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TEMPERATURE AND RAINFALL INFLUENCE ON SHOOT LENGTH IN PINOT NOIR, MERLOT AND CABERNET SAUVIGNON VARIETIES

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Abstract

Climate changes from last decades influenced plants growth including grapevine. The objective of the research was to evaluate the influence of temperature and rainfall on shoot growth in Pinot Noir, Cabernet Sauvignon and Merlot varieties located in two vineyards, Recaș and Buziaș-Silagiu, during five years (2011-2015). The vines were trained on vertical trellis by bi-lateral cordon and vertical shoot positioned. For research were selected the main shoots and lateral shoots from 25 vines from each variety. Shoots length was measured from the base to the growing tip. Shoots cease growth earlier in dry years 2012 and 2015 compared with the wettest years 2013 and 2014. The warm weather and moderate rainfall in 2011 favor shoots growth in all three varieties and both locations. Measurements show significant differences between shoots length. The longest shoots were found in Cabernet Sauvignon variety in Buziaș-Silagiu vineyard and the shortest in Pinot Noir variety from Recaș vineyard. Results also show that vines subjected to water stress and high temperatures had shorter main and lateral shoots.

Key words: *grapevine, length, rainfall, shoots, temperature.*

INTRODUCTION

Leaf area from canopy have a major importance in photosynthesis and therefore in vine development, creating the microclimate for grape berry development and ripening (Andreini et al., 2009; Deloire A., 2009). An excessive shoot length and dense canopy influence negative the grape veraison and ripening by shading and increase the humidity (Fournioux, 1997; Keller, 2015). Dense canopy favours diseases as rots and mildew. Canopy includes the shoots, leaves and flowers respectively berry bunches (Petrie et al. 2000; Dobrei et al., 2016b). Vine canopy depends on grapevine variety, cane pruning, plant vigor, growing area and is described by number of shoots/trunk, length, width, height and leaf area (Dokoozlian and Kliewer, 1995). Shoots emerge in the spring from buds and grow fast before bloom due to the energy reserves from roots and then their growing slow down as grape berries develops (Lorenz et al., 2005; Dobrei et al., 2014). Usually in well-balanced vineyards, shoots growth stop near veraison; if the shoot growing continues the canopy will need more green pruning to improve berries development and ripening, including leaf removal (Kliewer and Dokoozlian, 2005). The vine shoot length is important because they have poorly developed mechanical tissues, and when they reach a certain length, more than 40-60 cm, can no longer sustain themselves, bends over, which favor the pests and diseases, and prevents further maintenance work in vineyards (Sánchez and Dokoozlian, 2005).

Most vineyards around the world are found in the strip drawn by parallels 30 and 50 in both northern and southern hemispheres (Keller et al., 2005). Within these areas, climate has a great influence on the development of vineyards (Santesteban et al., 2010). The vine is quite resistant to drought; works well in areas with annual rainfall of 500-650 mm, but like most plants, vines need a decent amount of water to survive and grow (Smart et al., 1991; Schultz and Matthews, 1988).

Each physiological phenomenon is conditioned by reaching a certain level of temperature and humidity that marks the beginning or end of a biological stage (Hendrickson et al., 2004). Favorable temperature is correlated with a large amount of fruitful buds and more leaves (Gris et al., 2010). Both spring rainfall and higher temperatures greatly contribute to keeping the plant vigorous (Matthews et al., 1987).

The objective of the work was to evaluate the temperature and rainfall influence on main and lateral shoots growth in first three phenological stages in three grapewine varieties from Buzias-Silagiu and Recas vineyards, in the west of Romania area, during climate changing years 2011-2015.

