DOI: /10.5513/JCEA01/26.2.4425

Ripening time of apricot cultivars in the central part of Hungary

Kajszifajták érési ideje Magyarország középső részén

László SZALAY[1] (✉), József László BAKOS[2]

[1] Department of Pomology, Institute of Horticultural Sciences, Hungarian University of Agriculture and Life Sciences, Budapest, Hungary

[2] MATE Agrárcsoport Kft., Gödöllő, Hungary

✉ Corresponding author: szalay.laszlo@uni-mate.hu

Received: June 7, 2024; accepted: April 8, 2025

ABSTRACT

In Hungary, as in other parts of the world, the ripening time of apricot cultivars has been gradually shifting earlier in recent years. The main reason is a warming climate. To what extent, with what year-to-year variation? This is analysed using 26 years of data on 30 apricot cultivars. The ripening time is, of course, related to the preceding developmental processes, including the flowering time. Is it possible to predict the ripening time of cultivars by the number of days from flowering to ripening, or by heat unit collection during this period? We were curious about this too. Based on the results of our long-term observations in our experimental plantation in the central part of Hungary, the ripening time of the cultivars started 0.3-0.6 days earlier on average per year. The variation between years was significant. The ripening of 'Gönci magyar kajszi', which was the standard cultivar in many studies, was shifted two weeks earlier over the quarter of a century. Neither the number of days from flowering nor the heat units can be used to predict the onset of ripening of the apricot cultivars with great accuracy.

Keywords: *Prunus armeniaca*, beginning of ripening time, heat units, climate change

ÖSSZEFOGLALÁS

Az elmúlt években a kajszifajták érési ideje Magyarországon, hasonlóan más vidékekhez, fokozatosan egyre korábban következett be. Ennek fő oka a klímaváltozás. Milyen mértékben, milyen évenkénti eltérésekkel? Ezt 30 kajszibarackfajtára vonatkozó 26 év adatai alapján elemezzük. Az érési idő természetesen összefüggésben van az azt megelőző fenológiai folyamatokkal, köztük a virágzási idővel. Lehetséges előre jelezni az érési időt a virágzástól eltelt napok vagy a virágzás és az érés közötti időszak hőmérsékleti összegei alapján? Erre is kíváncsiak voltunk. Magyarország középső részén lévő kísérleti ültetvényeinkben végzett hosszú távú megfigyelések eredményei alapján a kajszifajták érési ideje évente átlagosan 0,3-0,6 nappal kezdődött korábban. Az évek közötti ingadozás jelentős volt. Negyed évszázad alatt a sok tanulmányban összehasonlító fajtaként szerelő 'Gönci magyar kajszi' érési ideje két héttel tolódott korábbra. Sem a virágzástól eltelt napok számával, sem a hőmérsékleti összegekkel nem tudjuk pontosan előre jelezni a kajszifajták érési idejét.

Kulcsszavak: *Prunus armeniaca*, érési idő kezdete, hőmérsékleti összegek, klímaváltozás

INTRODUCTION

Apricots occupy an important place in Hungarian fruit production. Knowing the ripening time of cultivars is very important from both a scientific and a practical aspect. Generative phenological characteristics, such as flower bud development, flowering time and ripening time, are closely related to the accurate description of the cultivars, and it is also necessary for the evaluation of the breeding materials (Janick and Moore, 1996; Bellini, 2007; Sansavini et al., 2019). From a practical point of view, we need to know the ripening time of the cultivars in order to market them (Bellini, 2007; Surányi, 2011). During the last decades, there has been a gradual change in the phenology of apricot cultivars in Hungary, as well as in other areas of the world, the main reason for which is the gradual warming of the climate. The most obvious sign of this change is the increasingly earlier flowering and ripening (Ramírez and Kallarackal, 2015; Haokip et al., 2020). The variation in flowering time and its background have been analysed in detail based on observations of the apricot cultivars over a long period (Szalay and Szabó, 1999; Szalay et al., 2000a, 2000b, 2005, 2011; Pénzes and Szalay, 2003).

