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# INFLUENCE OF THE ROOTSTOCK ON THE AUTUMN-WINTER DEVELOPMENT OF THE DIFFERENTIATING FLOWER BUDS IN TWO SWEET CHERRY CULTIVARS

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*KEY WORDS: Prunus avium, rootstocks Gisela and Weiroot, flower bud formation, flower primordia, double pistils*

## ABSTRACT

*The studies were conducted in 2003-2007 on 7-11 year-old trees of the cultivars 'Bigarreau Burlat' and 'Stella' grafted on the rootstocks P 1 (seedling of P. mahaleb L.), Gisela 5, Gisela 4, Weiroot 13 and Weiroot 72. From the beginning of September till the flowering the next year (every 7 days) spurs were collected from the two-year-old wood and their lateral buds were disclosed under a stereomicroscope. After the observations in the autumn it was established that under the influence of Gisela 5 there is the greatest number of flower primordia in one flower bud. Between 68 and 93% of the flower primordia initiated in winter in the separate variants have developed as flowers in spring, whereas the remaining ones have slowed their development or suffered frost damage.The greatest number of double pistils in the differentiating flower primordia have been observed in the trees on Gisela 5, Weiroot 72 and Gisela 4.*

## INTRODUCTION

The flower bud formation in the fruit trees undergoes three consecutive phases, the last one being the most prolonged, connected with the morphological differentiation of the flower buds (Buban, 1996).

In the sweet cherry the flowers are developed in the lateral buds of the spurs and in the buds growing in the basis of the longer shoots (Tromp, 2005). Initially the apical meristem of the buds produces only bud scales (Georgiev, 2001; Doleda et al.,1997; Tromp, 2005), and when their number in June - July reaches 22-25, bract and flower primordia appear (Guimond et al., 1998a), the real flower bud formation starts. Sepals, petals, stamens are consecutively differentiated on every one of the formed flower primordia, and finally the carpel appears. From the onset of the flower bud formation until the formation of the pistil parts (in September – October), according to the habitat and the temperature conditions in the respective year, from 67 to 90 days pass (Georgiev, 2001), whereas according to Faust (1989) – their number is from 86 to 112. A period of winter dormancy is followed again in spring by an accelerated course of bud development, which is similar in its rate to that of the summer months of the previous year (Tromp, 2005).

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The authors conducting research work in the field of flower bud formation in the sweet cherry have directed their attention mainly to establishing the onset of morphological differentiation of the flower buds and the factors influencing them in this respect (Guimond et al., 1998a; Georgiev, 2001; Doleda et al., 1997; Lichev and Garbatilova, 2005; Watanabe, 1982), this being easily explicable, taking into consideration the great practical application of this moment.

The studies referring to the development of differentiating flower buds in autumn and winter are very few. In this respect Georgiev (2001) has observed that in January in the cultivar 'Drogans gelbe' the flower stigmas are less explicitly widened, and the sepals, petals, stamens and styles are smaller compared with those of 5 other studied cultivars. According to the author this circumstance determines the higher hardiness of the flower buds of this cultivar.

It has been established that the initiation and development of the flower buds in the sweet cherry can be influenced by the meteorological conditions (Georgiev, 2001; Micke et al., 1983), the cultivars (Georgiev, 2001), the pruning (Guimond et al., 1998b).

The rootstocks probably (as a constituent part of the grafted fruit trees) influence the initiation and development of the flower buds of the graft. The influence of the rootstocks only on part of the cultivars included in the studies has been observed in the sour cherry (Elek, 1974) and the apple (Buban, 1967). As far as the sweet cherry is concerned, we did not discover data about studies, conducted along these lines in the literature available to us.

Taking into consideration all this, we set the task of conducting a study on the influence of 5 rootstocks (differing in their growth vigour) on the autumn-winter development of differentiating flower buds in two sweet cherry cultivars.