MATERIALS AND METHODS

The experiment was carried out in two well-known vineyards from west of Romania: Recas and Buzias-Silagiu, during 2011-2015. All three varieties (Pinot Noir, Merlot and Cabernet Sauvignon) were trained on vertical trellis by bi-lateral cordon and vertical shoot positioned. In each variety were selected for measurements the main and two lateral shoots from 25 vines. Grapevine shoots monitoring begun each year in the last decade of April and ended in July, during all five years of experiment. Plant material was selected from vines of 6 year-old, planted on east-west orientated rows. Lateral shoots were selected from node positions 2-3. Shoots length was measured from the base to the growing tip, in the first three stages: before bloom, full bloom and fruit set, until the summer trimming. Measurements were made using a metric tape. In both vineyards the vine management was uniform. In recent years, the temperature increased from the beginning of the spring, while rainfall are very heavy or are very small quantity in summer; often very wet and hot years (like 2014) alternate with very warm and dry years. From one area to another, during the winter, cold days alternate with frosty periods. Climatic variability influences blooming, growth and grapevine development, grape production and its quality, through the late spring frosts, high summer temperatures, heavy rains or hailstorms.

In May 2011 the average temperature was 0.1°C above normal. From May 1-8, the weather was colder than usual. Monthly rainfall was 18% lower than normal. There were heavy rains (on May 24, 25 and 28) often associated with thunderstorms and hail. In June the average temperature was 1.1°C higher than normal. During June 19-24, the weather was very hot. Between 25 and 30 June the temperature dropped significantly, reaching below normal values for this period. In July the average temperature was 1.2°C higher than normal. From 9 to 20 July, the weather was very hot (Figure 1).

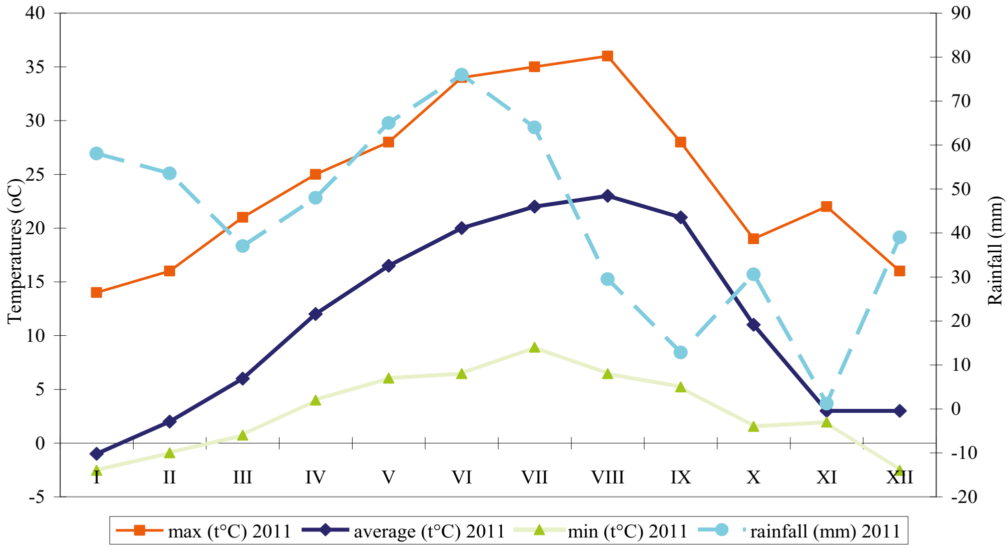

Figure 1. Temperatures and rainfall (2011)

Among 13-18 May 2012, the weather becomes very cold in the west. There were heavy rains, often thunderstorms and hail. In June, the average temperature was 3°C above normal. Monthly rainfall was 38% below standard normal. In July, the temperature was 4.5°C higher than normal standard. In 13-15 July and 28-30 July, the weather was very hot. Monthly rainfall was 48% below standard normal. May 2012 was characterized by a higher air temperature than normal. Often thunderstorms and hailstorms were recorded (Figure 2).