Ripening time is genetically determined, but it is greatly influenced by environmental factors. Therefore, ripening occurs at a different time of year in a given area, but the order of ripening time of the cultivars is mostly constant (Löschnig and Passecker, 1954; Nyujtó and Surányi, 1981; Pénzes and Szalay, 2003; Surányi and Szalay, 2011). The fruits on stone fruit trees do not ripen all at once. Ripening starts on the outside of the canopy, mainly on the southern side and on the short shoots. The fruit ripens later on the inner part of the tree and the long cropping units. It is therefore not easy to determine the specific ripening period of the cultivar. The most widely accepted method is to consider the day when 5% of the fruit on the trees of a given cultivar reaches 95% maturity as the starting day of ripening (Surányi, 2011). The time to ripening is also influenced by the rootstock, the growing system and the cultivation practices. Any factor (excessive nitrogen supply, improper pruning...) that pushes the development of the trees in a vegetative direction delays their maturation and ripening. However, stress effects (water deficit, nutrient deficiencies, pests...) lead to earlier maturation and ripening (Jackson and Looney, 1999; Pénzes and Szalay, 2003). Because of more intensive vegetative growth, ripening is later on young trees than on older ones. The ripening time depends to a large extent on the geographical location. The length of the ripening period is strongly influenced by the weather, being rapid in warm and prolonged in cool weather (Childers, 1983; Faust, 1989; Tromp et al., 2005). Due to the warming climate, ripening gradually became earlier in many areas (Zhang, 2012; Ramírez and Kallarackal, 2015; Haokip et al., 2020). This can also be observed in Hungary (Surányi, 2011).

Cultivar use has changed in Hungary over the last decades, which has also affected the change of the harvest period. The apricot ripening period used to start in the first days of July with the 'Korai piros' variety and end at the end of July with the late "rose" cultivars (Nyujtó and Tomcsányi, 1959; Nyujtó and Surányi, 1981). Today, the apricot harvest starts around 5-10 June with the 'Tsunami' and 'Aurora' cultivars, and there are also cultivars that ripen in September, such as 'Corlate' or 'Farclo' (Surányi, 2011).

From a practical point of view, it would be very useful to be able to accurately predict the ripening time of our cultivars in a given place as the harvest season approaches. Attempts have been made to do this by determining the number of days from flowering to ripening and the amount of heat units accumulated during this period. From the results of the heat unit calculation models, it appears that the relationship is less tight than for the heat units required for blooming (Ryugo, 1988; Faust, 1989; Tromp et al., 2005). The weather during the first six weeks of the growing season had a greater influence on the ripening time than later in the season. One degree higher average temperature during fruit development resulted in 6 days earlier ripening of the apricots (Nyujtó and Surányi, 1981; Surányi, 2011).

Despite the uncertainties, cultivar descriptions sometimes give an estimate of the number of days from flowering to ripening or the sum of heat units, but these can only be regarded as indicative. It is more common to give the expected ripening time of cultivars compared to a reference one (Szabó and Szalay, 2001; Pénzes and Szalay, 2003; Surányi, 2011).

In this paper, the data of 26-year ripening period for 30 apricot cultivars in central Hungary were analyzed.

MATERIALS AND METHODS

The place of our experimental work was in the gene bank cultivar collections of our university. The observations were carried out between 1995 and 2007 in Szigetcsép (northern latitude 47.25700; eastern longitude 18.96953), and from 2007 to 2020 in Soroksár (northern latitude 47.39768; eastern longitude 19.15101). Both locations are in the Budapest area, in the central part of Hungary. Their climatic characteristics are very similar, and the time course of the phenological processes is almost the same at the two locations. Phenological observations were carried out at both places between 2004 and 2009. There were no significant differences between the two locations in terms of the phenological processes of the apricot cultivars. In our work, 30 apricot cultivars were observed, and 3-4 trees of each cultivar the observed. The details of the observed cultivars are listed in Table 1.

The beginning of flowering and the beginning of ripening time were recorded in all 26 years on the trees of the tested cultivars. The day on which 5% of the flowers on the trees opened was considered the beginning of flowering, BBCH 61 (Meier, 2001). The beginning of ripening was considered the day when 5% of the fruits on the trees of the given cultivar reached 95% maturity, BBCH 85 (Meier, 2001). In our work, the beginning of flowering and the beginning of ripening were used for the calculations, as the beginning of the phenological phases can be recorded most accurately.

There have been years when the most frost-sensitive cultivars have failed to produce a crop due to spring frost damage. This type of year was 2020, and in the previous period, 1997, 2012 and 2018. In these years, the ripening time of these cultivars was estimated based on the ripening time of productive cultivars, considering the data from other years. The number of days between the beginning of flowering and the start of ripening was determined for each cultivar.

