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BLOSSOMING PHENOPHASE AT SOME APRICOT AND PEACH CULTIVARS DEPENDING ON AIR TEMPERATURE IN SOUTH-EASTERN AREA OF ROMANIA

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Abstract

Phenological phenophases (such as blossoming) are highly responsive to air temperature and are influenced by the dormancy period at fruit trees. The paper presents the ten-year results of the effect of air temperature on the flowering of four cultivars of apricot and four cultivars of peaches under the conditions of Valu lui Traian commune, Constanta county, Romania country. It was established that there were notable variations in the start, course, and length of flowering between the years. During the ten-year study period, the beginning of flowering was triggered at the earliest on March 13 in the year 2020 for the apricot (Tudor cultivar) and on March 20 in the year 2020 for the peach (Raluca cultivar). Apricot flowering lasted a maximum of 16 days (year 2019 - Olimp cultivar) and a minimum of 5 days (year 2020 -Tudor cultivar). In the case of peaches, flowering lasted a maximum of 22 days (year 2020 - Raluca cultivar) and a minimum of 6 days (year 2019 - Mimi cultivar). In years with an earlier flowering date, the differences in the start of flowering between of the cultivars were more noticeable.

Key words*: onset and end of blossoming, Prunus armeniaca, Prunus persica.*

INTRODUCTION

The region of Dobrogea is very famous for apricot and peach production. The south-eastern area with a specific climate and favourable agro-ecological conditions allow good results in apricot and peach cultivation and relatively stable yields. Despite the favourable conditions in the specified area, due to the early blossoming of diverse apricot and peach cultivars there are noteworthy contrasts within the course of the blossoming phenophase among the cultivars, as well as large differences in different years. Blossoming is one of the foremost phenophases for all fruit trees species. Studying the genotypes of apricots and peach when they bloom is also crucial for breeding, and effective production (Bellini, 2007). It is an essential element of the precise cultivar description (Ledbetter, 2008; Campoy et al., 2011). This phenophase is very important for apricot trees since they blossom early. One of the main reasons for the fluctuation in yields of apricot in the south-eastern area of Romania is the freezing of blossoms or unopened flower buds caused by low spring temperatures and late frosts (Moale C. and Asanica A. 2017). Flowering buds are more susceptible to frost because they have a shorter rest time and emerge from this state sooner, which is impacted by both winters, heavy frosts, and early spring when the trees have lost their hardening condition (Abrahma M.G. and Savage M.J. 2008). Plant growth and fructification can be positively or negatively impacted by global warming. The writings of a few authors included information about the consequences of climate change: Falloon P. and Betts R., 2010; Abrahma M.G. and Savage M.J., 2008; Challinor A.J. et al., 2007; Challinor A.J. et al., 2005. Phenology investigation can be used in horticulture to choose cultivars that are climatic accident-resistant, able to adjust to current changes in the climate, and not always cause harvest loss (Cosmulescu S. et al., 2015). In many regions of the world, the redistribution of species has already been caused by climate change. (Thuiller W. et al., 2005). Phenological phases can be used as markers of climate change because phenology and climate are closely associated (Kalvane et al., 2009). The regulation of phenological processes both prior to and during blooming is significantly influenced by

temperature (Lakatos et al., 2008; Rodrigo and Herrero, 2002).
Using four cultivars of apricot and four cultivars of peach, the work aims to analyse the impact of air temperature before and throughout the blossoming phase over a ten-year period.