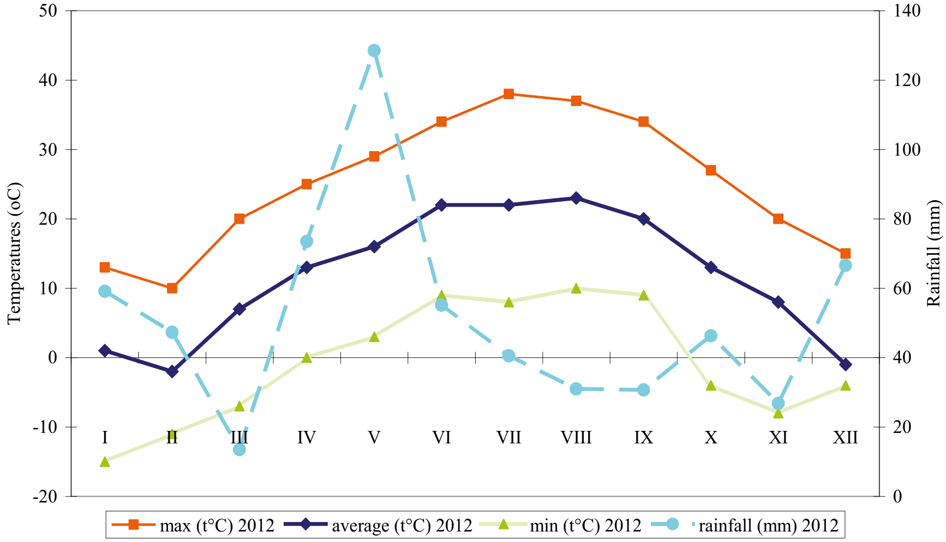

Figure 2. Temperatures and rainfall (2012)

The rainfall between 1st and 31 May (2013) was normal (26-50 l/m^2) in the north of Banat and around 51-100 l/m^2 in the other areas of the region. In June 2013 normal thermal days alternate with periods with higher air temperature than usual. The average daily air temperature values ranged from 17 to 29°C during the warmest periods. During June, there were rainy days, thunderstorms and hailstorms that partially/totally affected the vine by breaking canes and shoots (Figure 3).

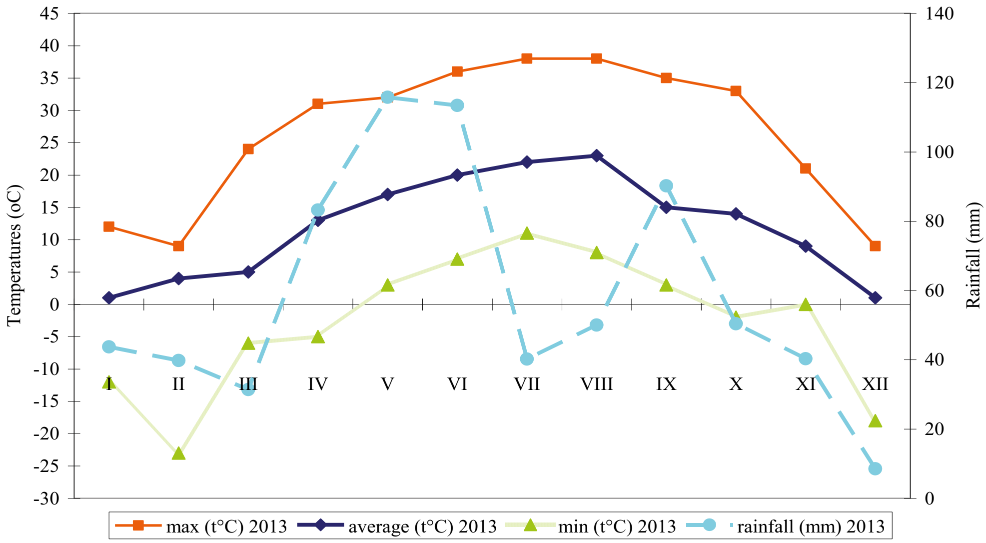

Figure 3. Temperatures and rainfall (2013)

In May 2014 normal days alternate with intervals in which the air temperature was lower than usual. Precipitations were among 51-100 l/m², in the south of Timis County, abundant (101-125 l/m²) and even excessive (126-212 l/m²) on large area in west of Romania. June 2014 had warmer days, with periods in which the air temperature was normal. During June 2014 heavy rainfall were recorded in large areas of the western part of the country, which led to an improvement of the soil moisture.

