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Journal homepage: asn.shu.bg**Study of some abiotic factors and their influence on the yield and quality of four cherry cultivars****Dimitar Vasilev*, Maria Kaschieva**

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Abstract: *The study was performed at the Experimental Station of Agriculture - Khan Krum in the period 2018-2019. The experimental plantation was established in 2001, the early Bigareau Burlat, middle early Bing and the late Germersdorfer and Van were tested. The planting material was produced on a mahaleb rootstock. The distance of planting was 6 meters interrow spacing and 5 meters intrarow spacing. The experiment was based on three replications each of them reported on a separate tree. When analyzing the frost percentage of flowers, 400 blossoms were taken from three levels of the crown of each tree, the same number of fruits were taken to determine the cracking percentage. Percentage of damaged blossoms, yield kg/ha and percentage of fruit cracking as a result of fallen rains during harvest were established. The purpose of the study is to investigate the influence of abiotic factors on the yield and quality of four sweet cherry cultivars. In this regard, the frost percentage in the range of values was 67,3 - 100%. Bigareau Burlat yield was not obtained, and it was relatively low from Germersdorf and Bing (20,1 - 24,6 kg/ha) at Van 84,6 kg/ha. The number of cracked fruits due to fallen rains during harvest was relatively high in Van and Bing (39,8 - 47,4%), while in the Germersdorf cultivar it was lower - 21,2%.*

Keywords: sweet cherries, frost, yield, cultivars**Introduction**

Sweet cherry (*Prunus avium* L.) is one of the most common fruit tree in our country. Over the last 15-20 years the interest in this crop has increased.

Negative winter temperatures, reverse spring frosts cause the underground and above-ground part of the cherries to freeze and thus they are a limiting factor in getting a good harvest [1, 5, 6, 12, 13, 14, 15, 16, 17].

Negative winter temperatures lead to freezing of fruit buds as well as damage 1,2,3-year old-fruit trees including apples, cherries and peaches. The cold resistance of Bing, Lambert and Van was investigated and the percentage of frozen buds in the last cultivars was found to be lower [1].

In this regard, a common occurrence during the last two decades was the early exit of deep rest especially in some stone fruit species such as apricot, peach and sweet cherry, which manifests in warming after long period of bad weather [6]. Other authors [10] have argued that growing rootstocks are more resistant to cold compared to weakly growing rootstocks.

According to some authors [5, 14], the critical temperature during the phenological phase is a showing the color of the petals from minus 1,7°C to minus 5,5°C. When full phenophases occur, full flowering and binding formation occur, critical temperatures are in range of minus 1,1 to - 2,2°C.

Testing sixteen sweet cherry cultivars under late spring frost conditions (-4,0°C), the authors [9] found frost on young cuts and three frozen stems. In most cultivars (eleven in number), Van among them the fruits were frozen at 100%. The most resistant cultivars were characterized by Kozerska and Sparkle (96,3 - 96,5%).

Vassilev [16] reports the late spring frost in 2011 when early blossoming cultivar Bigarreau Burlat (81,3%) was most affected, resulting in the lowest potential yield.

Data from studies of Malchev, Zhivondov and Malchev [12, 17] show that late spring frost resistance to cherries depends more on the cultivars than the used rootstocks. Popov [13] reports that, compared to Summit, the Bigarreau Burlat cultivar has stronger influence on the stability of flower buds.

Fruit cracking is also a limiting factor for high yields and high quality sweet cherry production. This phenomenon is observed when there is frequent and prolonged rainfall during the ripening stage. Cracking is considered to be due to adverse weather factors in combination with genetically determined differences between cultivars [3, 4, 5, 7, 14, 15].

Sekse [14], Christov and Stoeva [3], Correia et al. [4], Georgiev et al. [5], Koumanov [8], and Tsolov [15] describes the physiological mechanism by which fruit cracking occurs, namely high air humidity retention of water droplets on fruit in combination with high air temperature.

