

FLOWERING PHENOPHASE OF SOME APRICOT (*P. armeniaca* L.) CULTIVARS DEPENDING ON AIR TEMPERATURE

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Abstract: The paper presents the three-year results of the effect of basic climatic parameters on the flowering of 12 apricot cultivars in conditions of Čačak. The significant differences in the beginning, progression and duration of flowering among years were determined. The beginning of flowering in 2020 was on March 12, in 2021 on March 1, and in 2022 on March 24. Flowering phenophase in one cultivar lasted between 6 and 9 days in 2022 and between 8 and 16 days in 2021. Differences in the beginning of flowering among cultivars were more pronounced in years with earlier flowering date.

Keywords: apricot, the beginning of flowering, climatic conditions

Introduction

The region of Čačak is very famous for apricot production. The hilly - mountainous area with an average altitude of 300 - 500 m a.s.l., specific climate and favorable agro-ecological conditions allow good results in apricot cultivation and relatively stable yields. Despite the favorable conditions in the mentioned area, due to the early flowering of apricots, there are significant differences in the course of the flowering phenophase among the cultivars, as well as large differences in different years. Flowering is one of the most important phenophases for all fruit species. In apricot, this phenophase is of particular importance because apricot is a fruit species that blooms very early. This is one of the main reasons for irregular fruiting in this fruit species (Szalay and Szabo, 1999). Due to the spring frosts during or after flowering in certain areas, fruit formation fails. One of the main reasons of the variation in apricot production in Serbia is the freezing of flowers or unopened flower buds due to low winter and spring temperatures (Milošević et al., 2008; Radičević et al., 2011; Glišić et al., 2019).

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The aim of the work is to analyze effect of the climatic conditions (mainly air temperature) before and during the flowering period of 12 apricot cultivars in a three-year experiment.

Materials and methods

The experiment was conducted during 2020- 2022 in an apricot orchard in the village of Gornja Gorevnica, which is located about 10 km northwest of Čačak (43°53'N; 20°21'E; 390 m above sea level).

The experiment included 12 apricot cultivars: 'Tsunami', 'Aurora', 'Wonder Cot', 'Spring Blush', 'Orange Red', 'Goldrich', 'Betinka', 'Hungary Best', 'Roxana', 'Farbaly', 'NS-4' and 'Zaklopačka Ruža'. The trees were grafted onto a Myrobalan rootstock (*Prunus cerasifera* Ehrh.) and planted at a distance of 6 × 3.5 m (480 trees ha⁻¹). Training system was cauldron canopy with 3-4 basic shoulder branches. Standard cultural practices were applied, except irrigation.

Based on data from the Monthly Bulletins, of the Republic Hydrometeorological Service of Serbia, for air temperatures on February and March 2020, 2021 and 2022 were analyzed. The deviation of the mean air temperature from the multi-year average was calculated using the percentile method¹ and displayed graphically.

The investigation included detected characteristics of phenological phase of flowering (beginning, duration and end of flowering). The phenophase of flowering was determined by recording the start date (when open 10% of flowers) and the end of flowering (when with 90% of flowers the crowns fall slips). The duration of flowering phenophase is expressed in days. The results are presented graphically.

Results and discussion

The beginning of apricot flowering depends on the sum of air temperatures in January, February and March, but also on soil temperature.

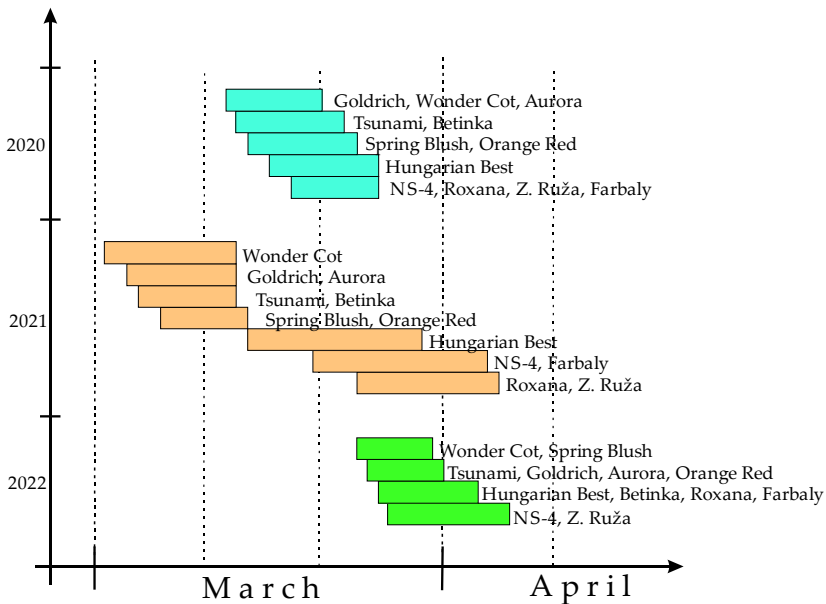
In 2020, February and March were significantly warmer than the long term average. The mean monthly temperature in February was 5.8°C, and in March was 7.6°C. February and March 2021 and 2022 were cooler than 2020 and had

