibility for the vine (Halpern et al., 2015).

Biostimulants enable the regulation / changing of physical processes to increase plant growth and to limit the stress for increased grape yield (Sorrenti et al., 2012).

Biostimulants can be recycled from organic and food waste, composts or other agricultural wastes, providing new methods for avoiding undesirable disposals and for environmental safe solutions (Dobrei et al., 2018).

Seaweed extracts, humic and fulvic acids, microbial inoculants, amino acids, etc., and different microorganisms like rhizobacteria or growth-promoting fungi are biostimulants which have the property to increase crop yields by at least 5-10% and fertilizer efficiency by

5-25% (Adesemoye et al., 2009; Calvo et al., 2014).

However, only few farmers are ready to use new products like biostimulants and to replace conventional fertilizers in agriculture (Salvi et al., 2016). The scepticism about alternative methods for replacing chemical fertilizers relates to the variable efficacy of biostimulants used in the field, in contrast with the results from laboratory tests or application in greenhouses (Gozzo and Faoro, 2013). By applying biostimulants, not only the yield or soil properties are improved, but also the grapevine by-product quality. Salvi et al. (2016) found out that, by applying the natural biostimulants to Sangiovese grape variety was improved the balance between phenolic and technological maturity of grapes, by increasing polyphenols and anthocyanins content and by maintaining the sugar amount in berries.

The aim of the research was to evaluate the effect and influence of biostimulants on growth and yield of two grape varieties Victoria and Muscat Hamburg in two growing seasons field experiment and to assess the economic performance of both varieties.

MATERIALS AND METHODS

The research was carried out during 2019-2020 growing seasons, years with large climate variability, in a full maturity vineyard from the Buzias-Silagiu wine-growing region, Timis County. Two table grape varieties (Victoria and Muscat Hamburg) have been chosen for research because the grape production costs in both varieties are high; vineyards management and fertilization has to be done with major attention. Small amount of fertilizers, biostimulants and stimulants, in addition to conventional chemical fertilization were used in experimental plots. In the field experiment were tested the following biostimulants: V_1 Terra sorb complex; V_2 Terra sorb foliar; V_3 Atonik; V_4 Fertilpolina; V_5 Blak Jak; V_6 Blak Jak + Terra sorb foliar; V_7Atonik + Terra-Sorb Complex; V_8Atonik + Fertilpolina; V_9 Control-normal fertilization $N_{80}P_{80}K_{80}$.

In all experimental plots were observed several economic indicators such as: grape yield, grape production value, grape production costs, cost price, additional costs, production increase and gross profit. Data from experimental field were statistically estimated and correlations between different indicators were calculated by using the GraphPad Prism Vers. 7.04, software.

RESULTS AND DISCUSSIONS

Production costs represent for all vineyards an indicator that suppose continuous improving and has a major influence on grape production and especially on gross profit. In this research, the production costs were similar for both varieties. Data for several economic indicators are presented in Tables 1 and 2. In all experimental plots, by adding various stimulant and biostimulants fertilizers to the conventional fertilization, the grape production costs increased, with limits ranging between 1962.5 euro/hectare for the V_3 and 2251 euro/hectare for V_8. In both years of research, grape production per hectare has not increased proportionnally to production costs. V_4 was among the plots with the highest grape production costs, but without the grape highest production. Fertilizers and biostimulants had major influence both on the cost price (in Euros) per tons of grapes, and especially on the gross profit. In both varieties, the V_7 plot recorded both the lowest production cost (102 Euros/tonne for the Victoria variety and 117 Euros/tonne for the Muscat Hamburg variety) and the highest gross profit per hectare (19,574.5 Euros in the Victoria variety and 13,066 Euros for Muscat Hamburg, respectively).

Concerning the cost price of grape production for both varieties, the only plots that recorded a higher cost than control plot were V_4 and V_8. Therefore, the highest expenses have not been fully balanced by the value of the grape production. For the gross profit obtained, the only plot with a lower profit compared with the control plot was the V_4 plot from the Victoria variety. If only the gross profit is mentioned, the only plot with a lower profit than control was the V_4 plot from the Victoria variety.

