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EFFECT OF PLANTING POSITION ON THE VINEYARD SLOPE ON GROWTH, PRUNING WEIGHT, AND COLD HARDINESS OF GRAPEVINE CANE

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Abstract
Grapevine is a perennial crop whose growth and productivity can be affected by many pedoclimatic and agrotechnological factors. Currently, land terracing is a common field organization for new vineyard plantations, reducing slope on the cultivated land, and for the introduction of new areas for agricultural production. One of these pedoclimatic factors is the position of vines on vineyard slope. The aim of this paper was to assess the effect of the grapevine position on the field slope on growth expressed by pruning weight and on cold hardiness of bud and cane grapevine. The research used relatively simple methods and it was conducted in a commercial hillside vineyard from Samburesti viticultural region in Romania. The grapevines used for this study were represented by three red grape varieties: Vitis vinifera L. cv. Cabernet Sauvignon, Vitis vinifera L. cv. Merlot, and Vitis vinifera L. cv. Feteasca Neagra. Annual growth of grapevine and cane maturation in the previous growing season was influenced by slope positions. The lowest pruning weight was recorder in Merlot planted at the top of the vineyard slope. For all grapevine cultivars we found statistically significant differences between vines cultivated on the top of slope and vines cultivated on the foot of slope.

Keywords: bud hardiness, cane hardiness, grapevine, pruning weight, slope vineyard.

1. INTRODUCTION

Romania is one of the most important viticultural countries in Europe and the whole world. European (*Vitis vinifera* L.) wine grape varieties are the most appreciated for the wine industry. Grapevine is a perennial crop, which according to the agricultural statistical database of Romanian Ministery of Agriculture and Rural Development is cultivated in Romania on more than 178000 hectares. Vineyards management strategies play an important role for growth and productivity of grapevine (Popescu, 2016). Vegetative growth and yield of grapevines are influenced by viticultural practices and due to a complexity of pedoclimatic conditions and technological factors. One of pedoclimatic conditions with impact on vegetative growth and yield of grapevines is the position of the grapevine on the vineyard slope.

Motounu (2009) defined that cold hardiness means the plant capability to resist without injuries to unfavorable conditions from winter. Ferguson et al. (2011) noted that during dormancy season cold hardiness of grapevine is a dynamically process influenced by temperature changes. Cold hardiness of grapevine is a feature that has an impact on yield. Grapevine is one of the temperate fruit crops

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most frequently damaged by freezing temperatures. Freezing injury can influence the level of grape yield and farmers income (Fennell, 2004). Winter pruning of vines is an important viticultural practice performs on the plant in order to optimize the level of grapevine yield (Rives, 2000). Grapevine pruning is a relatively simple method that has as a result a small number of buds per cane (Martin and Dunn, 2000). These buds will provide the grape harvest in the following growing season.

According to Ren (2015) sloping terrain trough the facilities for hydrology and availability of nutrients for plants creates specific microclimates in ecosystems. Most of vineyard are located on steep slopes and in this regards viticulture is one of the most erosion-prone land uses. Agricultural terraces are well represented in viticulture. Currently, operations for land transformation as levelling or terracing are common for new vineyard plantations. Land terracing is an option for facilitating a more intensive cropping in steep lands. Also land terracing play a role for soil and water conservation, accomplished by reducing slope on the cultivated land (Cots-Folch et al., 2006). Soil management system play a key role for hilly vineyards in order to avoid soil erosion (Biddoccu et al., 2016). Ferrero et al. (2005) reported that the values of the soil properties on sloping vineyards can be affected by slope position and vine-rows orientation. Cislaghi et al. 2017 reported the positive role of vineyard on slope stability provided by grapevine roots and their spatial distribution. Slope lowering by levelling without the implementation of terraces increased average annual soil loss by 26.5% (Jiménez-Delgado et al., 2004). Land slope in grapevine have been studied mainly for enviromentally impact of soil erosion. There are few studies related to the effect of slope on vegetative growth and productivity of grapevine.

The aim of the study was to examine the effect of position on the slope on growth and canes maturation of grapevine by relatively simple methods in order to be applied by grape growers direct in vineyards. The research was conducted in a commercial hillside vineyard.

2. MATERIALS AND METHODS

2.1. Vineyard description and growth conditions

The experimental site was at private vitivinicultural company named Domeniile Samburesti, in the Samburesti vineyard from Romania. Samburesti vineyard is one of the oldest viticultural areas in Romania mainly designed for red wines. The wines produced in Samburesti viticultural region can be registered under the European Union's quality logos „Protected Designation of Origin". These wine labels gived under the conditions of Regulation (EU) No 1308/2013 demonstrated that the products are high – quality wines.

