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INFLUENCE OF MARC USED AS AN ORGANIC FERTILIZER ON BIOCHEMICAL AND BIOMETRIC CHARACTERISTICS OF THE GRAPES

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Abstract

Organic fertilizer obtained from marc is a green technology that converts organic wastes into rich nutrient organic fertilizer available for plant. This work shows how to optimize the fertilization technologies of grapes and their influence on the evolution of some biometric characteristics (number of fruit/plant, the average mass of the fruit, mean weight for 100 grape beans, production) and biochemical grape indicators (total acidity, total sugar content, anthocyanins and polyphenols content). The experimental factors underlying it the organization scheme are: A Factor - grapes varieties: 'Feteasca Neagra', 'Pinot Noir', 'Merlot'; B factor - quantity of marc used as an organic fertilizer, with three graduations: 3, 4, respectively 5 kg marc/plant. In all three varieties studied, the dose of 5 kg marc/plant induced a higher production and ensured statistically compared to the doses of 4 and 3 kg/plant, respectively. On the average of the studied cultivars, the dose of 5 kg marc/plant induced a higher production, which was with 0.53 kg/plant higher compared to the treatment by 3 kg marc/plant. That meant a harvest increase of over 2.4 tons per hectare.

Key words: *marc, organic fertilizer, weight fruit, production, fruit quality.*

INTRODUCTION

"Organic Agriculture" is an sustainable alternative to conventional system as it aids in environmental protection, improved food quality and human health (S. Suthar, 2009; R. Pratap, 2011). It restricts use of agro-chemicals and genetically modified organisms; rather focuses on other agricultural practices like organic manure (compost, vermicompost, green manures, animal manures), crop rotations and biological control of pests to maintain productivity. Increasing awareness on consumers has uplifted the demand of organic products in global scenario. However, the organic supply has not been competent to meet the demand. Therefore, farmers are encouraged to move into organic farming.

Organic marc, a by-product of the wine industry, is another category of less used organic fertilizer, despite the low price and abundance in wine farms. It is a heterogeneous product, whose composition and texture vary according to the treatments it undergoes: recovery of alcohol, anthocyanins, etc. On average, organic marc contains between 14-25% rachis; 48-69% skins and 14-27% seeds (Bejan C., 2008).

Product quality determined by its indicators, such as: soluble dry matter and acidity, is influenced by the intake of water and fertilizers (Sumedrea, 2017).

Bio-fertilizers are essential components of organic farming the preparations contain live or latent cells of efficient strains of nitrogen fixing, phosphate solubilizing or cellulolytic micro-organisms. They are used for application objective to seed, soil or composting areas, with the increasing of the number of such micro-organisms and accelerate those microbial processes which augment the availability of nutrients that can be easily assimilated by plants (Mishra, 2013). Organic agriculture controls and intensifies the natural processes in order to balance the yield, with respect of ecosystems, including human health. It promotes the quality, not the quantity.

Development of durable agriculture takes in account the multifunctional role that it must have, in respect of the following principles: to use production methods capable to provide qualitative products by protecting the environment; to preserve and renew the natural resources; to promote those technologies friendly with the environment.

Researches all over the world proved that the ecological products obtained by non-polluting technologies have a better quality comparing with those obtained by conventional technologies, which imply a series of chemical products risky for human health.
The present experiment was, therefore, conducted to evaluate influence of the organic fertilizer obtained marc grape of biometric characteristics (number of fruit/plant, the average mass of the fruit, mean weight for 100 grape beans, production) and biochemical grape indicators (total titrable acidity, total sugar content, anthocyanins and polyphenols content).