In table 3 are presented data concerning the additional costs (Euro/ha), for each plot. Higher extra costs were recorded for V_8 and V_4 plots, of 307.9 and 288.4 Euros/ha respectively, while the lowest extra costs were recorded for V_3 and V_7 plots (19.2 and 40.5 Euro/ha, respectively).

There were no direct correlation between the additional costs and the grape production increase; some of the highest production expenditure did not provide appropriate production increases in both varieties. For example, V_4 plot has one of the highest extra costs, but had the lowest grape production increases for both varieties. On the contrary, the V_3 plot with the lowest additional costs recorded in both varieties had one of the largest grape production increases.

Higher extra costs were recorded in V_8 and V_4 plots of 307.9 and 288.4 Euros/ha respectively, and the lowest extra costs in V_3 and V_7 plots (19.2 and 40.5 Euros/ha, respectively).

Table 1. Production costs, yield, profit and costs in the Victoria variety

Experimental plot	Year	Production costs (Euro/ha)	Yield (kg/ha/year)	Production value (Euro/ha)	Yield costs (Euro/t)	Gross profit (Euro/ha)
V_1 Terra-sorb complex	2019	2188	18361	20491	119	18303
	2020	1762	19362	21414	91	19652
	Mean	1976.5	18862	20952.5	105	18977.5
V_2 Terra-sorb foliar	2019	2198	18356	20485	119	18287
	2020	1772	19316	21363	91	19591
	Mean	1985	18836	20919	105	18939
V_3 Atonik	2019	2175	18598	20755	116	18580
	2020	1750	19498	21565	89	19815
	Mean	1962.5	19048	21160	102	19197.5
V_4 Fertilpolina	2019	2402	18089	20187	132	17785
	2020	2062	19089	21112	108	19150
	Mean	2232	18589	20649.5	120	18417.5
V_5 Blak Jak	2019	2188	17998	20086	121	17898
	2020	1762	18999	21013	92	19251
	Mean	1975	18498	20549.5	106	18574.5
V_6 Blak Jak+ Terra-sorb foliar	2019	2216	18407	20542	120	18326
	2020	1790	19452	21514	92	19724
	Mean	2003	18929	21028	106	19025
V_7Atonik+Terra-Sorb Complex	2019	2196	18861	21049	116	18853
	2020	1771	19952	22067	88	20296
	Mean	1983.5	19407	21558	102	19574.5
V_8Atonik+Fertilpolina	2019	2421	18770	20947	128	18526
	2020	2081	19816	21916	105	19835
	Mean	2251	19293	21431.5	116	19180.5
V_9 Control-Conventional fertilization $N_{80}P_{80}K_{80}$	2019	2156	17907	19984	120	17828
	2020	1730	18861	20860	91	19130
	Mean	1943	18384	20422	106	18476

Table 2. Production costs, yield, profit and costs in Muscat Hamburg variety

Variant	Year	Production costs (Euro/ha)	Yield (kg/ha/year)	Production value (Euro/ha)	Yield costs (Euro/t)	Gross profit (Euro/ha)
V_1 Terra-sorb complex	2019	2188	15226	13582	143	11394
	2020	1762	17089	15107	103	13345
	Mean	1976.5	16157	14344.5	123	12369.5
V_2 Terra-sorb foliar	2019	2198	15271	13622	143	11428
	2020	1772	17135	15147	103	13375
	Mean	1985	16203	14453	123	12401
V_3 Atonik	2019	2175	15498	13824	143	11649
	2020	1750	17407	15388	103	13638
	Mean	1962.5	16452.5	14606	123	12643.5
V_4 Fertilpolina	2019	2402	15135	13500	158	11098
	2020	2062	16998	15026	121	12964
	Mean	2232	16453	14263	139	12031
V_5 Blak Jak	2019	2188	14953	13338	146	11150
	2020	1762	16816	14865	98	13103
	Mean	1975	15885	12102	122	12126
V_6 Blak Jak+ Terra-sorb foliar	2019	2216	15408	13744	146	11528
	2020	1790	17316	15307	103	13517
	Mean	2003	16362	14525	124	12522
V_7Atonik+Terra-Sorb Compex	2019	2196	15952	14229	137	12033
	2020	1771	17954	15871	98	14100
	Mean	1983.5	16953	15050	117	13066
V_8Atonik+Fertilpolina	2019	2421	15862	14149	152	11728
	2020	2081	17863	15791	116	13710
	Mean	2251	16862	14970	134	12719
V_9 Control-Conventional fertilization $N_{80}P_{80}K_{80}$	2019	2156	14635	13054	147	10898
	2020	1730	16407	14504	105	12774
	Mean	1943	15521	13779	126	11836

