

## The influence of site environment on bud development and fruitfulness in some grapevine varieties

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**Abstract** Yield in grapevine is greatly influenced by bud fruitfulness. Sunlight exposure of shoots favours the development of buds. The aim of the paper was to study the influence of temperature and location on bud fruitfulness in Cabernet Sauvignon, Italian Riesling, Chardonnay and Merlot varieties in three vineyards from the west of Romania: Buziaş-Silagiu, Recaş and Miniş respectively, during 2013-2015. Results show that in Buziaş-Silagiu in 2013, Italian Riesling variety recorded the highest fruitfulness per node (2.01). Overall, in the same vineyard, 2015 year was the highly fruitfully for all varieties compared with other two locations of research. The most fruitful in the research period was Merlot variety (2.12) fruitfulness per node.

### Key words

bud, fruitfulness, grapevine, temperature, varieties, vineyards

Successful grapevines are those sustainable and consistently productive over the years. Injury control due to low temperatures in dormant period it's a compulsory management practice in vineyards [1]. Injuries during dormant period can be caused by frosts, both in springs in the time or after bud brake and in autumn after the leaves fall [5]. The consequences of frost can be very damaging by the loss of fruiting buds, by reducing foliar area, increasing disease sensitivity, loss of vine trunks which cause gaps in the vineyard, declining production and grape quality and consequently less income [11]. Some of the productive potential of primary, secondary, and tertiary buds is removed during dormant pruning to keep a limited number of shoots that will harvest up to three clusters. Fruitfulness is also influenced by the climatic conditions in the blooming, flowering and fruit setting time [9]. Exposure to light increases the fertility of buds. A favourable exposure to sunlight, most often generates shoots both from the main bud and from one or both secondary buds, resulting in a higher number of flowers and respectively clusters per node [12]. Temperature has a critical role in the physiology of vine and especially in the development of spring buds, starting in vegetation taking place at a temperature of about 10°C, depending on the variety [6]. Long-term studies have shown that temperature positively influences the buds development and the fruit setting in grapevine [10].

### Materials and Methods

Field experiments were conducted in 2013-2015 period in three vineyards from west of Romania:

- In Silagiu-Buzias vineyards the average January temperature reaches -1.1°C and the average winter temperature is -0.1°C. In December and February, the temperature is positive. Spring is early, short and fairly warm, but low temperatures have been recorded in April and May as a result of cold air invasions in northern and north-western Europe. Rainfall is between 700-800 mm per year with an annual average value of 655 mm. Most rainfall falls in June, but also in May. The soil texture is clay-sandy, clay-powdery, and loam-powdery, with high proportion of coarse sand and porosity ranging from 45 to 50% which is optimal for grapevine growing.

- In Recas, winter temperatures are mild and do not affect buds development, heliothermal resources are favourable (heliothermal index, H.I. - 2.04), but water resources are slightly lower (hydric soil index, H.S.I - 1.1). In the Recaş vineyards, the dominant soils are the reddish brown soils with a porosity of 40-55% and a clay content of 14-35%.

- In Minis vineyards, temperatures below 0°C are recorded only in January and February, but rarely below -2°C. The warmest months in the summer are July and August, when the average temperature is above 21°C, favourable for the development and ripening of grape berries. In September average temperature is around 15° C. The soil consists mostly of brown- chocolate chernozem, with a high percentage of humus of 4-6% and a high content of nitrogen, phosphorus and potassium, with plenty of soil microbiological constituents. As texture, the soil is medium clay. The pH is slightly alkaline, with values of 8.04 and 8.07 respectively.

Plant material consists of 12, 10 and 8 years old grapevines. Vines were planted in east-west oriented rows. Across experiment were applied the same cultural practices in all vineyards, for each variety. Temperature and rainfall were the significant variables in each vineyard. Soil type, vine age, training and pruning methods were noted but not experimentally tested. Observed fruitfulness (as number of inflorescences per node), from the first 10 nodes on the shoot, in Cabernet Sauvignon, Chardonnay, Italian Riesling and Merlot was evaluated. Data were subjected to statistical analysis for obtain the average results for bud fruitfulness. Analysis and graphics were processing by GraphPad Prism 7.04 Software, Inc.

## Results and Discussions

Climatic factors influence the vine in all stages of development, but extreme temperatures are those that can cause irreversible damage [2]. High temperatures during ripening are beneficial for the accumulation of sugars, anthocyanins, flavours, acidity, while low temperatures in early bud-break time can cause great damage to viticulture or in variation-harvest season when yield and quality of grapes and wine are influenced [8].