## MATERIALS AND METHODS

The studies were conducted during the period 2003-2007 in the experimental plantation of the Fruit-growing Department at the Agricultural University in the town of Plovdiv. 7-11-year-old trees of the sweet cherry cultivars 'Bigarreau burlat' and 'Stella' were used grafted on the rootstocks P 1 (seedling of P. *mahaleb* L. selected in Bulgaria), Gisela 5 , Gisela 4, Weiroot 13 and Weiroot 72, which were planted at distances of 6,0 x 4,5 m using a randomized block design. The trees were trained as free-growing crowns; they were grown under the conditions of herbicide fallow and were gravity irrigated. They had winter pruning each year except the season 2004-2005.

For the sake of conducting observations on the development of the buds, weekly samples were collected from the beginning of September till the onset of flowering in the next year. In every one of the variants, 3 spurs in total were taken from 3 trees, disposed on the two-year-old wood in the south-east direction and well-lit by the sun.

The branches were immediately defoliated and their lateral buds were disclosed by means of a preparatory needle under a stereo-microscope, or were preserved for later observations in a solution of Formalin 70%, Ethyl Alcohol and concentrated Acetic acid in the ratio of 2:10:1. The number of flower primordia in the autumn was determined by the mean data of the microscopic observations in September and October. The length of the pistil was measured by a micrometer. The number of flowers in one flower bud was observed in the field the next year at the time of the appearance of the color of the flower, as for this purpose, 3 branches disposed on 3 trees were used in every variant. The percentage of double pistils was calculated on the basis of the microscopic observations during the whole autumn – winter period.

Some of the data obtained were statistically processed by the ANOVA method using the Student test.

The region of the experimental plantation is characterized by a comparatively mild winter and dry, hot summer, with maximum air temperatures in July and August often reaching $40^0$C. The annual overall precipitation is 400-500 mm, distributed irregularly, predominantly in winter, spring and autumn. The soil is slightly alkaline with pH=7,50 and a moderately sandy-loam mechanical composition.

## RESULTS AND DISCUSSION

The data from the microscopic observations in September – October reveal that both in the year 2004, and also in 2006, in both cultivars, the type of used rootstock has influenced the number of differentiated flower primordia in one flower bud. The greatest number of flower primordia is proved to be formed under the influence of Gisela 5, the smallest one – in P 1, whereas the remaining rootstocks occupy an intermediate position (Table 1). As far as the used cultivars are concerned, from the data we can observe that in the two years from all rootstocks (with the exception of Weiroot 13 in 2004) 'Stella' has a priority over the rest of them. A similar tendency has also been revealed in the flowers observed in spring (with the exception of Gisela 5 and Weiroot 13 in 2005) which, in combination with the number of flower primordia explains the greater fertility of the cultivar 'Stella', manifested in its growing in the fruit-bearing plantation.

The comparison between the data from the microscopic and field studies reveals that in the season 2004/2005 in the trees of the cultivar 'Bigarreau burlat' on P 1 and Weiroot 13, about 90-91% of the flower primordia have turned into flowers, whereas in the other rootstocks (which on principle are more dwarfing) the percentage of the grown flowers is comparatively lower – between 68% and 82%. The remaining flower primordia (which are between 9% and 32% for the separate rootstocks) have not turned into flowers because they have retarded in their development or have been damaged later on in winter to a different degree by the frosts.

This comparatively high percentage of the mortality of the flower primordia is probably due to the comparatively more unfavorable conditions for winter dormancy of the plants, manifested in the sudden fluctuations and critical values of the air temperatures in the season 2004/2005. Taken as a whole, the same tendency has also been observed in the cultivar 'Stella', where the formed flowers on the vigorous rootstocks are about 86-87%, whereas on the more dwarfing ones – it is between 75% and 78%. In the season 2006/2007, in spite of the favorable conditions for winter dormancy of the trees, the percentage of formed flowers in one fruit bud in the separate variants remains within the boundaries between 86% and 88% in the cultivar 'Bugarreau burlat', and from 83% to 93% in 'Stella'.