The experimental plot with the highest grape yield was V_7 with 1022.5 kg/ha for the Victoria variety and 1432 kg/ha for the Muscat Hamburg variety respectively. Analysing the ratio between the extra costs and the value of the grape production increase, the most efficient experimental plots proved to be V_7 and V_3, specifying that the value of the production increase is also influenced by the grapes price on the market (Wezel et al., 2014).

Table 3. Additional costs, production increase and value of production increase, in Victoria variety experimental variants

Variant	Year	Additional costs (Euro/ha)	Production increase (kg/ha)		Value of production increase (Euro)	
			Victoria	Muscat Hamburg	Victoria	Muscat Hamburg
V_1 Terra-sorb complex	2019	31.8	454	591	507	527
	2020	32.6	501	682	554	603
	Media	32.2	477.5	636.5	530.5	566
V_2 Terra-sorb foliar	2019	41.5	449	636	498	567
	2020	42.2	455	728	492	644
	Media	41.8	452	682	495	606
V_3 Atonik	2019	18.9	691	863	771	770
	2020	19.5	637	1000	704.5	884
	Media	19.2	664	931.5	738	827
V_4 Fertilpolina	2019	245.5	182	500	203	446
	2020	331.8	228	591	252	522
	Media	288.4	205	545.5	227.5	484
V_5 Blak Jak	2019	32.1	91	318	101.5	284
	2020	32.3	38	409	42	362
	Media	32.2	64.5	363.5	72	323
V_6 Blak Jak+ Terra-sorb foliar	2019	59.8	500	773	558	690
	2020	60.1	591	909	654	804
	Media	59.9	545.5	841	606	747
V_7 Atonik+Terra-Sorb Compex	2019	40.1	954	1317	1065	1175
	2020	41.0	1091	1547	1207	1368
	Media	40.5	1022.5	1432	1136	1272
V_8 Atonik+ Fertilpolina	2019	264.5	863	1227	963	1094
	2020	351.4	955	1456	1056	1287
	Media	307.9	909	1341.5	1009.5	1191

The highest grape production increase was registered in both Muscat Hamburg and Victoria varieties in V_7 and V_8 experimental plots in both 2019 and 2020 growing seasons.

In Figure 1 can be observed that in all experimental plots, the additional costs are low level, excepting V_4 and V_8, plots which recorded a very high increase of additional costs in both grape varieties and both experimental years.

Value of grape production increased to the highest level, over 1300 Euros, in V_7 Muscat Hamburg variety in both growing seasons. The same trend was observed in Victoria variety.

However, the value of grape production increased similar to the grape yield in both varieties in all plots during field trial.

The lowest grape production was recorded in both Muscat Hamburg and Victoria variety in V_5 plot (in both 2019 and 2020 growing seasons). Accordingly, the lowest value of production was registered by the same experimental plot. Gross profit (Euro/ ha) was quite uniform during field experiments in both grape varieties (Figure 2).

It cannot make the same affirmation about the value of grape production increase, which was very low level in V_4 and V_5 plots, while in V_7 plot was registered the highest level increase, in both grape varieties.

Grape production value was uniform over the years in all experimental plots in both grape varieties, but higher grape production was registered in Victoria variety.