There are new vineyard plantations in the Samburesti region. The experiment was on 7-year-old grafted grapevines. Grapevine parcels have drip irrigation and modern trellis systems with 3 wires. The vines were planted at 2.2 m between rows and 1 m within rows (4545 vines per hectare).

The vineyard is located in the southern part of the country at 44°48' north latitude and 24°48' south longitude. The general climate of this region is continental temperate. The sum of annual raifall are moderate (around 550 mm), the sum of active precipitations being around of 360 mm. The mean annual temperature is 10 °C. There are a mean of 1576 hours of sunshine per year.

The soils of the Samburesti vineyard are mostly clayey and clay-clayey. The soils was classified as chernozems and brown-red.

The first experiment was conducted on three different grafted grapevine cultivars. The grapevines for experimental observations were represented by three red grape *Vitis vinifera* varieties: *Vitis vinifera* L. cv. Cabernet Sauvignon, *Vitis vinifera* L. cv. Merlot and *Vitis vinifera* L. cv. Feteasca Neagra. The red wines varieties, Merlot and Cabernet Sauvignon, are originate from Bordeaux

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region (France). These cultivars were introduced in Romania more than 100 years ago and currently are among the most cultivated varieties for red wines in Romania. Vitis vinifera cv. Feteasca Neagra is an indigenous variety cultivated from ancient times in the vineyards of Romania.

2.2. Methods and measurements

The observations were registered after grapevine dormancy period and during the winter pruning in February, 2017. Annual and multiannual wood eliminated during winter grapevine pruning was weighed in the field and expressed in g per vine. Cane hardiness was evaluated was evaluated by the method of the relationship between the marrow and the wood. The determinations were made by evaluating the bottom grapevines and the top grapevine of the slope:

- *Vitis vinifera* L. cv. Cabernet Sauvignon (top of the slope 270 m, foot of the slope 240 m);
- *Vitis vinifera* L. cv. Merlot (top of the slope 270 m, foot of the slope 240 m);
- *Vitis vinifera* L. cv. Feteasca Neagra (top of the slope 210 m, foot of the slope 180 m).

In order to assess the effect of position on the slope (top or bottom) on growth and cane maturation of grapevine the following determinations were made:

- effect of position on the slope (top or bottom) on canes pruning weight (g/vine);
- effect of position on the slope (top or bottom) on grapevine buds viability (%);
- effect of position on the slope (top or bottom) on grapevine cane hardiness;
- effect of position on the slope (top or bottom) on cane diameter (mm).

2.3. Data analysis

In order to study the effects of position on field slope on grapevine, data was analyzed using the SPSS 16.0 statistical software (IBM Corporation, Armonk, New York, USA). Means were compared using Duncan's multiple range tests at $p < 0.05$. The results of this study are expressed as mean. Figures were performed using Microsoft Excel 2007.

3. RESULTS AND DISCUSSIONS

The vigour of grapevine growth from the previous season can be evaluated using cane pruning weight. The effect of position on the slope (top or bottom) on cane pruning weight varied from the top of the slope to the foot of the vineyard slope (figure 1). The grapevine pruning applied to the experimental variants showed that a smaller quantity of annual and multiannual wood was eliminated in the Merlot and Feteasc㠠Neagra varieties compared to the quantity of pruning weight in the *Vitis vinifera* L. cv. Cabernet Sauvignon. It can be seen that for the Cabernet Sauvignon cultivar the quantity of annual and multiannual wood eliminated by pruning has had higher values for the plants situated on the top of the slopes of the vineyard plantation compared to the grapevines at the base of the slopes of the vineyard plantation. The lowest pruning weight was recorded in the European variety of Merlot planted at the top of the vineyard slope. For all grapevine cultivars significant differences were showed between the vines planted on top of slope and plants cultivated on the bottom of field slope.

Cold hardiness of grapevine buds for *Vitis vinifera* L. cv. Merlot and *Vitis vinifera* L. cv. Feteasca Neagra were not influenced by the plant position on field slope. However for *Vitis vinifera* L. cv. Cabernet Sauvignon were found significant differences between plants from the bottom of slope and vines from top of vineyard slope (figure 2). In the case of normal temperatures during the dormancy period and in the case of good grapevine good maturation, the grapevine positions on field slope don't induce significant differences in bud viability and hardiness. Top and bottom positions of plants for Merlot and Feteasca Neagra showed 100% bud viability.