As, at an earlier stage of the vegetation, on the vegetative cone, the sepals, petals and stamens have differentiated, in September the separate parts of the pistil have also been formed. The growth of the pistil in both cultivars follows an ascending curve with a vigorous initial stage till the first ten-day period of November, when it subsides but does not interrupt, and in the first ten-day period of February again resumes its rate explosively (Figure 1). In this connection the opinion of Georgiev (2001), who, after studying 6 cultivars, has not established dormancy in the differentiating flower buds either, is topical. The author’s observation is based on the fact that in January the flower parts in the buds have been of a lager size in comparison with November the previous year.

In the course of our weekly microscopic studies we have been impressed by the fact that under the influence of some rootstocks, double pistils have been formed in the differentiating flower buds. Taking into consideration, that double fruit are subsequently formed from the double pistils, deteriorating the production quality, we consider it necessary to present the results obtained from this index too.

During the season 2003/2004 a greater number of double pistils has been observed only in Gisela 5, Weiroot 72 and Gisela 4 - between 6% and 9% for the cultivar 'Stella' and between 4% and 8% for 'Bigarreau burlat', whereas the remaining rootstocks have produced a quite weaker influence in this respect (Figure 2).

During the following two seasons the number of observed double pistils in all rootstocks for both cultivars, is insignificant. The greater number of double pistils in the season 2003/2004 is probably due to the higher mean 24-hour air temperature in the summer months (July, August and September) of 2003 - 22,6$^0$C in comparison with that in the year 2004 – 21,7$^0$C and in 2005 – 21,4$^0$C. The fact that, according to Micke et al. (1983) in the years with warmer summers, a greater number of double pistils are differentiated, gives us grounds for this assumption.

## CONCLUSIONS

The percentage of the flowers grown in spring from one flower bud (compared with the number of the flower primordia in the autumn) in the trees on the studied rootstocks is between 68% and 93%. With comparatively more abrupt fluctuations and critical values of the air temperatures, the percentage of the flowers grown in spring in the more dwarfing rootstocks (Gisela 5, Gisela 4 and Weiroot 72) is smaller than that in the vigorous ones P 1 and Weiroot 13. Under favorable conditions for winter dormancy of the trees, the percentage of the formed flowers in one fruit bud in the trees on the separate rootstocks do not differ significantly.

Dormancy in the development of the differentiating buds in the autumn – winter period has not been observed. The growth of the pistil, being it at a slower rate, continues in the period from November to the middle of the first ten-day period of February too.

Every other (out of the three studied seasons altogether) a greater number of double pistils has been observed – under the influence of Gisela 5, Weiroot 72 and Gisela 4 they are between 6% and 9% for the cultivar 'Stella' and between 4% and 8% for 'Bigarreau Burlat', whereas the remaining rootstocks have exercised their rather weaker influence in this respect.

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Table 1.

Influence of the rootstock on the differentiated in the autumn flower primordia and the flowers developed in spring in 1 flower bud in two sweet cherry cultivars

| Rootstocks | Season 2004/2005 | | | Season 2004/2005 | | |
|---|---|---|---|---|---|---|
| | Flower primordia, number (2004) | Flowers, number (2005) | Flowers, % (2005) | Flower primordia, number (2006) | Flowers, number (2007) | Flowers, % (2007 г.) |
| 'Bigarreau Burlat' | | | | | | |
| P 1 | 2,37 | 2,14 | 90,29 | 2,48 | 2,13 | 85,89 |
| Gisela 5 | 4,86 | 3,98 | 81,89 | 3,75 | 3,31 | 88,26 |
| Gisela 4 | 3,20 | 2,48 | 77,50 | 3,02 | 2,67 | 88,41 |
| Weiroot 13 | 3,70 | 3,38 | 91,35 | 2,51 | 2,16 | 86,05 |
| Weiroot 72 | 4,05 | 2,76 | 68,14 | 3,31 | 2,86 | 86,40 |
| LSD - 5 % | 0,42 | 0,40 | 8,26 | 0,30 | 0,29 | 9,57 |
| 'Stella' | | | | | | |
| P 1 | 2,82 | 2,46 | 87,23 | 3,33 | 3,10 | 93,09 |
| Gisela 5 | 4,88 | 3,83 | 78,48 | 4,50 | 3,73 | 82,88 |
| Gisela 4 | 4,37 | 3,40 | 77,80 | 3,65 | 3,26 | 89,31 |
| Weiroot 13 | 3,51 | 3,02 | 86,03 | 3,50 | 3,20 | 91,43 |
| Weiroot 72 | 4,35 | 3,30 | 75,86 | 4,08 | 3,56 | 87,25 |
| LSD - 5% | 0,40 | 0,29 | 7,40 | 0,41 | 0,36 | 11,10 |