¹ Then percentile of a quantity is that value of the observed quantity below which lies n percent of the data previously arranged in an ascending sequence.

similar mean monthly temperatures (4.10°C in February 2021 and 4.05°C in February 2022; 5.05°C in March 2021 and 5.00°C in March 2022).

The beginning of apricot flowering in 2020, 2021 and 2022 was not quite in accordance with mentioned monthly temperatures. The earliest flowering was recorded in 2021, although the average monthly temperatures for February and March were lower in 2021 than in 2020.

The beginning and course of apricot flowering in 2020, 2021 and 2022 are shown in Graph 1.



Graph 1. Apricot flowering in 2020, 2021 and 2022

Flowering in 2020. The beginning of flowering in cultivars ‘Goldrich’, ‘Wonder Cot’, ‘Aurora’, ‘Tsunami’, ‘Betinka’, ‘Orangered’ and ‘Spring Blush’ was from March 12-15. ‘Hungary Best’ started flowering on March 16, and ‘NS-4’, ‘Roxana’, ‘Zaklopačka Ruža’ and ‘Farbaly’ on March 18. The end of flowering was in the period from March 18-26.

Differences in the beginning of flowering between cultivars were 6 days. The average duration of flowering for one cultivar was 7-8 days. The total duration of apricot flowering in 2020 (for all cultivars) was 14 days.

Flowering in 2021. Although the average daily temperature in February 2021 was lower than in 2020, flowering of early apricot cultivars began much earlier compared to the previous year. The order of cultivars by start of flowering was similar to 2020, with 'Wonder Cot', 'Goldrich', 'Aurora', 'Tsunami', 'Bettinka', 'Orange Red' and 'Spring Blush' which were starting flowering first. The flowering of the mentioned cultivars started in the period from March 1 to 5. Early flowering of apricot was a result of two heat waves¹ that have appeared in February 2021 (Figure 1).

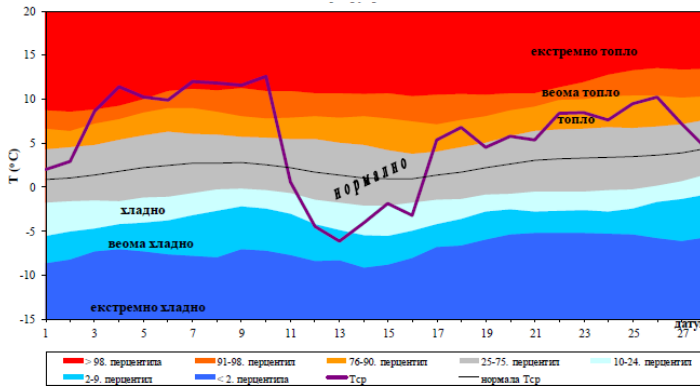


Figure 1. Daily mean temperatures in February 2021
<http://www.hidmet.gov.rs>

On the other hand, there were two cold waves during the period from March 5 to 7, as well as from March 15 to 22, (Graph 2), so flowering started much later in other cultivars. The average air temperature, by the percentile method, in March 2021 was in the normal category in most of Serbia, while in the central and southern parts, it was in cold category, so we had a very "stretched" flowering. Blasse and Hofmann (1993) stated that the air temperature must remain above +4 °C, for the started flowering to be normal. 'Hungary Best' started flowering on March 16, 'NS-4' and 'Farbaly' on March 20, and 'Roxana' and 'Zaklopačka Ruža' on March 24.

Differences in start of flowering among cultivars in 2021 were as much as 23 days. The duration of flowering (average value per one cultivar) was 8 to 16

¹ According to the percentile method, a heat wave is a period during which the maximum daily air temperature in the domain is very warm and extremely warm for five or more days.

days. The total duration of apricot flowering (average value for all cultivars) was 35 days in 2021.

