Volume 21(4), 73- 76, 2017
JOURNAL of Horticulture, Forestry and Biotechnology
www.journal-hfb.usab-tm.ro

Crop estimation and variability of yield components in Cabernet Sauvignon, Merlot, Pinot Noir and Burgundy varieties

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Abstract Four red grapevine varieties (Cabernet Sauvignon, Merlot, Pinot Noir and Burgundy), were evaluated for number of cluster/vine and cluster weight, for yield prediction during 2012-2016. Research was carried out in the vineyard of BUASVM, Timisoara. Green pruning was applied every year without buds or cluster thinning. The aim of the papers was to investigate the differences in cluster number per vine and cluster weight in successive years with extreme weather phenomena. The highest average clusters/vine were recorded in Merlot variety (17.0 ± 1.51 g) but in the same time was registered the highest variability regarding the number of clusters per vine (CV% = 19.94). The highest mean of clusters weight was recorded in Merlot variety (129.5 ± 7.79 g), followed by Burgundy variety (122.14 ± 6.69), while the smallest clusters were found in Pinot Noir (81.1± 2.97 g). Predicted harvest yield on number of producing vines/ha, number of clusters per vine and average clusters weight was the highest in Merlot variety in 2013 which was a very balanced years for grape and wine production, and the lowest yield predicted was in Pinot Noir in 2012, when frost and drought stress decreased the grape crop.

Key words

grape, cluster, weight, vine, yield, varieties

Water in correlation with other environmental factors is of major importance in the grapevine growth and development [18]. The water resource and air humidity influences not only the physiology of the vine, but also the grapes composition and the vine risk to winter frost injury [4]. In years with moderate rainfall, grape vines have a balanced development and high quality grape production [11]. The rainy years that bring high air humidity and a large water supply into the soil contribute to the excessive foliar and shoots growth, which subsequently leads to shading, with negative consequences on the development of grape bunches, on wood maturation and last but not least to the decrease of grapevine resistance to frost injury [9]. Winter cold has effect on next year's production by damages of bud development and fruitfulness, and fruit set [2]. In dry years, photosynthesis is limited, ripening occurs later, the viability of buds is reduced and risk to winter injury increased [5]. The high temperature associated with strong currents creates conditions for increased water consumption especially in the vines with large canopy [19]. Shoots are the most affected by water stress, which slow their growth, tendrils are short, and in severe drought stress the tip of the shoots dries and falls [8]. Extreme air drought during the first stage of veraison, which occurs in most varieties during July-August, negatively influences the development of grape berries and later on the sugars accumulation [1]. Other variables that can change the number of cluster/vine and the cluster weight besides environment are pests, and viticultural practices (pruning, suckering, shoot and crop thinning, etc.), fertilization, bird depredation or fungal diseases [15].

The aim of the paper is to investigate the differences between cluster weights in successive years, in three red grapevines varieties in the same experimental conditions, during 2012-2016, because environmental conditions are the main factor that affects cluster weight every year. Yield estimation is important for grape-growers vineyard management, and to can estimate which production of grapes will harvest any year.

Materials and Methods

The trial was carried out in the vineyard of Banat University of Agricultural Sciences and Veterinary Medicine from Timisoara, during 2012-2016. Three red varieties – Cabernet Sauvignon, Merlot and Pinot Noir, grown on the same soil and similar plots, spacing of 2 m by 1.4 m (3571 vines/ha) were investigated for average cluster weight at harvest to can predict the yield in the next season (using the traditional method) and the influence of weather on berry and cluster development (Figure 1). Vines were trained on vertical trellis with bilateral cordon system oriented in the West- East direction. Green pruning was applied each year, late in spring after the risk of frost, for keeping the normal load of shoots per vine. Clusters were chosen from the same vines on which the clusters per vine were numbered. One hundred clusters from each variety were sampled and the mean cluster was calculated. For yield production the following formula was used: PY = NV x CV x CW / 908 (where: PY = predicted yield/ha; NV = number of vines/ha; CV = number of clusters/vine; CW = cluster weight (g); 908 kg/tone) [3].