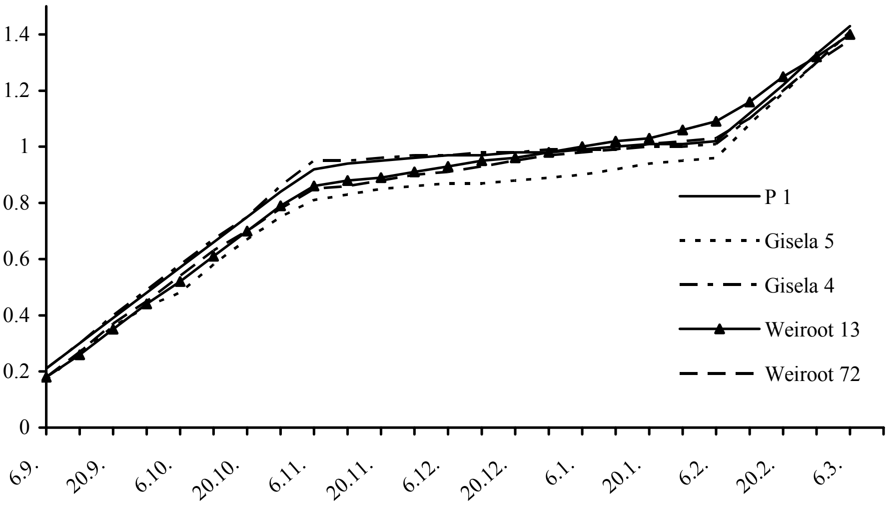


Figure 1. Growth rate of the pistil in the differentiating flower buds of the cultivar 'Bigarreau Burlat' on 5 rootstocks in the season 2004/2005

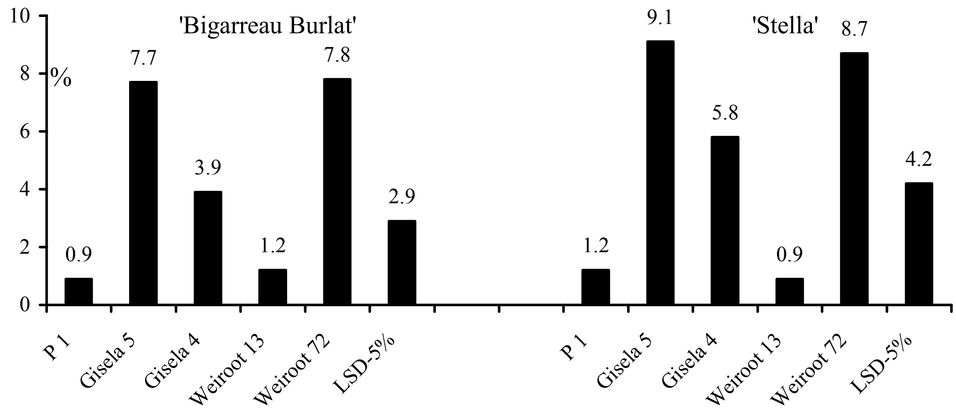


Figure 2. Influence of the rootstock on the percentage of the double pistils in the differentiating flower buds of the two sweet cherry cultivars in the season 2003/2004