MATERIALS AND METHODS

The investigations were carried at the Research Station for Fruit Growing Constanta, Romania, in the Valu lui Traian village, located at the 44°10' northern latitude and 28°28' eastern longitude. The area under discussion is around 13-14 km west of the Black Sea and has an average altitude of 72 m above sea level.
The experiment included the following cultivars for apricots: Elmar, Tudor, Olimp, Goldrich and for peaches: Raluca, Filip, Mimi, Redhaven. The apricot trees were grafted on the Constanta 14 rootstock and planted at a distance of 5 × 4 m (500 trees ha^{-1}) and the peach trees were grafted on the Tomis 1 rootstock and planted at a distance of 4 × 4 m (625 trees ha^{-1}). The canopy shape was a classic vase and standard cultural practices were applied. The air temperature was recorded by an automatic weather station (iMetos, IMT 300, Pessl Instruments, Austria) by a 1-h step. The study allowed finding some characteristics of the blossoming phenological phase (beginning, duration and end), respectively BBCH 61 - the date of the beginning of flowering, when 10% of the flowers opened, and BBCH 69 - the end date of flowering, when 90% of the flowers fell from the crown (Meier U., 2001).
To examine the relationship between Year of Calendar and beginning of blossoming date (DOY), the Pearson correlation coefficient was calculated. Pearson correlation analysis and scatter plot generation were performed using IBM SPSS Statistics version 26.

RESULTS AND DISCUSSIONS

The area has a semi-arid, continental climate with hot, dry summers, regular dry winds all year round, and mild winters that typically don't include any snow. For the 2013-2024 (November-April) period, the air temperature was monitored (mean air temperature at the height of 2 m, maximum and minimum air temperature, mean and absolute values). Compared to the multiannual monthly values of the mean air temperature, it was observed that the positive differences varied between 0°C (January 2015, 2020) and 4.0°C (April 2024), and the negative ones between -5.7°C (January 2017) and -0.2°C (December 2021). There were 39 positive differences and 27 negative differences, indicating a warming trend for the area where the studies were conducted (Figure 1). Mean values of the maximum air temperature varied between -0.2°C (January 2017) and 21.3°C (April 2018, 2024). Compared to the multiannual values of the mean maximum air temperature, 35 positive differences and 31 negative differences were obtained, which signifies a climate warming trend (Figure 2).
Mean values of the minimum air temperature varied between -7.6°C (January 2017) and 8.3°C (April 2024). Compared to the multiannual values of the mean minimum air temperature, 34 positive differences and 32 negative differences were obtained (Figure 3). Regarding the absolute values of the air temperature during the period under study, the highest temperature was recorded in April 2016, the 32.8°C, respectively, and the lowest was -17.6°C and was recorded in January of 2014 and 2017 (Figure 4).

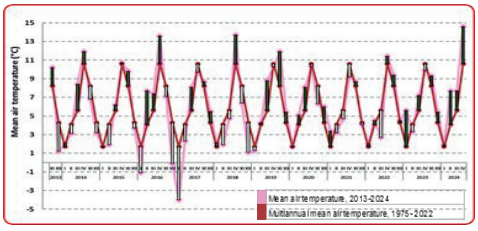


Figure 1. Mean air temperature (°C), 2013-2024 (November-April) comparative with multiannual mean air temperature (°C), 1975-2022 (November-April)

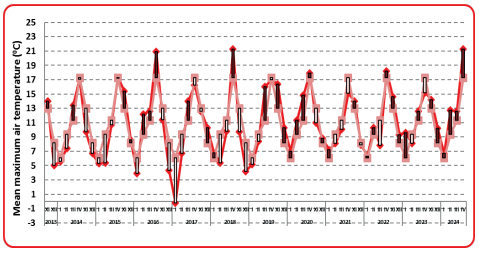


Figure 2. Mean maximum air temperature (°C), 2013-2024 (November-April) comparative with multiannual mean maximum air temperature (°C), 1975-2022 (November-April)

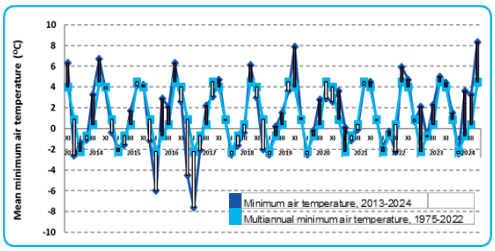


Figure 3. Mean minimum air temperature (°C), 2013-2024 (November-April) comparative with multiannual mean minimum air temperature (°C), 1975-2022 (November-April)