MATERIALS AND METHODS

The experimental factors studied were: Factor A - grapes cultivars: 'Feteasca Neagra', 'Pinot Noir', 'Merlot', grafted on the SO 4-4 and factor B - dose of marc used as an organic fertilizer, with three graduations: 3 kg/plant, 4 kg/plant, 5 kg/plant. The experience presents average data for two years from the application of marc (2018-2019). The experience took place in a plantation which was established in 1997 at the National Research and Development Institute for Biotechnology in Horticulture Stefanesti, with the planting distance of 2.20 x 1 m. The process of separating the marc is very important, because each component has a specific composition and post-processing technology. Thus, the marc resulting as a by-product of pressing grapes, which consisted of bunches, skins, seeds and residues of must or wine not extracted by pressing, was dried before application, using a microwave equipment -MW-6kW.
The set of biometrical and chemical analyses consisted in the following indicators: number of fruit/plant, total titrable acidity (TTA), total sugar content (TSC), anthocyanins and polyphenols. The total acidity was determined by the titrimetric determination method. The total sugar content was determined by the Fehling-Soxlet titrimetric method. Total polyphenol content was measured by colorimetric Folin-Ciocalteu method. Total anthocyanins content was measured by spectrophotometric absorbance at wave length λ = 540 nm (adapted method after Bărăscu et al., 2016). The extracts were filtered under vacuum and completed up to 50 ml volume. The results were calculated using the formula: Total anthocyanins = DO540 x F, where DO540 is absorbance at wavelength λ = 540 nm and factor F = 11.16. The total anthocyanins content was expressed in mg/100 g in fresh weight.
For the statistical interpretation of the results, the data were included in an Excel database and then statistically analyzed with the SPSS 14.0 program, which uses the Duncan test (multiple t test) for a 5% level of significance.

RESULTS AND DISCUTIONS

Both the number of grapes per plant and their weight are basic indicators used in viticulture to express the productive potential of the varieties. According to the data from Table 1, there are positive correlations between the biometric indicators: number of grapes per plant, average mass of grapes and production per plant.

Table 1. Correlation matrix of the biometric indicators

		Number of grapes/plant	Fruit weight (g)	Production
Number of grapes/plant	Pearson Correlation	1	-,733(**)	,458(**)
	Sig. (2-tailed)		,000	,000
	N	81	81	81
Fruit weight (g)	Pearson Correlation	-,733(**)	1	,220(*)
	Sig. (2-tailed)	,000		,049
	N	81	81	81
Production	Pearson Correlation	,458(**)	,220(*)	1
	Sig. (2-tailed)	,000	,049	
	N	81	81	81

**Correlation is significant at the 0.01 level (2-tailed
*Correlation is significant at the 0.05 level (2-tailed).

As a result, the following coefficients in correlation with the production of grapes on the plant were recorded: r = 0.458* for the number of grapes per plant, r = 0.220* for the average mass of grapes between fruit production. Further, the influence between the two experimental factors (variety and dose of marc) on the biometric and biochemical quality indicators of the grapes was analyzed. The quantity of the harvest depends on the size of the grapes and the number of inflorescences, so that cultivars with the same
percentage of fertile leaves or with the same fertility coefficient give different grape harvests in terms of production level (Bădulescu, 2013).
Analyzing the interactions between the two experimental factors, it is noted that, in terms of the number of grapes/plant, fertilization

doses induced significant differences only at the 'Merlot' cultivar. It registered the highest number of grapes per plant at the fertilization dose with 5 kg marc/plant (33.11 grapes/plant), compared to 27.67, respectively 27.55, in the case of 4 kg marc/plant (Figure 1). On the average of the cultivars, the best results on the number of grapes per plant were obtained at fertilization with 5 kg of marc/plant, the average number of grapes per plant reaching 21.85 grapes/plant, exceeding the sample treated with 3 kg of organic fertilizer with 3.14 grapes/plant (18.71 grapes/plant at dose of 3 kg of marc/plant).

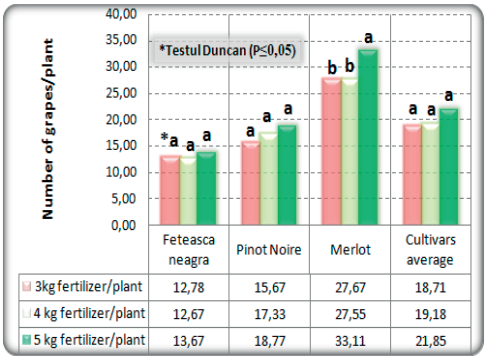

Figure 1. Influence of the marc dose on the number of grapes depending on the cultivars

In the 'Feteasca Neagra' and 'Pinot Noire' cultivars, the organic fertilization dose led to significant differences in the average fruit mass, thus, the highest mass in the case of the two mentioned cultivars was registered at the organic fertilization dose with 5 kg marc/ plant. In the case of the 'Merlot' cultivar, the organic fertilization did not induce significant changes in the average mass of the grapes (Figure 2).

