

Seasonality of weather and phenology of reproductive organs of flower of sour cherry cultivars in Hungarian climatic conditions

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Summary: Sour cherry (*Prunus cerasus* L.) is one of the most important fruit crop grown in Hungary. The flowering phenology and pollen shedding/stigma viability ratio, in an effort to elucidate the reproductive phenology of nine economically important sour cherry cultivars (Érdi bőtermő, Debreceni bőtermő, Csengődi, Kántorjánosi 3, Pándy 279, Újfehértói fürtös, Petri, Éva, and Oblascinszka) all widespread in the Hungary, was studied at Újfehértó climatic condition. The main aims were to investigate how possible environmental cues influence timing and development of phenophases and whether different cultivars have different seasonal responses to these cues. Likely effects of climatic changes on phenological development patterns were also considered. Our results revealed important aspects of the reproductive biology of sour cherry flowers. The amplitude of the phenophase “beginning of blossoming” between cultivars did not exceed 6 days. There is maximum 3 days difference in blooming length of different direction in each cultivar. Pándy 279 showed high variability when the position of flowers changed on the tree shoots. Újfehértói fürtös was stable in all four directions of tree. The pollen shedding period and stigma viability ratio was well synchronous. Pollen shedding phenomenon occurred in the range limitation of secretory activity of stigmas in all five cultivars. Distribution of pollen shedding over the secretory activity of stigmas is almost good. In all five cultivars maximum pollen shedding occurred about the high temperature part of the day.

Key words: Phenology, sour cherry cultivars, microphenology, pollen shedding, stigma viability

Introduction

Phenology data are quite variable because other factors influence the sensitivity of plants to weather and climate, for example genetics and age of the plant, photoperiod response, soil conditions, pests, diseases, and competition from other plants. Phenology in the case of flowers refers to the viability of reproductive organs of flowers which can be called microphenology of flowers (Davarynejad et al. 1993). Diver (2002) believes that phenology is the study of the annual cycles of plants and how they respond to seasonal changes in their environment. For example, in botany phenology refers to the timing of flower emergence, sequence of bloom, fruiting, and leaf drop in autumn. Phenology provides not only insights into how plant growth can be affected by such conditions, but also possible outcomes of management options. These examples highlight the importance of woody plant phenology, not only as an indicator of plant responses to environmental conditions, but also in terms of economically fruit production (Sekhwela & Yates, 2007).

There have been detailed studies on the triggers of phenological development in different vegetation types of woody plants (Shackleton, 1999; van Rooyen et al., 1986b; Childes, 1989; Huang et al., 2006). Similar observations on

the pollination biology where climatic condition in flowering time was related to decreasing or increasing of fruit set and fruit development (Washitani et al., 1994; Lehtila & Syrjanen, 1995; Matsumura & Washitani, 2000; Brys et al., 2004; Soltész et al., 2004; Holb & Schnabel, 2005) has been studied.

Phenological patterns of flowers have been observed in some fruit cultivars, (Davarynejad et al., 1993; apple, Davarynejad et al., 1996; pear, Hrotkó, 1985; *Prunus mahaleb*, Davarynejad et al 2007, sour cherry). According to Racskó et al (2007) sour cherries have a very short period of effective pollination. Pollination ought to ensure within one or maximum two days after the opening of flowers. There seem to be no studies on microphenological patterns of flowers of the above mentioned sour cherry cultivars. However, similar studies have been done by Ansari & Davarynejad (2008) on three Hungarian sour cherry cultivars (Érdi bőtermő, Érdi jubileum and Cigány meggy) which grown in Iran climatic condition. They showed the side effects of weather factors fluctuations such as temperature and humidity on the reproductive organs behavior of flowers like pollen shedding and secretory activity of stigmas.

In this study, phenological development of five economically important sour cherry cultivars has been

studied within the Hungarian climatic conditions. The main aim was to investigate how possible microclimatic cues influence the timing and anthesis of anthers or pollen shedding periods and stigma viability of sour cherry flowers and whether choosing the different cultivars combination for better pollination.

Materials and methods

The study was carried out at the fruit Research and Education Center, Újfehértó, Eastern Hungary at an altitude of 3450–3500 m, which is located about halfway between the cities of Debrecen and Nyereghaza. The mean annual temperature is 25 °C, and the annual rainfall over 50 years was 500 mm. In general the flowering time of fruits is partially rainy and the pollination period occurs in rainy weather. Winds are predominantly from the east-northeast.