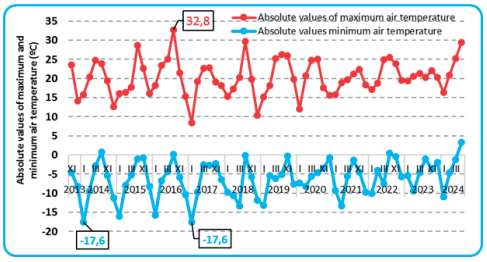


Figure 4. Absolute values of maximum and minimum air temperature (°C) in 2013-2024 (November-April) period

Characterization of the studied cultivars

Elmar is apricot cultivar that was patented in 2013. The tree vigor is medium, with a large habit. The blossoming time is late, very abundance. The cultivar is auto fertile. The ripening time is early. The fruit shape is oval with the average weight is between 45-55 g. The flesh is medium orange with red on the sunny part, good aroma and fine texture, non adherent to the stone. The recorded average yield is 18.7 t/ha. It can be used for fresh consumption or can industry.

Tudor is apricot cultivar breeded in RSFG Constanta; the tree vigor is big and recommended planting distance 5/5 m or 5/4 m; blossoming time: early, very abundance; the bearing is mainly on short fruiting; ripening time is early, 20 June to 10 July; the fruit shape is round, with orange and red skin, medium to big, firm, non-adherent at stone and the yield is high (18.7 t/ha); the stone has big size, round shape and bitter core. It is used for fresh consumption or for can industry (jam, compote, nectare).

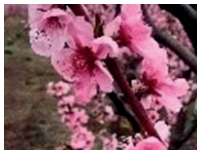
Goldrich is an apricot cultivar of American origin. The ripening period is early, in the first half of July. It is medium to small tree and recommended planting distance 4/4m or 4/3.5 m. Blossoming is early and very abundant. The pulp is orange, with medium texture, juicy, non-adherent to the stone. The productive potential is high. Resistant to temperature oscillations during spring time.

Olimp is apricot cultivar breeded in RSFG Baneasa. The tree is of medium vigor, the inverse-conical crown, bears fruit predominantly on bunch branches (may bunches), with late flowering. The variety is partially self-fertile. The mass of a fruit is 65-75 g. The shape of the fruit is spherical-ovoid; the skin is orange with a little red on the sunny side, and the flesh is light orange with a firm texture. The ripening period is August 10-12. The cultivar is very productive. It is disease and frost resistant. Pollinators: Commander, Favorit, Selena, Sirena.

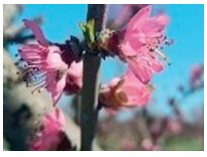
Raluca it is a standard peach that has medium vigor; the flower is a campanulate type and the blooming is abundant. Fruit shape is round, slightly asymmetrical with a little mucrone. The

fruit is Redhaven and Cardinal type; mean weight is 165 g, with yellow flesh, very juicy. The fruit will begin to ripen first week in July.

Filip it is one of the best peach cultivar with flat fruit obtained in Romania; it is not require pollinators. It is precocious and economically bearing since the 3rd year. The production is very high (23-25 t/ha for a density of 625 trees/ha, or 35-38 t/ha for 833 trees/ha) and constant. The fruit is flat, very atractive, red, with white flesh, superior taste and flavor which remember the fig and honey. Fruits destination: fresh consumption and processing.



Mimi it is a very good clingstone (pavia) cultivar, precocious with a high and constant yield (21-25 t/ha). The fruits have medium size (150-180 g), are very attractive, with orange and firm flesh, sweet (12.5-13.0% dry matter), flavoured. It has a middle ripening time. It is frost resistant and tolerant to *Taphrina deformans* and *Sphaerotheca pannossa*. It is resistent to transportation and storage better than the proper peaches. Destination: processing (jam and compote- sliced fruit) and fresh consumption.