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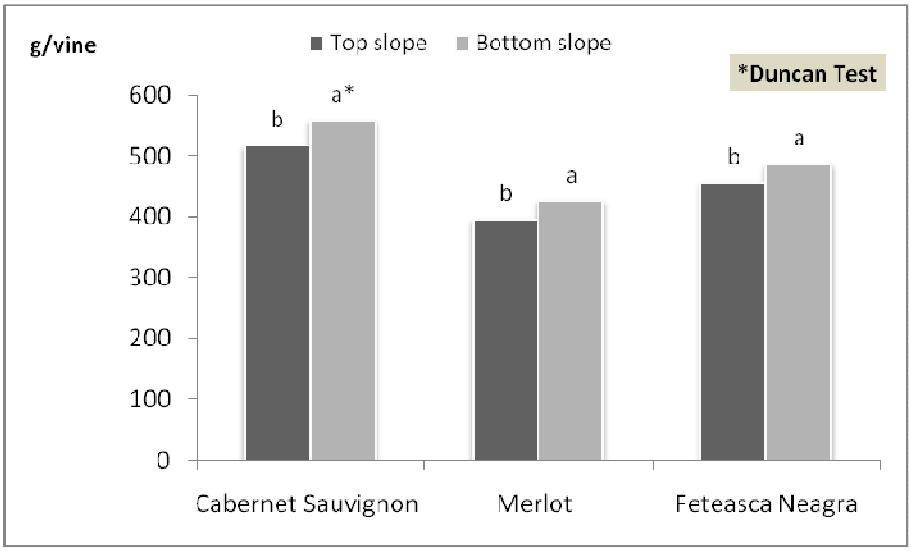

Figure 1. The effect of position on the slope (top or bottom) on canes pruning weight (g). *Mean values followed by the same letter are not significantly different according to Duncan's multiple range test ($p < 0.05$)*

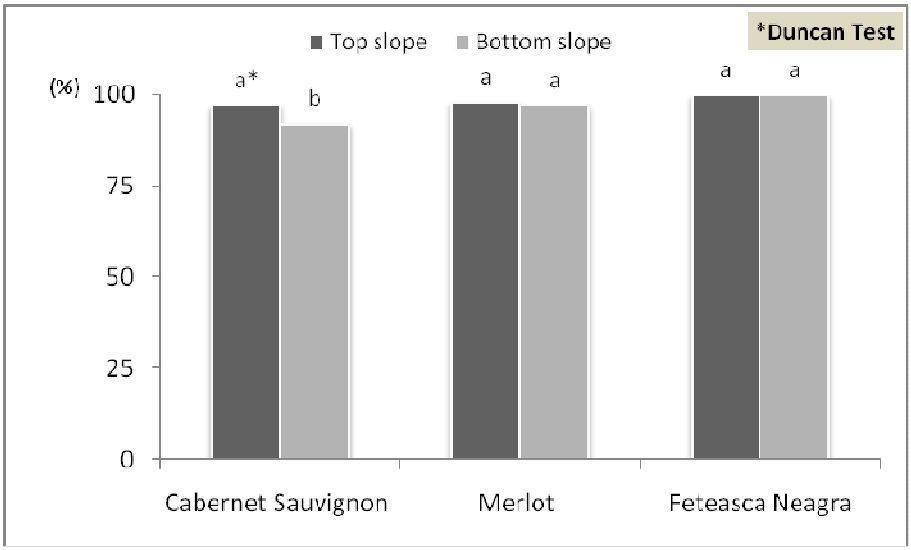

Figure 2. The effect of position on the slope (top or bottom) on grapevine buds viability (%). *Mean values followed by the same letter are not significantly different according to Duncan's multiple range test ($p < 0.05$)*

Relation between marrow and wood tissues of cane grapevine could be a useful parameter in order to appreciate the level of cane grapevine maturation. When the ratio between marrow and tissue is favorable to wood, the cane maturation is not affected. Also, the cold hardiness of cane grapevine is poor affected by freezing temperatures. In the case of *Vitis vinifera* L. cv. Feteasca Neagra, we did not find any statistically significant difference between plants situated on top or bottom positions on the vineyard slope. For Cabernet Sauvignon and Merlot we found significant differences between top and bottom plants positions on the vineyard slope (figure 3).