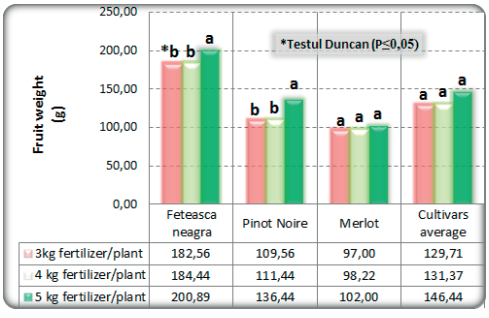

Figure 2. Influence of the marc dose on the fruit weight of grapes depending on the cultivar

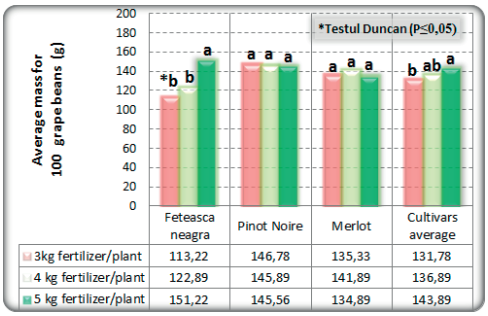

Figure 3. Influence of the marc dose on the mass of 100 grape beans depending on the cultivar

On the average of the cultivars (Figure 3), the highest average mass of 100 grape beans were obtained at fertilization with 5 kg of marc per plant, which reaching 143.89 g, value that exceeding the sample treated with 3 kg of organic fertilizer with 12.11 g (131.78 g).

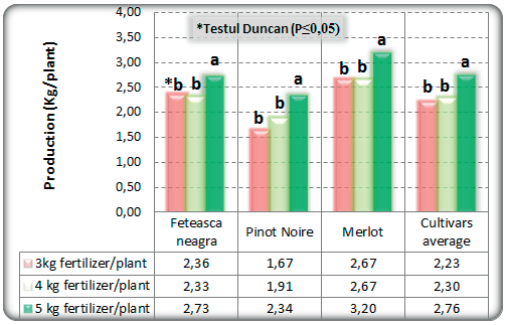

Figure 4. Influence of the fertilizer dose on the production depending on the cultivar

Grape production is the basic indicator in establishing economy and profitability in the application of a measure or a whole complex of agrotechnical measures (Badulescu, 2013).
Organic fertilization dose induced a significant increase in grape/plant production.
Thus, on the average of the cultivars, the highest production was registered in the case of organic fertilization dose with 5 kg marc/ plant (2.76 kg/plant), compared to the treatment with the lower doses of organic fertilizer, which recorded 2.30, respectively 2.23 kg/plant) (Figure 4). It was observed that, for all three varieties studied, on the average of the two years of study, dose of 5 kg marc/plant induced a higher production and these are ensured statistically compared to the doses of 4 and 3 kg/plant, respectively. The highest production

was recorded for the 'Merlot' cultivar, at all dose of organic fertilization, and the smallest to the 'Pinot Noire' cultivar.

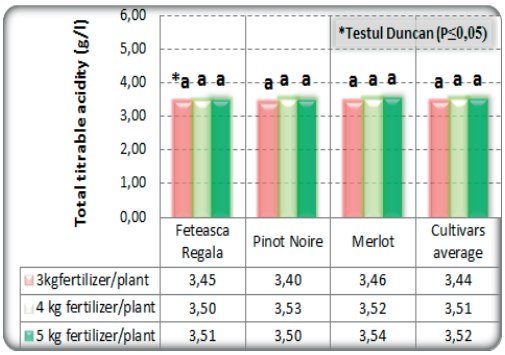

Figure 5. Influence of the marc dose on the total acidity of grapes depending on the cultivar

If we analyze the influence on the total acidity of the grapes depending on the fertilizer dose, the effect on the TTA wasn't statistically different for any variety. As compared to the other varieties, 'Merlot' displayed the highest value of TTA (between 3.46 of the doze with 3 kg/plant and 3.54 g/l in the case of the fertilization dose with 5 kg, but this was entirely due to the genetic characteristics, not to the fertilization (Figure 5).

Fruits accumulate starch in the early stages of maturation, which are subsequently hydrolyzed in sugars at consumption maturity (Magein and Leurquin, 2000; Sumedrea, 2017).