In west of Romania were those three locations for researches are located, average mean temperatures and rainfall during 2013-2015 are shown in Figure 1. For bud-break (April) to setting (June), the weather can be described as follows:

In April 2013, the air temperature was generally higher than normal. Rainfall was recorded as local rain,

showers on small areas in small quantity, with thunderstorm winds. In April 2013, the monthly rainfall average (46.8 mm) was 9% lower than the normal climates. During April 1-30<sup>th</sup> - 2013 was reduced rainfall quantity (11-25 l / m<sup>2</sup>), in Miniş-Măderat area, normal (26-50 l / m<sup>2</sup>) in Buziaş - Silagiu, and increased rainfall (51-75 l / m<sup>2</sup>) in Recaş area. Isolated in the Buziaş-Silagiu area, moderate drought stress (150-250 m<sup>3</sup> ha<sup>-1</sup>) was reported. As a result, the biological processes in the vineyards were more intense, in all areas. The vine in most of the vineyards has completed its bleeding stage, mainly the bud -break and leaves separated. Soil and climate conditions were generally favourable for field work (fertilization, herbicides application, pest treatments in vines and pruning). Overall, May 2013 was characterized by a higher air temperature than normal. The rainfall between May 1st and 31st 2013 was normal, (26-50 l m<sup>-2</sup>) in the north of Banat area (Miniş-Măderat) and raised (51-100 l m<sup>-2</sup>) in the other two locations respectively. From time to time heavy rainfalls were recorded with lightning, damaging winds and local hailstorms. In June 2013 normal warm days alternate with days with higher than normal temperatures. The average daily temperature values ranged from 17 to 29°C during the warmest periods, with positive thermal deviations of 1 to 9°C and 11 to 24°C, close to climate normal. In June, the atmosphere becomes more unstable, with showers, thunderstorms and hail that damaged the grapevine, breaking the canes and shoots. In the month of June rainfall was lower than normal in the research area.

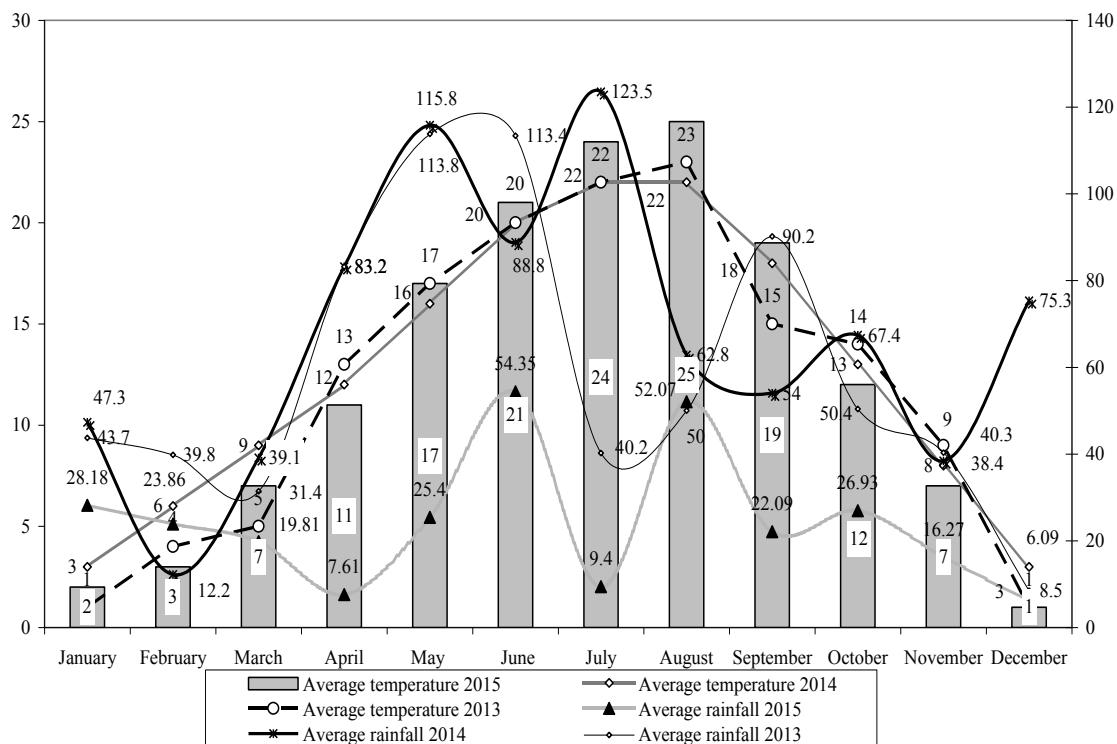


Figure 1. Average temperature and rainfall during 2013-2015 in west of Romania

Throughout the month were recorded rainfall, especially showers, thunderstorm and hailstorm. Rainfall during 1 -30<sup>th</sup> June was low amounts (21-50 l m<sup>2</sup>) in Buziaş -Silagiu and Miniş-Măderat and normal (51-100 l / m<sup>2</sup>) in Recaş vineyards. Vine in this period was finished lives separated, flowering, berries setting and growing [3].