Most of the cultivars grown in Bulgaria do not have crack resistance [5]. According to Kafle et al. [7], treating the fruit with solution containing calcium limit the damage. Georgiev et al. [5] reports that such treatment leaves traces and deteriorates the commercial appearance of sweet cherries. In this regard Blanco et al. [2] argue that the cultivation of sweet cherries has become a high tunnel.

In the last 10-15 years, the impact of abiotic stress factors has increased due to climatic change. Their frequency is increasing, which is a factor limiting the production of high yields and quality sweet cherry production. The purpose of this study is to determine the influence of abiotic factors on the yield and quality of four sweet cherry cultivars over two consecutive years.

Materials and methods

The study was conducted at the Experimental Station of Agriculture - Khan Krum in the period 2018-2019. The experimental orchard was established in 2001, the early cultivar Biggareau Burlat, middle early Bing and late Germersdorfer and Van were tested. The propagation material was produced on mahaleb rootstocks. Planting distances were 6 meters (in a row) and 5 meters (inside the row). The soil was gray forest.

The experiment was repeated three times as each time the result three trees were taken into account. On 12 April 2018 year the last spring frost was detected and the minimum temperature lowered to - 3,7°C degrees. The same phenomenon was detected in 2019 – on 14 April (- 4,2°C). The results were reported in two consecutive years with rainfall during the ripening of cherries. When analyzing the frost percentage of each tree, 400 blossoms were taken from three levels of the crown. The same number of fruits was taken to determine the cracking percentage. Percentage of damaged flowers has been identified; as well as obtained yield kg/ha and rate of cracking of fruit as a result of fallen rain during harvest maturity. The cracking index was determined by the Werner-Christensen method. The formula to calculate the data was:

$$CI = \frac{(5a + 3b + c) \times 100}{250}, \text{ where}$$

a - number of cracked fruits after 2 hours in distilled water
 b - number of cracked fruits after 4 hours in distilled water
 c - number of cracked fruits after 6 hours in distilled water

The annual index is derived from the average of three samples taken over three days [5].

Data were statistically processed according to Duncan's criterion [11].

Results and Discussion

The influence of abiotic factors on fruit production and quality has been known for decades. In relation to climate change over the last two decades the impact of stressors has intensified and in many cases has led to lack of harvest. As a result of the soft and warm winter, the studied cultivars came out of deep rest early and the growing season started 7–10 days earlier compared to 2018. Spring frost appeared on 4 April, 2019. In this regard, frostbite occurred which coincided with the phonological phase of bud bursting (2018) and full flowering (2019).

In the period 20–25 March 2018 the air temperatures dropped to $-3,9^{\circ}\text{C}$ followed by icing branches which led to cherry blossoms frosting (Table 1).

Table 1. Damaged blossoms at lowered temperatures to $-3,9^{\circ}\text{C}$ in 2018 and $-4,5^{\circ}\text{C}$ in 2019

Cultivar	Frost damage, %		
	2018	2019	On average over two years
Bigareau Burlat	100,0 a	100,0 a	100,0 a
Bing	93,6 a	94,8 a	94,2 a
Germersdorfer	94,2 a	96,0 a	95,1 a
Van	63,7 b	70,9 b	67,3 b
LSD 5%	7,0	7,8	7,2

In the early flowering cultivar Bigarreau Burlat this phenomenon leads to lack of harvest (Table 2), while in the middle – early Bing and Germersdorfer it is associated with a significant decrease in yield. Yields close to normal for the cherry culture were obtained from the Van cultivar (72,6 kg/ha).

A returnable spring frost, when the temperature drops to $-4,5^{\circ}\text{C}$ reported in 2019, adversely affects the cherry blossoms. The reported frost was from 70,9 for the Van cultivar to 100,0% for Bigareau Burlat. In the other two cultivars the damaged blossoms were from 94,8 to 96,0%. Accordingly, the yield obtained from Germersdorfer and Bing was low 21,2–21,7 kg/ha. Yields close to normal for the cherry culture were obtained from the Van cultivar (96,6 kg/ha).