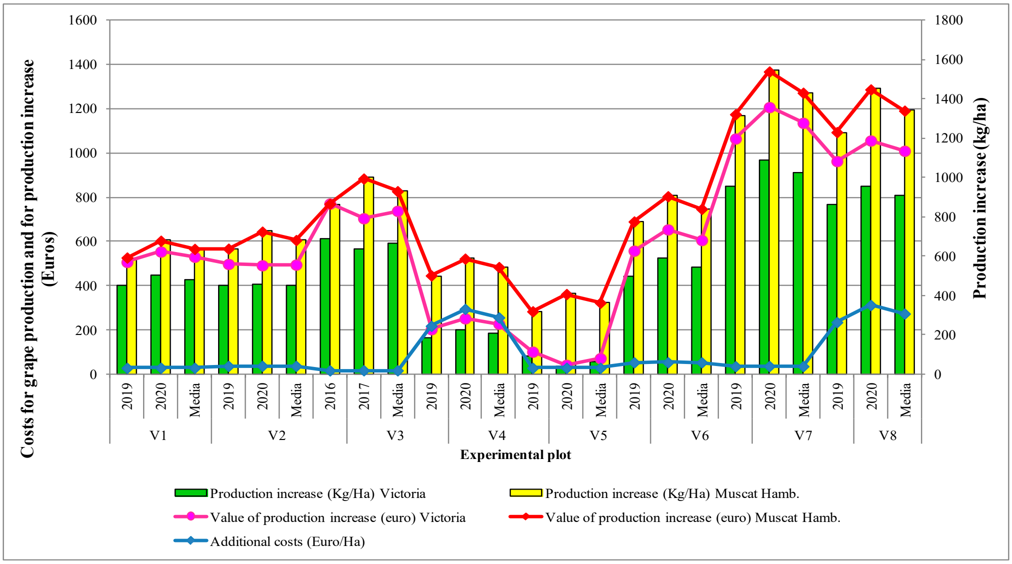

Figure 1. Additional costs, production increase and value of production increase, in experimental variants

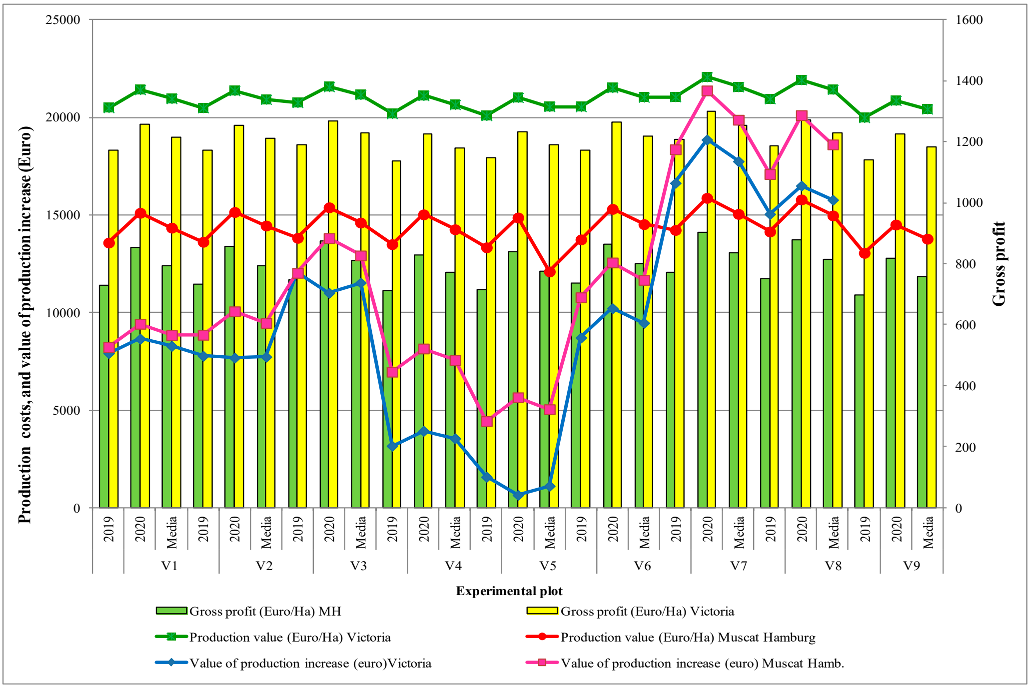

Figure 2. Value of production, value of production increase and gross profit in experimental variants

Colla et al. (2017), reported that after they use three biostimulants for testing on greenhouse tomato, although total production cost increased, but the nutrients status and tomato yield were improved up to a level of net economic benefits. The Pearson correlation (Table 4) between grape yield and gross profit is positive and very significant (r = 0.9809). Between production costs and grape yield selling price there is very strong and positive relationship (r = 0.9494) as well as between production value and grape yield (r = 0.8940) and between production value and gross profit (r = 0.8727). The relationship between grape yield and yield costs is negative (r = -0.8203). Very strong negative correlation there is between yield costs and gross profit (r = -0.9058).