Redhaven. This peach cultivar is a self-pollinating fruit tree, making it great for gardens and orchards. Since this tree is so vigorous, we recommend regular pruning and thinning. It is disease-resistant. The trees produce luscious, top-quality fruit, with medium-sized peaches. The flowers are pink and fragrant. The fruits ripen in July, its are sweet peaches with almost fuzzless skin over firm, creamy-textured yellow flesh. These peaches are great as a fresh snack or for canning and freezing.

In apricot, the beginning of blossoming took place at the earliest in 2020 for the Tudor cultivar (13 March) and at the latest in 2021 for the Olimp cultivar (10 April). The end of blossoming occurred at the earliest in 2014 for the Tudor cultivar (24 March) and at the latest in 2021 for the Olimp cultivar (23 April). The shortest duration of flowering was recorded in 2020 for the Tudor cultivar (5 days), and the longest duration of flowering was in 2019 for the Olimp cultivar (16 days) (Table 1).

Table 1. Phenophase of apricot blossoming in the period 2014-2023

Year	Cultivar	Blossoming phenophase		
		Beginning (BBCH 61)	End (BBCH 69)	Duration (days)
2014	Elmar	23 March	31 March	9
	Tudor	15 March	24 March	10
	Goldrich	19 March	28 March	10
	Olimp	26 March	02 April	8
2015	Elmar	26 March	05 April	11
	Tudor	17 March	28 March	12
	Goldrich	21 March	01 April	12
	Olimp	26 March	05 April	11
2016	Elmar	17 March	29 March	13
	Tudor	14 March	28 March	15
	Goldrich	14 March	28 March	15
	Olimp	19 March	02 April	15
2017	Elmar	25 March	31 March	7
	Tudor	18 March	28 March	11
	Goldrich	15 March	28 March	14
	Olimp	27 March	06 April	11
2018	Elmar	7 April	15 April	9
	Tudor	4 April	13 April	10
	Goldrich	4 April	15 April	12
	Olimp	6 April	13 April	8
2019	Elmar	19 March	01 April	14
	Tudor	19 March	02 April	15
	Goldrich	22 March	02 April	12
	Olimp	25 March	09 April	16
2020	Elmar	17 March	28 March	12
	Tudor	13 March	17 March	5
	Goldrich	16 March	29 March	14
	Olimp	25 March	06 April	13

Year	Cultivar	Blossoming phenophase		
		Beginning (BBCH 61)	End (BBCH 69)	Duration (days)
2021	Elmar	5 April	14 April	10
	Tudor	5 April	14 April	10
	Goldrich	5 April	13 April	9
	Olimp	10 April	23 April	14
2022	Elmar	1 April	09 April	9
	Tudor	1 April	06 April	6
	Goldrich	1 April	15 April	15
	Olimp	3 April	14 April	12
2023	Elmar	25 March	02 April	9
	Tudor	24 March	03 April	11
	Goldrich	20 March	30 March	11
	Olimp	27 March	08 April	13

A group of values is plotted in increasing order from left to right in Figure 5, indicating a directly proportional relationship between the beginning of the blossoming date (DOY) and the calendar year. The results indicate a positive, moderate and statistically significant correlation between Year of Calendar and DOY (r = 0.404**, p = 0.010). This correlation suggests a trend of delayed flowering over the years during the period studied (2014-2023).

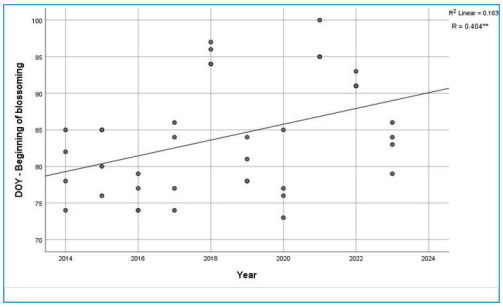


Figure 5. Directly proportional relationship between beginning of blossoming date (DOY) and calendar year of apricot

In peach, the beginning of blossoming took place at the earliest in 2020 for the Raluca cultivar (20 March) and the latest in 2015 for the Mimi cultivar (13 April).