Meteorological data were provided by meteorological stations located in the area of the plantations or their immediate vicinity. The heat units were calculated by summing up the average daily temperatures, maximum plus minimum temperatures divided by two (Ryugo, 1988) between the BBCH 61 and BBCH 85 phenological stages. In present paper the heat units for 10 selected cultivars are displayed. Statistical evaluations were performed with the Excel 365 programme. Averages and standard deviations were calculated. The trend of the changing of the BBCH 85 phenological stage was calculated by linear regression analysis with a significance level.

RESULTS

The ripening time data for the 30 apricot cultivars studied are shown in Table 2. The cultivars are listed in the table in order of flowering time, so it can be seen that there is no close correlation between flowering time and ripening time. A good example is 'Harlayne', which has late flowering but not late ripening time. Over the 26 years, there was a large variation in the ripening time for each cultivar year-by-year, and a gradual earlier shift in ripening times was observed. Ripening onset dates of three cultivars are also plotted (Figure 1).

For the presentation, the earliest, mid-season and the latest cultivars were selected. All of them show large inter-annual variability in the starting date of ripening, and a negative value of the slope of the trend lines indicates a gradual earlier shift. On average over the years, 'Aurora' started to ripen on 12 June, and started 0.32 days/year, which means a change of 8 days in 26 years. The extremes were in 1999 and 2007, the start of ripening on 25 June and 1 June respectively. The average day of the beginning of ripening of 'Gönci magyar kajszi' was on 7 July in our study period, with an average annual variation of 0.52 days (14 days in 26 years).

Table 1. List of tested apricot cultivars and their origin

No	Cultivar	Origin (country)*	Pedigree	Ripening time
1	Aurora	USA	unknown	early
2	Bergeron	France	unknown (random seedling)	late
3	Budapest	Hungary	’Nancy’ x (’Magyar kajszi’, ’Kései rózsa’, ’Acme’)	late
4	Callatis	Romania	unknown	late
5	Ceglédi arany	Hungary	’Ceglédi óriás’ x ’Rózsabarack C.1668’	late
6	Ceglédi bíborkajszi	Hungary	unknown	middle
7	Ceglédi kedves	Hungary	seedling of ’Ceglédi óriás’	late
8	Ceglédi óriás	Hungary	unknown	middle
9	Ceglédi Piroska	Hungary	’Magyar kajszi C.1789’ x ’Ceglédi óriás’	early
10	Comandor	Romania	unknown	late
11	Goldrich	USA	’Sunglo’ x ’Perfection’	early
12	Gönci magyar kajszi	Hungary	unknown (land selection)	middle
13	Harcot	Canada	unknown	early
14	Harglow	Canada	unknown	middle
15	Hargrand	Canada	unknown	middle
16	Harlayne	Canada	unknown	middle
17	Harmat	Hungary	unknown	early
18	Harogem	Canada	unknown	middle
19	HW 409	Canada	unknown	early
20	Ligeti óriás	Hungary	unknown	middle
21	Litoral	Romania	unknown	late
22	Magyar kajszi C.235	Hungary	unknown	middle
23	Mandulakajszi	Hungary	unknown	late
24	Olimp	Romania	unknown	late
25	Orange Red	USA	unknown	early
26	Pannónia	Hungary	’Magyar kajszi’ x ’Késői rózsa’	middle
27	Rakovszky	Hungary	unknown	middle
28	Rózsakajszi C.1406	Hungary	unknown	late
29	Sirena	Romania	unknown	late
30	Veecot	Canada	seedling of ’Reliable’	early

Note: *location of breeding or selection

Table 2. Ripening time of apricot cultivars (1995-2020)