During the month of April 2014, rainfalls were low quantity (12-25 l/m<sup>2</sup>) in Recaş area, normal (26-50 l / m<sup>2</sup>) in Miniş -Măderat area and high amount (76-100 l/m<sup>2</sup>), even excess (101-208 l / m<sup>2</sup>) in Buziaş-Silagiu area. In May 2014 temperature was normal but there were intervals in which the air temperature was lower than usual. There were May days with showers and heavy rains, lightning and strong winds, locally pecking, as well as hailstorms. Rainfalls were high (51-100 l / m<sup>2</sup>) on small areas in the south of Banat, abundant (101-125 l/m<sup>2</sup>) and even excess (126-212 l/m<sup>2</sup>) on large areas of Banat. The vine was at bud-break, the growth of shoots/leaves, or flowering in all vineyards. On favourable temperature and humidity level in the air and soil, the biological processes of the vine have generally evolved, and on lands with a good supply of soil water, the growing rates have been slightly increased in all the three vineyards - Recaş, Miniş-Măderat, Buziaş-Silagiu. In June 2014,

atmospheric instability has continued to grow, with extremely hard raining, strong thunderstorm winds and hailstorms. During June 2014 large amounts of rainfall were recorded in large areas of the western part of the country, which led to an improvement of the soil moisture levels. Generally, weather conditions were favourable for the grapevine growth and development. In most of the vineyards, the shoots continue to grow, leaves to separate and berries setting and growing [4].

In the last decade of April 2015 in the research area, grapevine phenology evolved in favourable temperature in air and moisture in soil. In May 2015, normal amounts of rainfall (26-50, l m<sup>2</sup>) were recorded in most of the days but at the same time heavy rainfall of 51 to 200, l m<sup>2</sup>, were reported on extended surfaces in the research area. During this period, the vine is finishing the bleeding phase, and bud-break and blossoming have continued. Moisture level in the soil (0-100, cm) at the end of May 2015 shows low values (moderate drought stress/600-900, m<sup>3</sup>ha<sup>-1</sup>) and particularly low (strong drought stress/300-600 m<sup>3</sup>ha<sup>-1</sup>). In Buziaş -Silagiu area, water supply was in normal level (900-1200 m<sup>3</sup>ha<sup>-1</sup>) or close to the optimum (1200-1600 m<sup>3</sup>ha<sup>-1</sup>). In all three vineyards, the grapevine was in leaf unfolds and extends, shoots elongating, beginning of flowering, and berries of the size of grain.