The end of blossoming occurred the earliest in 2014 for the Raluca cultivar (03 April) and the latest in 2015, 2018, 2021 and 2022 for the Mimi cultivar (21 April).

The shortest flowering period was recorded in 2019 for the Mimi cultivar (6 days), and the longest flowering period was in 2020 for the Raluca cultivar (22 days) (Table 2).

Table 2. Phenophase of peach blossoming in the period 2014-2023

Year	Cultivar	Blossoming phenophase		
		Beginning (BBCH 61)	End (BBCH 69)	Duration (days)
2014	Raluca	23 March	03 April	12
	Filip	25 March	05 April	12
	Redhaven	27 March	07 April	12
	Mimi	28 March	09 April	13
2015	Raluca	08 April	18 April	11
	Filip	09 April	18 April	10
	Redhaven	12 April	20 April	9
	Mimi	13 April	21 April	9
2016	Raluca	24 March	05 April	13
	Filip	25 March	05 April	12
	Redhaven	27 March	07 April	12
	Mimi	29 March	09 April	12
2017	Raluca	10 April	17 April	8
	Filip	05 April	19 April	15
	Redhaven	05 April	17 April	13
	Mimi	07 April	20 April	14
2018	Raluca	10 April	17 April	8
	Filip	11 April	19 April	9
	Redhaven	07 April	19 April	13
	Mimi	10 April	21 April	12
2019	Raluca	01 April	08 April	8
	Filip	01 April	08 April	8
	Redhaven	03 April	09 April	7
	Mimi	06 April	11 April	6
2020	Raluca	20 March	10 April	22
	Filip	22 March	10 April	20
	Redhaven	25 March	11 April	18
	Mimi	29 March	11 April	14
2021	Raluca	07 April	15 April	9
	Filip	07 April	16 April	10
	Redhaven	10 April	19 April	10
	Mimi	12 April	21 April	10
2022	Raluca	05 April	12 April	8
	Filip	07 April	15 April	9
	Redhaven	10 April	18 April	9
	Mimi	07 April	21 April	15
2023	Raluca	25 March	07 April	14
	Filip	29 March	08 April	11
	Redhaven	02 April	12 April	11
	Mimi	04 April	14 April	11

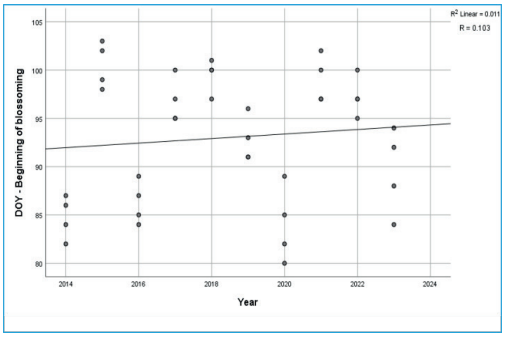


Figure 6. Directly proportional relationship between beginning of blossoming date (DOY) and calendar year of peach

There is a very weak and positive linear correlation (r = 0.103) between the calendar year and the peach blooming date (Figure 6). This suggests that, as the years pass, there is a very slight tendency for the peach tree to bloom later, but this trend is extremely weak.

CONCLUSIONS

The apricot and peach tree, thermophile plants, has found favorable conditions for growth and development in south-eastern area, where the mean annual temperatures meet the special requirements.

The moderate and significant correlation (r = 0.404**, p = 0.010) suggests that external factors, likely climatic changes, may influence apricot blooming patterns.

The variation in flowering duration among cultivars indicates genetic differences in response to environmental conditions.

The observed trend could impact pollination synchronization and fruit set, potentially requiring adjustments in orchard management.

The very weak positive correlation (r = 0.103) suggests that peach flowering remains relatively stable over time, indicating a lower sensitivity to annual climatic variations.

The variability between cultivars highlights the importance of genetic traits in determining blooming time.

ACKNOWLEDGEMENTS

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