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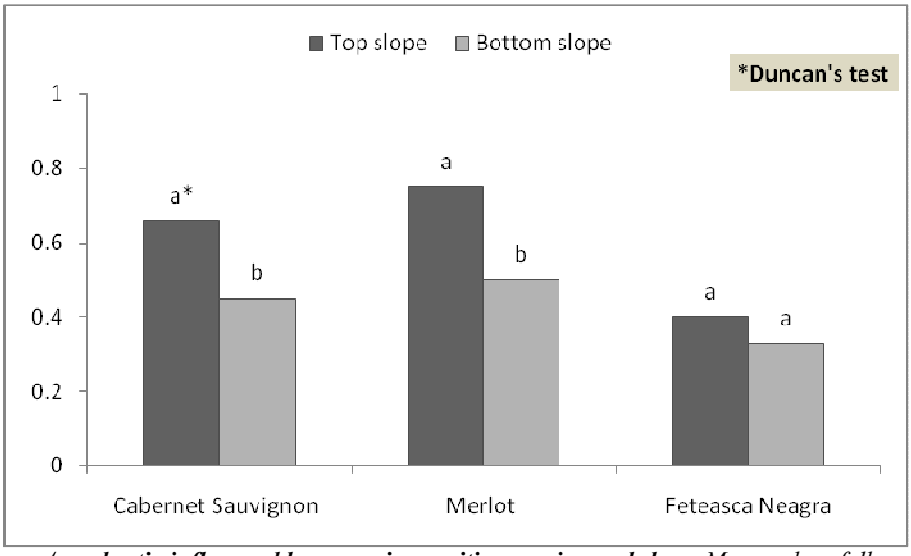

Figure 3. Marrow/wood ratio influenced by grapevine position on vineyard slope. *Mean values followed by the same letter are not significantly different according to Duncan's multiple range test ($p < 0.05$)*

Annual growth represented by diameter of grapevine canes did not show significant differences in Merlot vines. Regarding the influence of slope position in the studied cultivar, we found significant differences between *Vitis vinifera* L. cv. Cabernet Sauvignon and between *Vitis vinifera* L. cv. Feteasca Neagra. The largest differences between the cane diameter at the foot and at the top of the slope were recorded in *Vitis vinifera* L. cv. Feteasca Neagra and the smallest differences were found in *Vitis vinifera* L. cv. Merlot (figure 4).

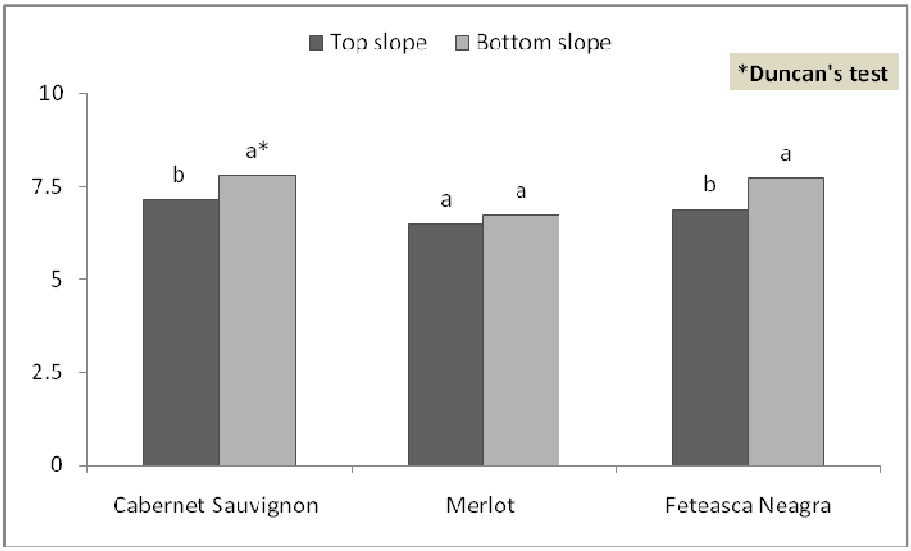

Figure 4. The effect of position on the slope (top or bottom) on cane diameter (mm). *Mean values followed by the same letter are not significantly different according to Duncan's multiple range test ($p < 0.05$)*

4. CONCLUSIONS

Currently, land terracing is a common field organization for new vineyard plantations, reducing slope on the cultivated land, and for the introduction of new areas for agricultural production. The

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methods applied in this research are very simple and could be very easy used by farmers in order to evaluate the annual growth of grapevine and cane maturation in the previous growing season. Cane maturation and buds viability are important indicators to appreciate cold hardiness of grapevine buds and cane. The slope positions in vineyards influenced pruning weight, bud and cane cold hardiness. For all studied grapevine cultivars significant differences were showed between the vines planted on top of vineyard slope and plants cultivated on the bottom of field slope. No significant differences regarding the cane diameter of grapevines were found between the vines cultivated on bottom and top vineyard slope.

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