Table 4. Correlation between economic indicators in 2019-2020

Variables	Production costs (Euro/ha)	Yield (kg/ha/year)	Production value (Euro/ha)	Yield costs (Euro/t)	Gross profit (Euro/ha)
Production costs (Euro/ha)	**1**	-0.6212	-0.5051	0.9494	-0.7490
Yield (kg/ha/year)	-0.6212	**1**	0.8940	-0.8203	0.9809
Production value (Euro/ha)	-0.5051	0.8940	**1**	-0.6838	0.8727
Yield costs (Euro/t)	0.9494	-0.8203	-0.6838	**1**	-0.9058
Gross profit (Euro/ha)	-0.7490	0.9809	0.8727	-0.9058	**1**

Table 5. Correlation between additional costs, production increase and value of production increase during 2019-2020

Variables	Additional costs (Euro/ha)	Production increase (kg/ha) Victoria	Production increase (kg/ha) Muscat Hamburg	Value of production increase (Euro) Victoria	Value of production increase (Euro) Muscat Hamburg
Additional costs (Euro/ha)	**1**	0.0650	0.2011	0.0654	0.2000
Production increase (kg/ha) Victoria	0.0650	**1**	0.9705	0.9999	0.9714
Value of production increase (Euro) Muscat Hamburg	0.2011	0.9705	**1**	0.9701	1.0000
Value of production increase (Euro) Victoria	0.0654	0.9999	0.9701	**1**	0.9710
Value of production increase (Euro) Muscat Hamburg	0.2000	0.9714	1.0000	0.9710	**1**

There were no negative correlations between economic indicators (grape production increase, additional costs and the value of production increase) during 2019 and 2020 growing seasons. Very strong positive correlation there was between grape production increases and the value of production in both grape varieties. The small negative correlation was recorded between grape production increase and additional costs (r = 0.0650) and between value of production increase in Victoria variety and additional costs (r = 0.0654). However, additional costs were very low correlated with grape production increase and the value of production for both table grape varieties. According to Mule (2015) research results, the use of bio-fertilizers has many benefits, like: reduced cost of crop cultivation, the net income of farmers increased steadily, saves water, products are sold with higher price, reduce the energy use, reduce pollution and establish higher compatibility between crop and environment.

CONCLUSIONS

On the background of the current viticulture issues outlined above, in order to be able to continue the grape growing in a competitive market, the viticultural holdings have to improve the crop technologies both by reducing the costs and the reasonable use of the inputs.

Therefore, the increasing need to reduce soil and environmental pollution, a modern fertilization concept is required to decrease the overall amount of fertilizers applied, but in the same time to ensure a higher level of fertilizers absorbed by the vines and, to lower the amount of fertilizers trapped in the soil. Low amount of fertilizers, stimulants and biostimulants are viable alternatives that, under reasonable additional costs, provide significant grape production increase and economic performance. These fertilizers are well assimilated by the vine and help to release the fertilizer components from the soil. Besides increasing production and maximizing profits, stimulants and biostimulants reduce soil and groundwater pollution. Among the investigated experimental plots, are noticed the V_7, V_3 and V_2 plots which, in the conditions of reduced additional expenses, ensure high grape production and high profits. There are experimental plots (V_8) that provide high grape yields and values of grape production, even do not provide the highest profit due to high extra costs. For the possibility of selecting the most suitable inputs concerning fertilization, besides the terroir conditions of each vineyard, a number of economic indicators like additional costs, grape production increase, grape production value or gross profit, must be carefully analysed, considering the financial situation of the vineyard, the grape wine by-product market and the selling price.

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