Cultivar	Ripening time[1]	Changing[2]	Length of ripening[3]	Cultivar	Ripening time[1]	Changing[2]	Length of ripening[3]
Aurora	163.0 ± 5.9	-0.3166*	7.8 ± 1.2	HW 409	182.7 ± 6.4	-0.3067+	7.7 ± 1.1
Harmat	167.3 ± 5.6	-0.2870*	7.7 ± 1.0	Harogem	191.5 ± 6.8	-0.4743**	8.8 ± 1.4
Goldrich	184.3 ± 6.4	-0.3687*	7.8 ± 0.9	C. kedves	194.0 ± 5.8	-0.3796**	7.7 ± 1.4
C. bíbork.	186.0 ± 6.8	-0.4433*	7.0 ± 1.0	Litoral	201.9 ± 5.9	-0.3527*	8.5 ± 1.4
C. óriás	186.7 ± 6.8	-0.3545*	7.8 ± 1.2	Bergeron	195.9 ± 7.1	-0.5305**	7.5 ± 1.1
Ligeti óriás	189.4 ± 5.7	-0.3113*	7.5 ± 1.1	Mandulakajszi	193.8 ± 6.4	-0.4376**	7.7 ± 1.5
C. Piroska	180.5 ± 6.0	-0.3810*	7.5 ± 1.0	Callatis	197.3 ± 7.7	-0.6307***	7.7 ± 1.2
Veecot	184.7 ± 5.8	-0.4005**	7.7 ± 1.0	Budapest	200.7 ± 5.8	-0.4026**	7.7 ± 1.3
Harcot	180.7 ± 6.3	-0.3688*	7.7 ± 1.2	Harglow	190.1 ± 6.0	-0.3937**	7.8 ± 1.1
Orange Red	175.6 ± 6.2	-0.4196**	7.9 ± 1.1	Sirena	200.4 ± 7.1	-0.5065**	7.8 ± 1.4
Rakovszky	191.8 ± 6.1	-0.4273**	7.7 ± 1.5	Olimp	202.6 ± 5.9	-0.3900**	8.5 ± 1.4
Gönci m. k.	188.5 ± 6.7	-0.5231**	8.6 ± 1.4	Comandor	200.1 ± 6.9	-0.4932**	7.8 ± 1.4
M. k. C.235	187.6 ± 6.8	-0.5125**	7.7 ± 1.2	R. k. C.1406	202.8 ± 5.9	-0.4003**	7.7 ± 1.5
Hargrand	191.3 ± 6.1	-0.4339**	8.6 ± 1.3	Ceglédi arany	195.2 ± 5.7	-0.3848**	8.6 ± 1.6
Pannónia	190.4 ± 6.4	-0.3969**	7.6 ± 1.1	Harlayne	189.9 ±5.8	-0.3732*	7.6 ± 1.2

Note:
[1] Average day of the beginning of ripening (Julian day) in 26 years and its standard deviation;
[2] The change in the date of the beginning of ripening during the 26 years, the slope of the trend line;
[3] Mean length and standard deviation of ripening time, significance levels: ***0.001, **0.01, *0.05, +0.1.

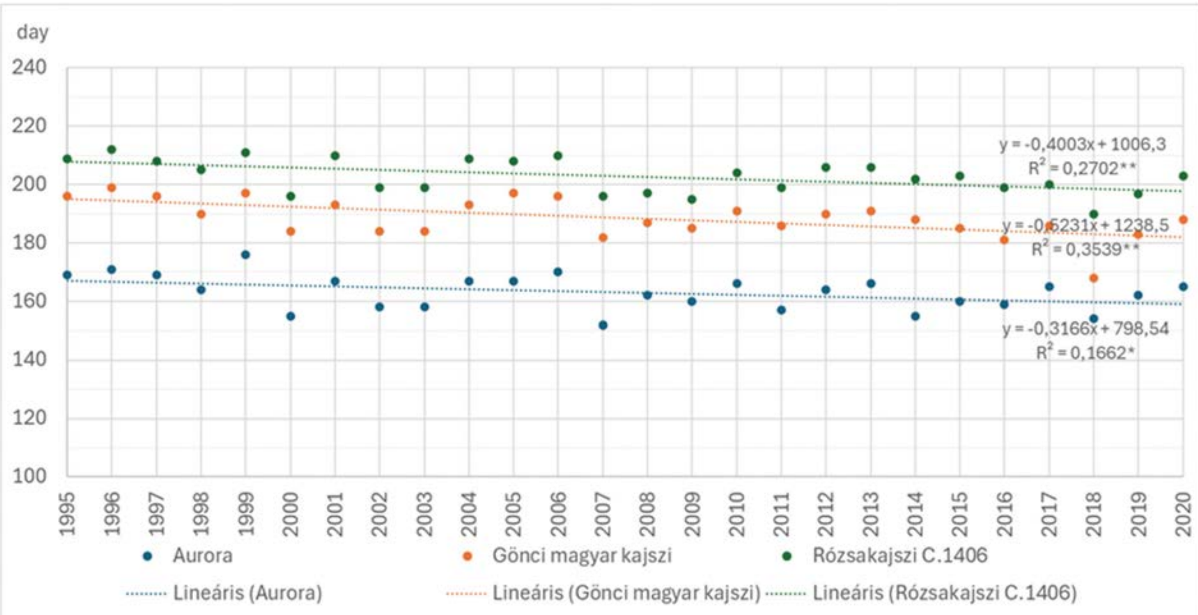

Figure 1. Beginning days of the ripening time of apricot cultivars (Julian day) in the 26 years of the study period (1995-2020) and the trend of the beginning of ripening, significance levels: *0.05, **0.01