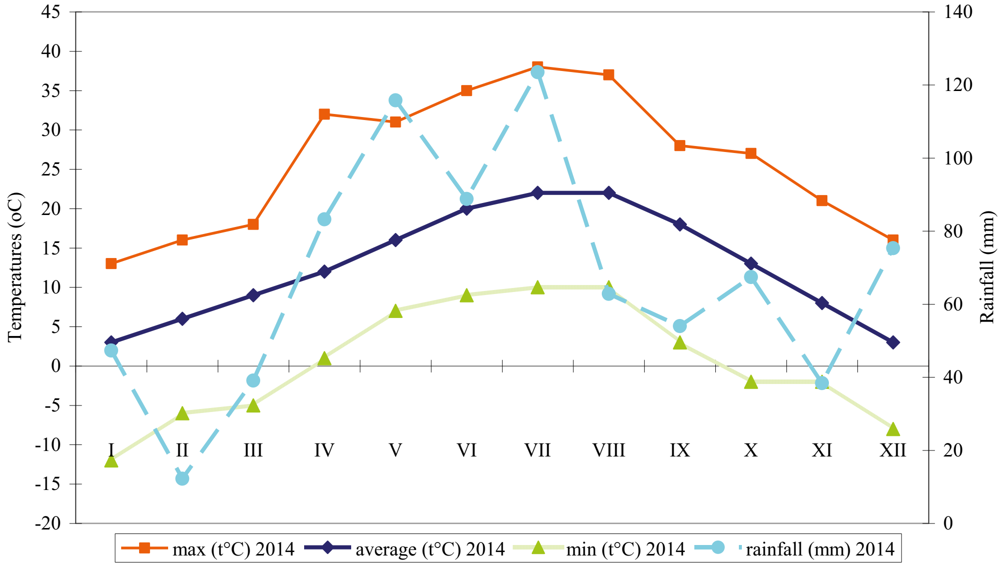

Figure 4. Temperatures and rainfall (2014)

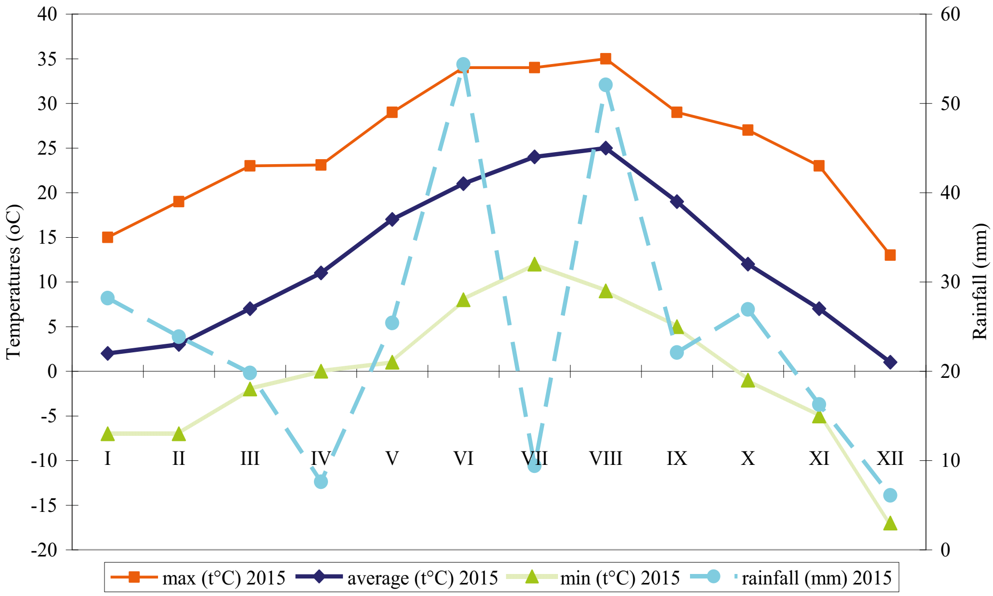

Figure 5. Temperature and rainfall (2015)

Quantities of water in the interval 01-30 June 2014 were reduced (12-50 l/m²), in the western Timis County, normal (51-100 l/m²) on extended surfaces and very high (01-150 l/m²), in the south. Weather conditions were favorable for vine growth and development in the vine.