In Table 1, the average value of damaged blossoms from the discussed period of two years is presented. It becomes evident that the rate of frostbite ranged from 67,3 to 100%. The tendency of the damaged blossoms from Bigareau Burlat was 100%, while in the case of Bing and Germersdorfer the obtained results were from 94,2 to 95,1%. The frost – proof blossoms of the cultivar Van were only 67,3% for very good statistical proof.

The lowering of the air temperature $-4,5^{\circ}\text{C}$ in the city of Plovdiv coincided with the phonological phase full flowering and it lead to damage to the blossoms of cultivars Bigareau Burlat, Bing and Van [12,

17]. According to the authors data, the damage to the studied cultivars was as follows: Bing – 100%, Bigareau Burlat – 96,1%, and Van – 93,0%.

Table 2. Yield received in the period 2018–2019

Cultivar	Yield kg/ha		
	2018	2019	On average over two years
Bigareau Burlat	-	-	-
Bing	27,4 b	21,7 b	24,6 b
Germersdorfer	18,9 b	21,2 b	20,1 b
Van	72,6 a	96,6 a	84,6 a
LSD 5%	23,2	35,4	29,3

In this regard, the average yields of the cultivars Germersdorfer and Bing (20,1 – 24,6 kg/ha) that were obtained in our survey, and Van (84,6 kg/ha) are approaching normal for cherry (Table 2).

It is noticeable that the yield obtained in 2018 from cultivars of Bing and Germersdorfer is higher compared to 2019 which can be explained by the low rate of frost. The statistical data prove that the yields obtained by Van exceed the other cultivars.

Table 3. Cracking of sweet cherry fruit

Cultivar	Cracking, %		
	2018	2019	On average over the two years
Bigareau Burlat	-	-	-
Bing	39,6 a	40,0 b	39,8 b
Germersdorfer	20,7 b	21,7 c	21,2 c
Van	44,6 a	50,2 a	47,4 a
LSD 5%	3,8	7,8	5,8

According to studies of Christov and Stoeva [3] in the region of Kyustendil the precipitation in June 2014 leads to cracking of the fruits of the cultivars Bigareau Burlat (26,0%), Bing (40,0%) and Van (34,0%). This results were obtained at 84,8 mm in rainfall in the period 11-20 June.

Over the past few years, rainfall has been observed which coincided with the ripening period of some cultivars of some cultivars of cherries. In this regard, we have recorded the percentage of cracking of the fruits in cultivars of Bing, Germersdorfer and Van (Table 3). From the presented results it is evident that the crack of fruit in 2018 ranged from 20,7 to 50,2%. Cultivars Bing and Van have a relatively high percentage of cracked fruits (40,0–52,0%). The Germersdorfer cultivar has a relatively low percentage of precipitation – damaged fruits (20,7%). In this regard, the rainfall reported for Khan Krum in the period 16–30 June were 101 mm (Figure 1). The large amount of precipitation can explain the significant number/percentage of cracked fruits obtained in our study in the cultivar Van (50,2%).

The same trend was maintained in 2019 as the impression made the high percentage of cultivars of Van (44,6%) and Bing (39,6%). Relatively stable was cultivar Germersdorfer in which the damaged fruits were hardly 21,7%.

Figure 1. Rainfall for June 2018

It is apparent from the data presented in Figure 2 that 45,0 mm of rain were established in the period 16–26 June. The results for the two years was maintained as the most cracked fruit was of cultivar Van (47,4%), with Bing – 39,8% and relatively low rate was obtained at the Germersdorfer cultivar (21,2%).

Figure 2. Rainfall for June 2019

Conclusion

The return of spring frosts has an adverse effect on the buds and blossoms of the sweet cherry. The average for the two years of freezing is relatively higher for the cultivars Bigareau Burlat, Bing and Germersdorfer, while for Van it is relatively low.

The high percentage of frost on Bigareau Burlat, Bing and Germersdorfer resulted in a lack of yield for the first cultivar, and in the other two, the fruit production was very low. The obtained yield of the Van cultivar was normal, which was due to the significantly lower percentage of frozen blossom organs.

A higher percentage of cracked fruit was found in the Bing and Van cultivars, while in Germersdorfer it was significantly lower for the two years of the study.

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