While in 1996 the first fruits started ripening on 18 July, in 2016 they were harvested on 30 June. On average, 'Rózsakajszi C.1406' started to ripen on 22 July, and ripening has been shifted forward by 0.4 days per year, a change of 10 days in 26 years. Outermost values: the fruits started to ripen on 31 July 1996 and on 9 July 2018.

The studied apricot cultivars ripened in the months of June and July, with a significant effect of year, and all of them had a progressively earlier onset of ripening (Table 2). The average longevity of ripening time was 7-9 days, depending on the cultivar, with large year-to-year variations due to different weather conditions. The shortest ripening period was in 2003 (5-7 days) and the longest was in 2005 (9-11 days).

In each year, the number of days between flowering and ripening of the studied apricot cultivars was determined. The mean and extreme values are presented in Table 3. The 30 apricot cultivars are also listed here in order of flowering time. On average over the years, the time from the beginning of flowering to the beginning of ripening ranged from 76 to 112 days, depending on the cultivar. The differences between years were large, indicating the strong influence of the different environmental conditions of different years on the ripening time.

In the years of the study period, the heat units (daily average temperature sums) between the beginning of flowering and the beginning of ripening of 10 selected apricot cultivars were determined (Table 4).

Table 3. Number of days between flowering and ripening of apricot cultivars (1995-2020)

Cultivar	Day[1]	Min.[2]	Max.[3]	Cultivar	Day[1]	Min.[2]	Max.[3]
Aurora	76.4 ± 10.8	57	102	HW 409	93.1 ± 11.1	71	113
Harmat	80.6 ± 11.0	61	106	Harogem	101.7 ± 110.5	74	120
Goldrich	96.9 ± 11.5	75	123	Ceglédi kedves	104.1 ± 10.0	83	124
C. bíbork.	98.5 ± 11.3	72	125	Litoral	111.8 ± 10.6	91	135
C. óriás	99.1 ± 11.2	72	123	Bergeron	105.3 ± 11.1	76	128
Ligeti óriás	101.8 ± 10.4	80	125	Mandulakajszi	103.0 ± 10.5	78	123
C. Piroska	92.8 ± 11.5	70	118	Callatis	106.4 ± 11.2	76	127
Veecot	96.8 ± 11.0	78	121	Budapest	109.8 ± 10.2	93	133
Harcot	92.3 ± 11.3	70	116	Harglow	99.2 ± 9.9	76	117
Orange Red	87.1 ± 10.9	65	112	Sirena	109.5 ± 10.9	83	133
Rakovszky	103.1 ± 10.1	82	123	Olimp	110.6 ± 10.3	92	132
Gönci m. k.	99.3 ± 10.8	72	123	Comandor	108.2 ± 10.8	84	131
M. k. C.235	98.4 ± 11.0	71	123	R. k. C.1406	110.9 ± 10.3	92	132
Hargrand	102.1 + 9.8	81	124	Ceglédi arany	103.3 ± 10.1	83	123
Pannónia	101.1 ± 10.6	77	125	Harlayne	98.3 ± 10.1	77	118

Note:
[1] The number of days between the beginning of flowering (BBCH 61) and the beginning of ripening (BBCH 85) in an average of 26 years and its standard deviation;
[2] The smallest value of 26 years;
[3] The highest value of 26 years.

Table 4. Heat units in °C between flowering and ripening of apricot cultivars (1995-2020)

Cultivar	Average heat unit[1]	Min.[2]	Max.[3]	Deviation[4]	Deviation in %[5]
Aurora	1139.1 ± 83.0	959.0	1369.5	230.4	20.2
Ceglédi bíborkajszi	1627.2 ± 97.0	1422.5	1777.0	204.7	12.6
Ceglédi óriás	1643.4 ± 99.9	1422.5	1811.0	220.9	13.4
Veecot	1594.0 ± 101.6	1415.5	1855.5	261.5	16.4
Gönci magyar kajszi	1665.7 ± 92.9	1434.0	1855.0	231.7	13.9
Hargrand	1727.8 ± 87.6	1560.5	1904.5	176.7	10.2
Harogem	1729.8 ± 104.8	1494.0	1918.0	235.8	13.6
Bergeron	1812.1 ± 99.7	1537.5	1975.5	274.6	15.2
Rózsakajszi C. 1406	1963.3 ± 99.0	1773.0	2111.5	190.3	9.7
Harlayne	1677.8 ± 93.0	1480.9	1850.1	196.9	11.7