First decade of July 2014 was warm weather, after which the temperature increased gradually. The higher temperature ranged between 19 ... 35°C and the lowest between 10 ... 26°C. There were heavy rainfalls but also thunderstorms, and isolated hailstorms. The rainfall in the period 01-31 July 2014 was among 51-100 l/m^2, in the southwest and central of the Timis County. On extended areas rainfall were heavy (101-125 l/m^2) and over normal (126-241 l/m^2), which favored the downy mildew (*Plasmopara viticola*) and powdery mildew (*Uncinula necator*) (Figure 4). In May 2015, in the center of the region, normal (26-50 l/m^2), high (51-100 l/m^2), abundant (101-125 l/m^2) and excess rainfall (126-200 l/m^2) were reported on extended areas of Banat. Moisture in the 0-100 cm of soil at the end of May 2015, in Timis County, was low values. The summer season of 2015 was characterized by a warmer weather than normal. Between May and June, the amount of rainfall was deficient (< 150 l/m^2) (Figure 5). Data were subjected to statistical analysis using Statistica 13.0.159.7 software for Windows (One way ANOVA).

RESULTS AND DISCUSSION

Results concerning the length measurements of main shoots in Pinot Noir, Cabernet Sauvignon and Merlot varieties, from Buzias-Silagiu and Recas vineyards, among 2011 and 2015, are shown in Figure 6. In Pinot Noir the longest main shoot before bloom was in 2014 (27 cm) when were recorded daily temperatures of 31^{0}C and nights with no less than 7^{0}C. The same behavior was observed in the other two varieties, Cabernet Sauvignon (64 cm in 2014) and Merlot respectively (49 cm). The spring of 2015 (similar to 2011) was cool, with temperatures slightly below the average of the period, which delayed the blooming with about 7-10 days without major influence on the vine phenology. However the shortest main shoots before bloom, in all three varieties, were registered in 2015 followed by results from 2011.

Higher grow rates were observed before full bloom, followed by slow grow after fruit set due to the competition for nutrients and water among canopy and bunches (Figure 6). In full bloom stage, the longest main shoot was recorded in Cabernet Sauvignon (104 cm) in 2014. In fruit set stage, remains the same rank of main shoot length for all varieties. Young shoots were green, healthy and vigorous, and flower bunches equally distributed on the canes. In 2014 the constant rainfalls at regular intervals, alternating with sunny and low wind days helped to air the vineyard and decreased humidity around flowers.