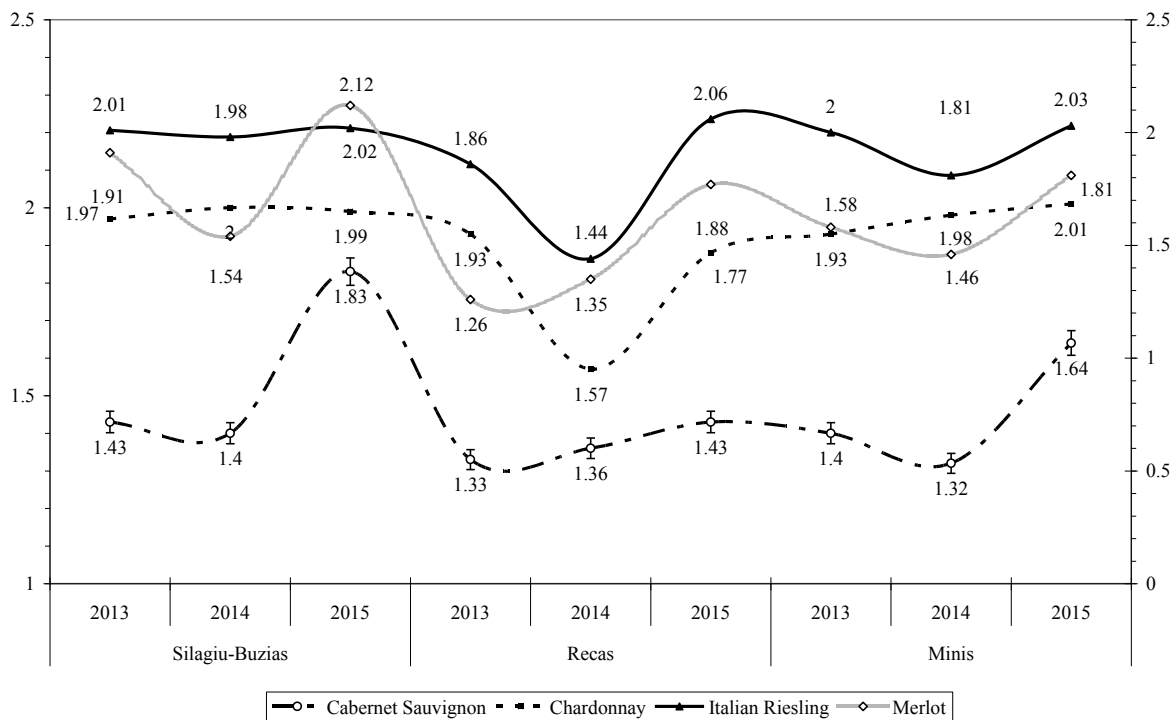


Figure 2. Observed bud fruitfulness (per node) in Cabernet Sauvignon, Chardonnay, Italian Riesling and Merlot

During May-June, the amount of rainfall was small (<150 l m<sup>2</sup>). In Recaş vineyards were recorded normal amounts of rainfall (51-100 l m<sup>2</sup>) while in Buziaş-Silagiu soil moisture was optimum (151-200 l

m<sup>2</sup>). The number of inflorescences per nodes (1-12), observed after bud break in last decade in April and first decade of May are shown in Figure 2. The potential fruit set and fruitfulness was higher due to the

inflorescence emerge from the secondary buds, but which after all didn't contribute to final fruitfulness.

In 2013 in Italian Riesling from Buziaş-Silagiu vineyards, was observed the highest bud fruitfulness per node (2.01). Italian Riesling has medium-long vegetation (170-185 days), medium vigour and high fertility, favoured in April-May 2013 by air temperature higher than normal in Buziaş –Silagiu and normal rainfall. The lowest number of bud fruitfulness (1.43), was recorded in Cabernet Sauvignon, well-known as a variety with a medium fertility. In 2013 the large amount of rainfall in Reçaş vineyards area favoured the canopy development and therefore the shoots were less exposed to sunlight. In Chardonnay variety was found the highest fruitfulness and the lowest in Merlot variety. Excepting Merlot variety which had the lowest bud fruitfulness in 2013, in Miniş vineyards varieties had similar behaviour like in Buziaş-Silagiu vineyards.

Kidman et al. (2013), found in cabernet Sauvignon variety grown in Australia, an observed fruitfulness among 1.07 and 2.73, while in Merlot variety, the fruitfulness recorded was higher (1.41 – 2.62). Bud fruitfulness from Reçaş vineyards was the lowest in all varieties compared with other two locations, with the highest in Chardonnay (1.57) and the lowest in Merlot (1.35). Favourable temperature and water soil level improved the development of vine in Buziaş -Silagiu vineyards, where the same variety (Chardonnay) registered the highest bud fruitfulness (2.00).

Sánchez and Dokoozlian (2005), found in San Joaquin Valley of California, a number of observed fruitfulness per node among 1.32-1.62 in Cabernet Sauvignon and 1.71 -2.03 in Chardonnay variety, respectively. Compared with previous two years, in the last year of research, in Miniş vineyards were recorded in all varieties the highest bud fruitfulness per node, with the highest in Italian Riesling (2.03), followed by Chardonnay (2.01), Merlot (1.81) and by Cabernet Sauvignon (1.64) respectively. Overall years of research, 2015 was the highly fruitful for all varieties from the Buziaş-Silagiu vineyards. Year 2015 being one of the hottest years in the last decade with a lot of sunshine, result in higher bud fruitfulness for all grapevine varieties. In 2015 Merlot grape variety from Buziaş-Silagiu recorded 2.12, fruitfulness per node.

Studding the fruitfulness of Concord variety from California vineyards, Martinson et al. (2012), concluded that the fruitfulness varies around 25% from year to another and helps grape growers to estimate the production of the next year by evaluating the flower primordia in the dormant season.

## Conclusion

Bud viability is used by grape-growers to determine the number of grape cluster on the trunk. The effect of node position on shoot, influence the

fruitfulness; negative in the first five and positive in 5 to 10 nodes. Sunlight correlated with the temperature influenced the most the bud fruitfulness. Merlot variety from Buziaş-Silagiu vineyards, recorded the highest fruitfulness per node over the years (2.12) compared with the other varieties.

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