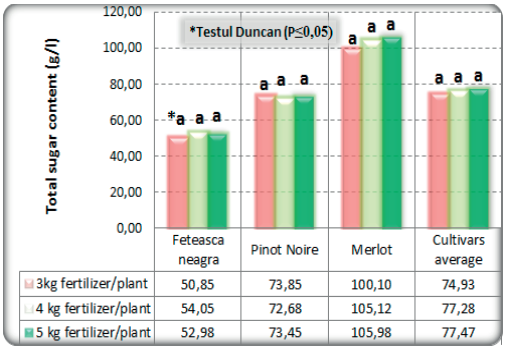

Figure 6. Influence of the fertilizer dose on the total sugar content (g/l) of grapes depending on the cultivar

At all the 3 applied doses of fertilizer, the level of sugar accumulation in the grapes, didn't recorded significantly different for any of the three cultivars studied (Figure 6). The results also show that among the three cultivars studied, 'Merlot' accumulated the highest sugar content in the grapes, at all three doses of fertilization, but this is a trait of the cultivar and isn't dependent on fertilization.

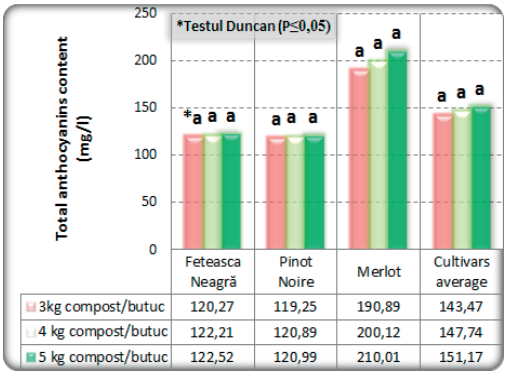

Figure 7. Influence of the marc dose on the total anthocyanins content (mg/l) of grapes depending on the cultivar

At all the three applied doses of marc, the anthocyanin content accumulation in the skins, was not significantly different for any of the three cultivars studied (Figure 7). 'Merlot' cultivar recorded the highest anthocyanins concentration in the skins, at the all three doses of marc, but this is a trait of the cultivar and is not dependent on fertilization.

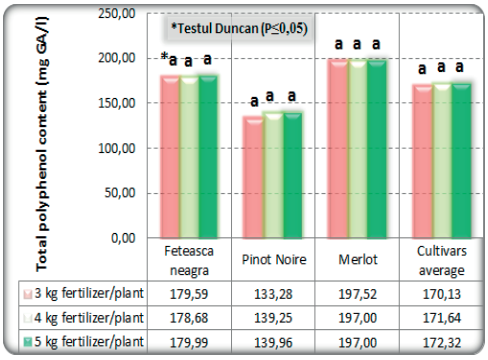

Figure 8. Influence of the marc dose on the total polyphenol content (mg/l) grapes depending on the cultivar

'Merlot' and 'Feteasca Neagra' cultivars registered the higher levels of polyphenol content than the 'Pinot Noire' variety, but this is a characteristic of the cultivar and does not depend on the dose of marc applied. Research

in the field of phenols extracted from plants (Schaffer et al., 2005) shows that phenols depend quantitatively and qualitatively on genetic information (species, variety), environment and geographical conditions. Climate, season, light, temperature, maturation period strongly influence the synthesis of phenols in plants (Aherne and O'Brian, 2002). On the average of the cultivars, the marc dose didn't determines significant changes of the grape content in polyphenols (Figure 8).

CONCLUSIONS

The different doses of fertilization led to significant differences between the basic indicators used in viticulture for the characterization of fruiting processes and finally on grape production.

In all three varieties studied, the dose of 5 kg marc/plant induced a higher production and ensured statistically compared to the doses of 4 and 3 kg/plant, respectively. Thus, on the average of the studied cultivars, the dose of 5 kg marc/plant induced a higher production, which was with 0.53 kg/plant higher compared to the treatment by 3 kg marc/plant. That meant a harvest increase of over 2.4 tons per hectare.

The growing up of the yield with the increase of the quantity of marc applied was possible due to the increase of the average number of grapes/plant and respectively of the average weight of the grapes. Thus, on the average of the studied varieties, the average number of grapes per plant was higher with 3.14 and the average weight of 100 grape beans increased with 12.11 g.

There is therefore a positive correlation between the simple correlation coefficients between fruit production and quantitative indicators, these being: r = 0.458** for the number of grapes per plant, r = 0.220* for the weight of a grape).

Merlot cultivar recorded the highest content in total sugar, anthocyanins and polyphenols, but these were not influenced by organic fertilization with marc, being rather a characteristic of the variety.

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