Note:
[1] the average and standard deviation of the heat unit of the period between the beginning of flowering and the beginning of ripening during the 26 years of the study period;
[2] smallest value;
[3] largest value;
[4] is the largest deviation from the average;
[5] the largest deviation from the average in %; in the table, the cultivars are listed in order of flowering time.

The data for the earliest, the latest and a cultivar with a medium ripening are also plotted in Figure 2. The earliest cultivar 'Aurora' required an average temperature of 1139 °C for ripening, the middle-season cultivar 'Gönci magyar kajszi' required 1666 °C and the late cultivar 'Rózsakajszi C.1406' required 1963 °C. The data showed large year-to-year variation. The largest deviation from the 26-year average varied between 10 and 20% per cultivar.

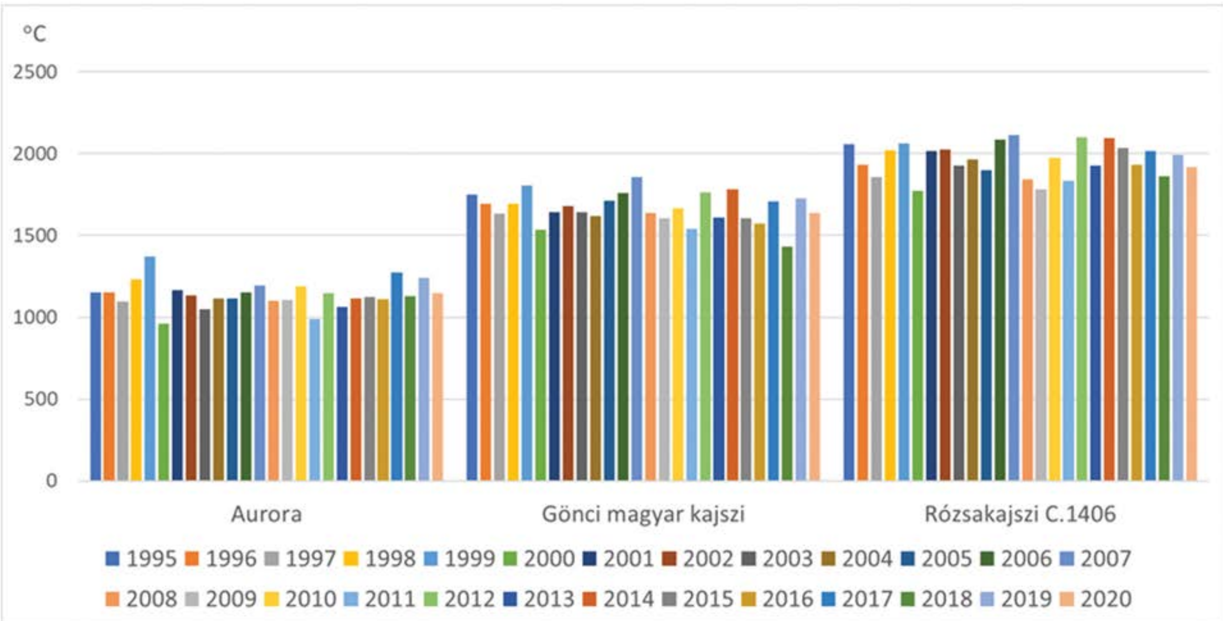

Figure 2. Heat units of the period between flowering and ripening of apricot cultivars in the 26 years of the study period (1995-2020)

DISCUSSION

The ripening time is an important characteristic of apricot cultivars. Knowing and predicting it as accurately as possible is important from both a scientific and a practical aspect (Soltész, 1998, 2013; Bellini, 2007).