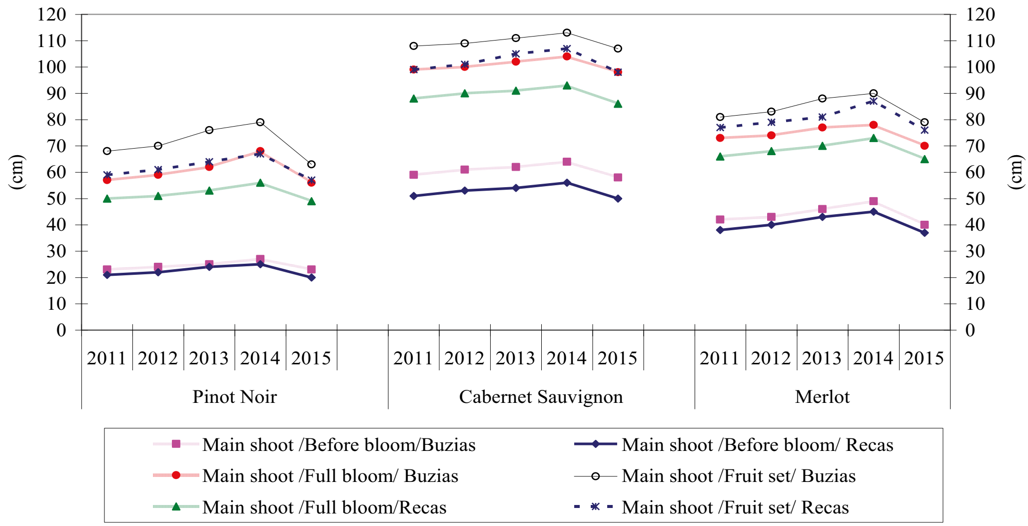

Figure 6. Main shoot length before bloom, full bloom and fruit set stages, in Pinot Noir, Cabernet Sauvignon and Merlot varieties, from Buzias -Silagiu and Recas vineyards (2011-2015)

Cheng et al. (2014), in a study concerning the influence of soil properties and climatic conditions of 2011 and 2012 years, on Cabernet Sauvignon variety, found that the average shoot length at harvest, in two vineyards from China, was between 122 and 136 cm, length that can be reached and exceeded by main shoots of Cabernet Sauvignon from Buzias-Silagiu and Recas until the harvest time.

Sabbatini and Schilder (2012) found in their research from Michigan vineyards, longest main shoot in Pinot Noir variety in all three stages: 67 cm (before bloom), 76 cm (full bloom) and 95 cm (fruit set) respectively. Reynolds and Naylor (1994) investigate Pinot Noir variety in a glasshouse situated in British Columbia, Canada.

Lateral shoots measured between 47 and 108 days after full bloom was among 6 and 143 cm. Lateral shoots from the Pinot Noir grown in both vineyards from the west of Romania are included in these limits and are much shorter. Schreiner et al. (2013), studied the impact of NPK supply on leaf area and shoot growth before bloom stage in pinot Noir variety. According to their research results, the shoot length was between 84-117 cm, and little influenced by different NPK supply.

Pinot Noir is a medium vigor variety and temperatures above 35^0C in 2014 and 2013 summer days slow the shoot growing due to the shutting down of the photosynthesis.

Cabernet Sauvignon has large vigor and medium fertility (65-70% fertile shoots). It has good tolerance to frost (-20, -22^0C), very resistant to drought, good tolerance to oidium, gray mold and rots (Dobrei et al., 2016b).

The vegetative vigour of Cabernet Sauvignon from high altitude vineyards of Southern Brazil was studied by Rufato et al. (2014) after application of prohexadione-calcium for reducing shoot growing. Despite the treatment, the main shoot final length range among 209.7 and 258.1 cm).

During 2006 -2009, Borghezan et al. (2012), evaluate shoot growth in Merlot and Cabernet Sauvignon, cultivated in São Joaquim vineyards from Brazil. They found out that the main shoots average length in both varieties was quite similar for around 130 days, until ripening stage. The final main shoot length was in average 3.22 m for Merlot variety and 2.90 m for Cabernet Sauvignon. Growing rate observed was 5.0 cm per week before blooming and around 25.0 cm per week after until grow decrease after fruit setting. In Leal G.R. (2007) studies, on Pinot Noir variety from New Zealand, main shoot final growth was 89.1 m.

Hunter and Visse (1990), in their research developed in South Africa, concerning the effect of defoliation on Cabernet Sauvignon growth, found longer lateral shoot length in berry set stage, amongst 63 - 91 cm, very significant longer compared to lateral shoots of Pinot Noir from Buzias-Silagiu or Recas vineyards. Longer lateral shoots are the result of partial defoliation which improved the light environment and leaves photosynthesis in the vine canopy (Dobrei et al., 2016c).