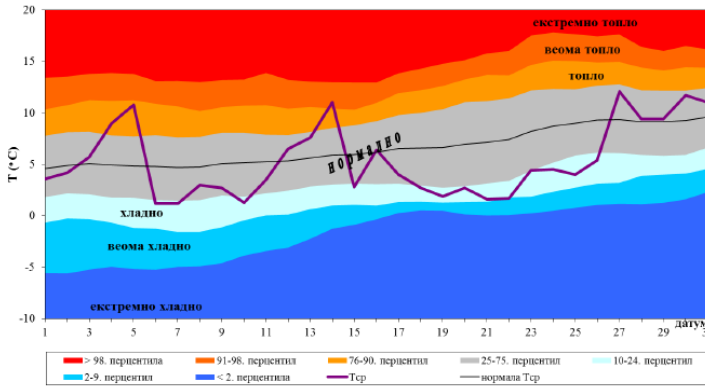


Figure 2. Daily mean temperatures in March 2021 (<http://www.hidmet.gov.rs>)

Flowering in 2022. Start of flowering of all tested cultivars in 2022 was differed by only 3 days. ‘Wonder Cot’ and ‘Spring Blush’ started flowering on March 24; ‘Goldrich’, ‘Aurora’, ‘Tsunami’ and ‘Orangered’ on March 25; ‘Hungary’s Best’, ‘Betinka’, ‘Roxana’ and ‘Farbaly’ on March 26 and ‘NS-4’ and ‘Zaklopačka Ruža’ on March 27. The duration of flowering (for one cultivar) was 6 to 9 days in 2022. The total duration of flowering in all examined apricot cultivars in 2022 was 12 days.

Apricot is fruit species which is characterized by early flowering. In addition to the genetic characteristics of the cultivar, the flowering time is influenced by the weather conditions before and during flowering. Milatović (2013) noted that the variation in flowering between years is four to five times higher than the variation between cultivars. This means that flowering time is more influenced by environmental factors (especially temperature) than by genotype. Apricot flowering begins when mean daily temperatures drop at 10-15°C, and maximum daily temperature reach 15 to 20°C. The average monthly air temperature in the months before the beginning of flowering (January and February) is not necessarily decisive for the beginning of flowering, as in 2020 and 2021. According to the average monthly air temperature, February 2020 was warmer than February 2021, and there were two heat waves in February 2021. But, there was also a part of the February 2021 (6 days) when the mean monthly temperature curve was in cold to very

cold range according to the percentile method, which caused lower mean monthly air temperature.

In 2022, the average monthly temperature in February was almost the same as in February 2021, but the apricot flowering started much later. This is due to the fact that the average air temperature, according to the percentile method, in March 2022, was in cold category in most parts of Serbia.

The difference in the beginning of flowering among early and late flowering cultivars was only 3 days in 2022. In 2020, flowering duration was 6 days, while in 2021 it was 23 days. The average value of the difference between the cultivars with the earliest and the latest flowering time is 7 to 10 days under conditions of Serbia (Milatović, 2013). According to the results of Glišić et al. (2017), the difference was higher in years with earlier flowering, while in years with later apricot flowering this difference was much smaller and amounted 2-3 days. In areas with warmer climates, such as Italy and Spain, these differences in apricot flowering were significantly larger (Della Strada et al., 1989; Rodrigo and Herrero, 2002; Ruiz and Egea, 2008). Contrary, these differences were smaller in countries with a colder climate (Vachůn, 2003; Szalay et al., 2006). The duration of flowering in cultivars ranged from 6 to 9 days in 2022 to 8 to 16 days in 2021. Milatović (2005) notes that the duration of flowering of certain apricot cultivars ranges from 5 to 17 days. Licznar-Małańczuk and Sosna (2005) state that the best flowering period for 'Hungary Best' lasted an average of 8 days (3-13 days), over a ten-year period. Our results are consistent with these reports. According to the results of Milatović et al. (2000) and Glišić et al. (2017) an earlier beginning of flowering usually leads to a longer duration of the flowering period, which was confirmed by the results of our work.

According to the average values of the beginning of flowering of the tested apricot cultivars, 'Goldrich', 'Wonder Cot', 'Aurora' and 'Tsunami' can be classified in the group of very early flowering cultivars. The cultivars 'Spring Blush', 'Betinka' and 'Orange Red' are early-flowering cultivars. 'Hungary Best' was mid-flowering cultivar, while 'NS-4', 'Roxana', 'Farbaly' and 'Zaklopačka Ruža' were late-flowering cultivars according to the time of flowering.

Conclusion

The following conclusions can be drawn from the results presented:

- The average date for beginning of flowering of the tested apricot cultivars was on March 12 in 2020, March 1 in 2021, and March 24 in 2022.

- Duration of flowering in tested cultivars was between 6 and 9 days in 2022, and between 8 and 16 days in 2021.

The difference in the beginning of flowering among the cultivars with the earliest and latest flowering dates was only 3 days in 2022, 6 days in 2020, while this difference was as the highest in 2021, 23 days. The differences in the beginning of flowering among the cultivars were more pronounced in years when flowering began earlier.

Acknowledgement

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