The main cultivar in Hungary is 'Gönci magyar kajszi', which, according to older literature, started to ripen between 12 and 14 July in the central part of Hungary (Nyujtó and Tomcsányi, 1959; Nyujtó and Surányi, 1981). In the early 2000s, the 10th of July was already described as this phenological stage (Szalay, 2009; Szalay et al., 2011). It matures even earlier south of Hungary (Milosevic et al., 2021). A gradual earlier ripening period has been observed for other apricot cultivars and other fruit species as well (Surányi, 2011; Sansavini et al., 2019; Bassi et al., 2023). One important reason for the change in phenological processes is the gradual warming of the climate (Chuine et al., 2010; Zhang, 2012; Ramírez and Kallarackal, 2015; Haokip et al., 2020). Meteorological forecasts predict further warming in Hungary (Izsák and Szentimrey, 2020).

The ripening time of apricot cultivars is genetically determined, but it is greatly influenced by environmental factors. Therefore, the ripening time varies from place to place and from year to year. However, the order of ripening time of cultivars is mostly constant, and the ripening time of them in a given area can be determined by several years of studies (Soltész, 1998, 2013; Pénzes and Szalay, 2003; Szalay et al., 2011).

In the present work, the ripening time of 30 apricot cultivars over 26 years was studied in our experimental plantation in central Hungary. Gradually, earlier flowering times year-by-year were observed for all cultivars, with a large annual variation. Depending on the cultivar, the average start of ripening was 0.3-0.6 days earlier per year.

The usefulness of ripening time prediction methods was also investigated. The number of days between flowering and ripening was determined. However, the deviation and inter-annual variation of the data were so large that it calls into question the accuracy of the forecasting method.

Determining the amount of heat units required for ripening has been the aim of many researchers. Daily average temperatures from flowering to ripening have been summarized (Childers, 1983; Ryugo, 1988; Faust, 1989; Westwood, 1993; Tromp et al., 2005). This does not give accurate results, however, because fruit development, like all other developmental processes, is influenced by numerous environmental factors, not just by temperature (Nyujtó and Surányi, 1981; Ryugo, 1988; Faust, 1989; Tromp et al., 2005; Surányi, 2011). Our studies have confirmed this by testing selected cultivars. There was a deviation of 10-15% from the average in some years, but a deviation of 20% has been occurred as well.

CONCLUSIONS

Climate change has strongly influenced the generative phenological processes of apricot cultivars in our experimental plantations in central Hungary. Over a quarter of a century, the average ripening time of the apricot cultivars studied has been pushed back by two weeks.

Based on the results of our research, we can state that neither the number of days from flowering to ripening nor the calculation of heat units can accurately predict the ripening time of apricot cultivars. For practical purposes, it is more useful to compare the expected ripening time of cultivars with a reference cultivar (Szabó and Szalay, 2001; Pénzes and Szalay, 2003; Szalay, 2009; Szalay et al., 2011).

REFERENCES

Bassi, D., Cirilli, M., Foschi, S., Iglesisas, I., Giovannini, D., Badenes, M.L., Gasic, K. (2023) Cultivars. In: Manganaris, G.A., Costa, G., Crisosto, C.H., eds. Peach. CABI, USA. 92-113.

Bellini, E. (2007) The fruit woody species. Firenze: ARSIA, Volume 1. and 2.

Childers, N. F. (1983) Modern fruit science. Gainesville, Florida, USA: Horticultural Publications.

Chuine, I., Morin, X., Bugmann, H. (2010) Warming, photoperiods and tree phenology. Science, 329 (6), 277-278. DOI: https://doi.org/10.1126/science.329.5989.277-e

Faust, M. (1989) Physiology of temperate zone fruit trees. New York: John Wiley and Sons.

Haokip, S. W., Shankar, K., Lalrinngheta, J. (2020) Climate change and its impact on fruit crops. Journal of Pharmacognosty and Phytochemistry, 9 (1), 435-438.

Izsák, B., Szentimrey, T. (2020) To what extent does the detection of climate change in Hungary depend on the choice of statistical methods? International Journal on Geomathematics, 11, 17. DOI: https://doi.org/10.1007/s13137-020-00154-y

Jackson, D. I., Looney, N. E. (1999) Temperate and subtropical fruit production. Reading, UK: CABI Publishing.

Janick J., Moore J. N. (1996) Fruit breeding. New York: John Wiley & Sons., Inc.

Löschnig, H.F., Passecker, D.F. (1954) Die Marille (Aprikose) und ihre Kultur. Wien: Österreichischer Agrarverlag.

Meier, U. (2001) Growth stages of mono-and dicotyledonous plants. BBCH Monograph (2rd edition). Federal Biological Research Centre for Agriculture and Forestry, Germany.