Merlot is a medium - large vigor. It is adapted to different soil and climate except arid areas. Variety resistance to frosts is low (-16°C - 18°C) and drought, and medium to diseases. Sprouting takes place early, and is consequently sensitive to spring frosts Unfavorable weather during flowering leads to millerandage (Dobrei et al., 2015).

Variety is also susceptible to mold (although it has a better mold resistance than other varieties) (Robinson J., 2003). It is a poorly tolerant to drought and frost-resistant (-18^0C) (Dobrei A., 2004). Similar results to those from Buzias-Silagiu and Recas vineyards, concerning the main shoot length in Merlot variety (from 37 to 90 cm) were found in two trials conducted during 1995-1998 in the Research station Agroscope Changins-Wädenswil from Switzerland.

Jemini et al. (2010) found a shoot length in Merlot variety affected by downy mildew, between 12.30 cm in the second decade of May and 81.99 cm after 30 days in June in the 1996 trial and between 25.91 and 78.59 in 1998.

Lateral shoots length before bloom, full bloom and fruit set stages, in Pinot Noir, Cabernet Sauvignon and Merlot varieties, from Buzias-Silagiu and Recas vineyards (2011-2015) are shown in Figure 7.

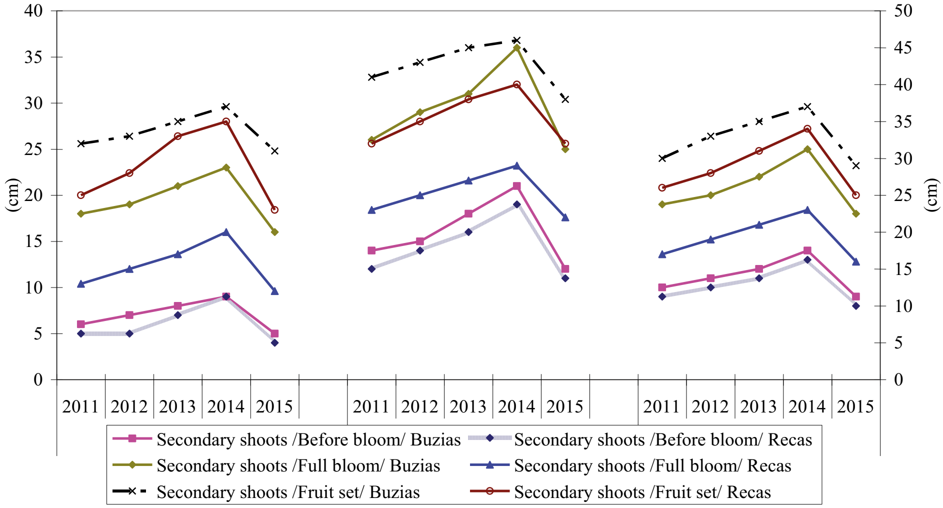

Figure 7. Secondary shoots length before bloom, full bloom and fruit set stages, in Pinot Noir, Cabernet sauvignon and Merlot varieties, from Buzias-Silagiu and Recas vineyards (2011-2015)

In the first stages of development, lateral shoots compete for nutrients and water with the other components of the vine, but after a 30 cm length they can be a source of nutrient compounds for the bunches. Lateral shoots length measured by Leal G.R. (2007) in Pinot Noir from New Zealand ranged in the same limits (5-10.4 cm) like those from Buzias-Silagiu and Recas.

CONCLUSIONS

Both low and very high temperatures influence the grapevine canopy, by decreasing shoot growth and photosynthesis. Pinot Noir had in 2015 the shortest main and lateral shoots because although it is a frost-resistant variety and drought, high humidity associated with low temperatures during the flowering (end of May) affects berries setting, significantly and influencing considerably the next harvest. The longest shoots were found in Cabernet Sauvignon variety in Buziaș-Silagiu vineyard and the shortest in Pinot Noir variety from Recaș vineyard. Although between the two vineyards there were not significant differences concerning the shoots length, Cabernet sauvignon had longer main and lateral shoots in each phenological stage. Results also show that vines subjected to water stress and high temperatures had shorter main and lateral shoots.

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