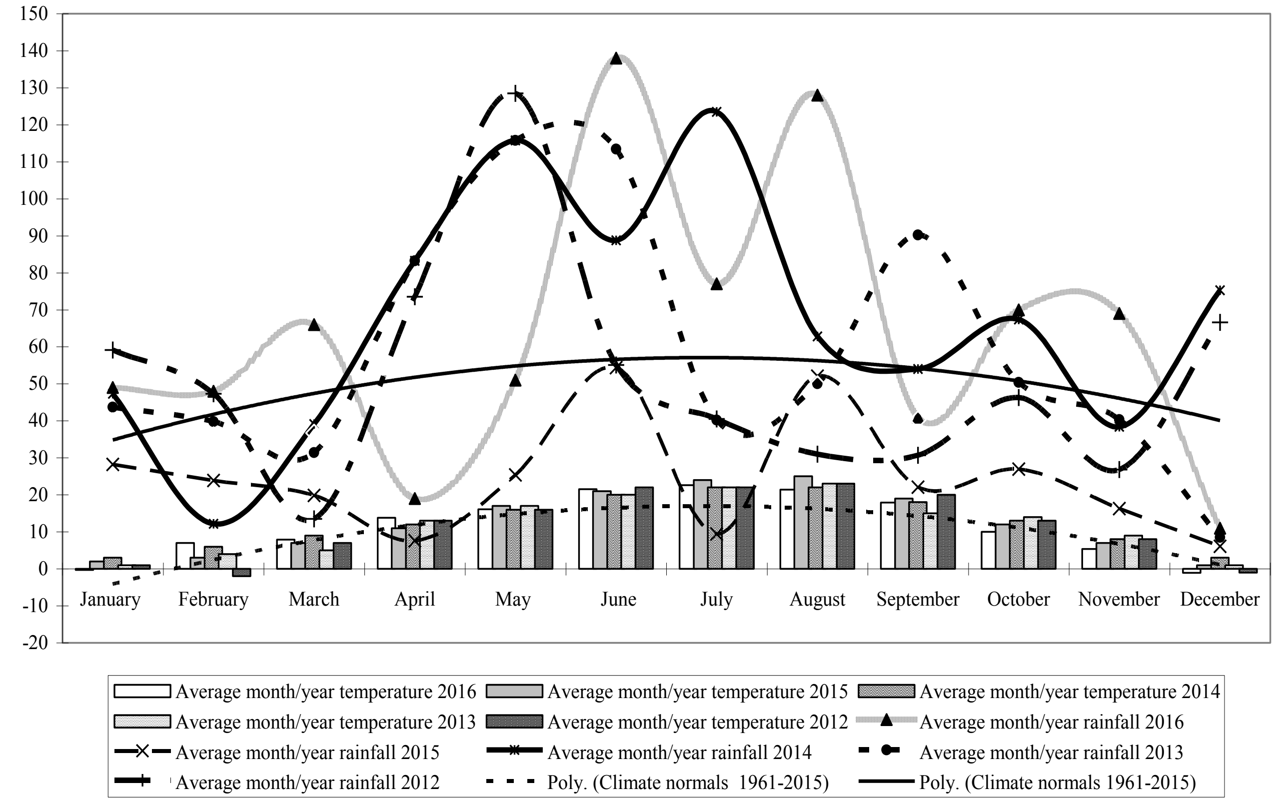

Figure 1. Average month /year temperature and rainfall during 2012-2016

Data were subjected to statistical analysis using Statistica 13.0.159.7 software for Windows (One way ANOVA).

Results and Discussions

No cluster thinning was done in the grape cultivars during research time. From Table 1 data can be observed that the highest number of bud fruitfulness and the highest number of cluster per vine respectively, was recorded in Merlot variety in 2013. In the same time in Merlot variety was recorded the highest variability concerning the number of clusters / vine (CV% = 19.94).

Table 1

Annual average number of clusters/vine in red grapevine varieties during 2012-2016

Varieties/Year	2012	2013	2014	2015	2016	$\bar{x} \pm s\,\bar{x}$	S^2	S	Cv%
Cabernet Sauvignon	14	19	15	16	19	16.6 ± 1.02	5.3	2.3	13.85
Merlot	13	21	19	14	18	17.0 ± 1.51	11.5	3.39	19.94
Pinot Noir	12	18	14	16	17	15.4 ± 1.07	5.8	2.4	15.58
Burgundy	13	17	13	18	15	15.2 ± 1.01	5.2	2.28	15.00

$p < 0.671$

In 2012, bud fruitfulness and flowering was influenced in all varieties with major effect in Pinot Noir by low temperatures from March. Cabernet Sauvignon is late ripening cultivar with fruit maturation problems in cool and wet autumns. Intensity of variation was the lowest for Cabernet Sauvignon variety (13.85%) which show a uniform number of clusters per vine during 2021-2016. Less uniformity in clusters per vine was recorded in Merlot variety during research (CV% = 19.94). Fidelibus et al. (2006), [7] found in Cabernet Sauvignon from California vineyards, much higher number of cluster/vine between 68 and 135. In Clone 777 of Pinot Noir from California, McGarry (2011) [14] found an average of 14.9 clusters/vine, very closed to the average clusters/vine from our research. In North-Western of Croatia, in Zagreb vineyard hills, Merlot variety had in average 29.7 to 30.6 clusters/vine, while in Cabernet Sauvignon the number of clusters/vine was much higher than in Romania, from 35.3 to 38.3 [10].