Milosevic, T., Milosevic, N., Glasic, I. (2021) Early tree performances, precocity and fruit quality attributes of newly introduced apricot cultivars grown under western Serbian conditions. Turkish Journal of Agriculture and Forestry, 45 (6), 919-833. DOI: https://doi.org/10.3906/tar-2010-39

Nyujtó F., Surányi D. (1981) Kajszibarack (Apricot). Budapest: Mezőgazdasági Kiadó. (in Hungarian)

Nyujtó F., Tomcsányi P. (1959) A kajszibarack és termesztése (Apricot and its cultivation). Budapest: Mezőgazdasági Kiadó. (in Hungarian)

Pénzes B., Szalay L., eds. (2003) Kajszi (Apricot). Budapest: Mezőgazda Kiadó. (in Hungarian)

Ramírez, F., Kallarackal, J. (2015) Responses of fruit trees to global climate change. New York, London: SpringerBriefs in Plant Science, Springer Press.

Ryugo, K. (1988) Fruit culture: Its science and art. New York: Jon Wiley and Sons.

Sansavini, S., Costa, G., Gucci, R., Inglese, P., Ramina, A., Xiloyannis, C., Desjardins, Y., eds. (2019) Principles of Modern Fruit Science. Leuven, Belgium: International Society for Horticultural Science.

Soltész, M. (1998) Gyümölcsfajta-ismeret és -használat (Knowledge and use of fruit cultivars). Budapest: Mezőgazda Kiadó. (In Hungarian)

Soltész, M. (2013) Magyar gyümölcsfajták (Hungarian fruit cultivars). Budapest: Nemzeti Agrárgazdasági Kamara. (In Hungarian)

Surányi, D. (2011) A Sárgabarack (The Apricot). Magyarország Kultúrflórája. II./9. Gödöllő: Szent István Egyetemi Kiadó. (in Hungarian)

Surányi, D., Szalay, L. (2011) A sárgabarack virágzásbiológiája, a termésképződés élettana (Flower biology and fruit development of apricot). In: Surányi, D., ed. A Sárgabarack (The Apricot). Gödöllő: Szent István Egyetemi Kiadó. 120-151. (in Hungarian)

Szabó, Z., Szalay, L. (2001) Kajszi (Apricot). In: G. Tóth M., ed. Gyümölcsészet (Pomology). (2nd edition). Nyíregyháza: Primom. 198-215. (in Hungarian)

Szalay, L. (2009) Kajszi (Apricot). In: Tóth M., (ed). Gyümölcsfaj- és fajtaismeret (Fruit species and cultivars). Notes for university. Budapest: Corvinus University of Budapest. 127-136. (in Hungarian)

Szalay, L., Mády, R., Nagy, Á. (2005) Kajszi fajtahasználat Magyarországon (Apricot cultivar use in Hungary). Kertgazdaság, 37 (3), 36-48. (in Hungarian)

Szalay, L., Papp, J., Szabó, Z. (2000a) Variability in the blooming time of apricot varieties in Hungary. Acta Horticulturae, 538, 139-141. DOI: https://doi.org/10.17660/ActaHortic.2000.538.20

Szalay, L., Papp, J., Szabó, Z., Nyéki, J. (2000b) Floral bud development, blooming time and fertility relations of some Rumanian apricot varieties in Hungary. International Journal of Horticultural Science, 6 (3), 41-43. DOI: https://doi.org/10.31421/IJHS/6/3/101

Szalay, L., Surányi, D., Nyujtó, F. (2011) A sárgabarack fontosabb termesztett fajtái Important cultivars of apricot). In: Surányi D., ed. A sárgabarack (The Apricot). Magyarország kultúrflórája. II./9. Gödöllő: Szent István Egyetemi Kiadó. 254-272. (in Hungarian)

Szalay, L., Szabó, Z. (1999) Blooming time of some apricot varieties of different origin in Hungary. International Journal of Horticultural Science, 5 (1-2),16-20. DOI: https://doi.org/10.31421/IJHS/5/1-2/14

Tromp, J., Webster, A. D., Wertheim, S. J. (2005) Fundamentals of temperate zone tree fruit production. Leiden, The Netherlands: Backhuys Publishers.

Westwood, M. N. (1993) Temperate-zone pomology. Portland, Oregon, USA: Timber Press.

Zhang, X. (2012) Phenology and climate change. In Tech Press, Europe and China. DOI: http://dx.doi.org/10.5772/2146