The average cluster weight of the grapes is a very important character because is both an element of productivity and an element of vines quality [16].

Cluster weight is influenced by environmental conditions, canopy management, fertilization, pests and diseases, especially downy mildew *(Plasmopara viticola)* [6].

In Table 2 are shown clusters weights for Cabernet Sauvignon, Merlot, Pinot Noir and Burgundy varieties, during 2012-2016.

Table 2

Annual average weight of clusters in red grapevine varieties during 2012-2016

Varieties/Year	2012	2013	2014	2015	2016	$\bar{x} \pm s\,\bar{x}$	S^2	S	Cv%
Cabernet Sauvignon	99.7	105.8	101.3	93.2	82.1	96.42 ± 4.11	84.497	9.19	9.53
Merlot	106.8	141.4	117.2	132.7	149.4	129.5 ± 7.79	303.61	17.42	13.45
Pinot Noir	78.2	82.6	74.1	78.9	91.7	81.1± 2.97	44.215	6.64	8.18
Burgundy	108.4	146.2	125.7	118.3	112.1	122.14 ± 6.69	223.973	14.96	12.24

$p < 0.0005$

Clusters weight in Cabernet sauvignon and Pinot Noir varieties during 2012-2016 had low variability as coefficient of variability values shows, 9.53 and 8.18 respectively. In Merlot variety the average clusters weight was the highest, while the smallest clusters was found in Pinot Noir in 2014.

Kidman et al. (2013) [12], found in Merlot variety during 2009-2011, in a vineyard from South Australia clusters weight among 79 and 214 g. Compared to these extreme values, Merlot variety from research had a more balanced of clusters weight, with less variability, and an average of 129.5g. Higher cluster weight (171.7 to 295.1g), was found in Cabernet Sauvignon by Fidelibus et al. (2006) [7] during 2000-2003. Average clusters weight in Merlot variety from Zagreb area, was closed to Romanian Merlot variety, with values among 137.2 to 140.2 g, in 2010 and 2011 respectively. For Cabernet Sauvignon variety the clusters weight were also higher, with values between 102.6 and 103.5 g [10]. Shellie (2007) [17] in a study from Idaho vineyards, found in Cabernet Sauvignon, an average clusters weight of 115.3 g, in Pinot Noir, clusters of 98.1 g in average, while in Merlot variety, clusters weight was in average 110.6 g.

Crop size is different each year and different for each grape variety. Often, grape growers estimate the crop size to know for the current year how much crop to expect, for estimate the fruit composition or for maintain the canopy management. Kurtural and, O'Daniel (2006), [13] stated that there is 64% variation in crop size each year due to the different number of clusters and 27% in clusters weight. They considered a good estimation if the yield difference from year to year is around 15%. In Table 3 is presented the estimation of yield for the four red grape varieties between 2012 and 2016.

Table 3

Predicted harvest yield (tons/ha) in Cabernet Sauvignon, Merlot and Pinot Noir varieties during 2012-2016

Varieties/Year	2012	2013	2014	2015	2016
	tons/ha				
Cabernet Sauvignon	5.450	7.845	5.958	5.852	6.127
Merlot	5.419	11.645	8.742	7.267	10.547
Pinot Noir	3.681	5.804	4.074	4.908	6.084
Burgundy	5.521	9.761	6.390	8.353	6.607

Grape crop was decreased in 2012 by hard frost from February and then by the strong atmospheric and soil drought in the months from June to August. 2013 was a balanced year without extreme temperatures or rainfall, excepting the drought period in July and August, with grapes of high quality for wine. Heavy rains and hailstorm from 2014 have destroyed part of the grape harvest. But the warm days of August and September favoured the sugar accumulation and the grapes were more sweet. The harvest was delay by rainfall with a couple of weeks. The best results in the unfaivorable year 2014 were recorded in the resistant variety to pests and diseases –Merlot. Year 2015 was normal for viticulturists who cultivated grapes for wine, after in the previous year rains and mildew destroyed nearly half of total grape production. In difficult year (2016) for wine industry, with many extreme weather phenomena (frost, hail, drought), grape production was for some varieties about 10-15% lower than the one recorded in the previous year, while Merlot variety was more tolerant to downy mildew and pests.

Conclusions

The best year for grape and wine production of high quality was 2013 followed by 2016. From all four red grape varieties, Merlot variety recorded the best results, with the highest number of clusters per vine and the highest mean of clusters weight. Higher clusters weights of Merlot variety correspond to a better resistance to pests and diseases and an increase of berry number per cluster. Pinot Noir known as a sensible variety to environment pests, diseases and canopy management recorded the lowest results.

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