The climate in the days of observation was cool, foggy days alternated with sunny days. The humidity at the study site ranged from 45% in the morning to about 85% for most of the day. Meteorological stations were established at the site and ran continuously throughout the study period. Atmospheric temperature, relative humidity and wind speed were recorded every hour intervals. Day length was derived from solar radiation measurements using first morning and last evening readings above zero as sunrise and sunset, respectively. The main soils of the areas are sandy loam. The trees were grafted on *Prunus mahaleb* rootstock and planted in 1991, 3 m apart in rows that were 6 m apart.

Observations of blooming dynamic followed on flowers distributed to the four quarters of the heavens on the end of branches and five tree of each cultivar with 4 branches selected, a sample comprising 100–500 flowers per branches. With the beginning of bloom, every day at the same time (between 10 and 12 AM). The number of flowers according to their stage of development from the bud phase, opening and petal shedding was registered.

The flowering index (Index-V) was calculated according to the formula originally described by Mathe (1977) and Mathe et al. 1993:

$$(\text{Index-V}) = (t-b) / (b+v+t)$$

Where b = number of buds, v = number of flowers at anthesis and t = number of flowers at a post-anthesis stage (at the end of flowering).

Microphenological observations were started at 7 mornings and carried out until 7 afternoons for the duration of the flowering time. The floral biology was monitored in detail of each cultivar, revealing details, such as morphological changes, flowering period, flower lifespan, anther dehiscence, nectar secretion of stigma surfaces and stigmatic status (the color variation of stigma, color varies from pale green to deep brown). The floral parts were studied by using a hand lens. To determine the positioning of stigmas

and anthers within the flower, 12 flowers in the East, West, North and South directions were randomly chosen and tagged to be studied. The phenophases of flowering were taken under consideration by using Index-V which designed for the characterization of the course of flowering (including the flowering dynamics). All the data were analyzed statistically for any relationship between plant attributes and monitored climatic variables using excel statistic program.

Results

Simultaneous blooming is one of the main preconditions for optimal pollination. Table 1 shows the length of flower phenophases of sour cherry cultivars. There is maximum 3 days difference in blooming length of different direction in each cultivar. 3 days difference in *Pándy 279* sour cherry between north and west direction. In fact, *Pándy 279* sour cherry showed high variability when the position of flowers changed on the tree shoots. *Újfehértói fürtös* sour cherry was stable in all four directions.

The length of flower phenophases is determined by the meteorological parameters like temperature, precipitation and radiation. As different directions of tree shoots may receive variable content of weather parameters like temperature and radiation, probable differences between directions might be seen. The amplitude of the phenophase “beginning of blossoming” between cultivars did not exceed 6 days.

Focusing on the length of flowering phenophases it could be deduced that late blooming cultivars like *Pándy 279* which belongs to late blooming group (Nyéki et al., 2003), showed a longer flowering duration (Table 1) in comparison with early or medium early blooming ones like *Csengődi* which belongs to medium early group.

Sour cherry belongs to the group of medium early-blooming fruit trees but it is the latest among the stone fruits. Most of the examined sour cherries in this experiment belong to the late blooming group (*Pándy 279*, *Debreceni bőtermő*, *Kántorjánosi 3* and *Oblacsinszka*) according to 5 group system. Reviewing the blooming process of examined sour cherry varieties showed rather irregular distribution of main blooming period of cultivars in north direction in comparison with other 3 directions (Figure 1). According to Nyéki (1989), studying the overlap of main blooming period (when more than 75% of flowers opened) could give important information's on blooming groups of varieties under various climates and could play an important role to choose proper polliniser for target varieties.

Among examined varieties, *Pándy 279* which is self incompatible showed more diversity than other varieties from the viewpoint of main blooming period and is mutually inter-incompatible with its co-grouped cultivars (*Debreceni bőtermő*, *Kántorjánosi 3* and *Oblacsinszka*).

Oblacsinszka variety which is in the same group with *Pándy 279* sour cherry showed 1–2 days difference in main blooming period. Totally, the self incompatible varieties

Table 1. Length of flowering phenophases of sour cherry cultivars

| Cultivar \ Direction | North | South | East | West | Average |
|--|-------|-------|------|------|---------|
| Length of flowering phenophases (days) | | | | | |
| Érdi bőtermő | 14 | 14 | 13 | 12 | 13.25 |
| Debreceni bőtermő | 13 | 13 | 11 | 12 | 12.25 |
| Kántorjánosi 3 | 13 | 13 | 14 | 13 | 13.25 |
| Éva | 14 | 14 | 14 | 13 | 13.75 |
| Petri | 13 | 13 | 14 | 14 | 13.5 |
| Újfehértói fűrtös | 13 | 13 | 13 | 13 | 13 |
| Csengődi | 10 | 10 | 12 | 12 | 11 |
| Pándy 279 | 16 | 15 | 14 | 13 | 14.5 |
| Oblacsinszka | 14 | 14 | 15 | 13 | 14 |

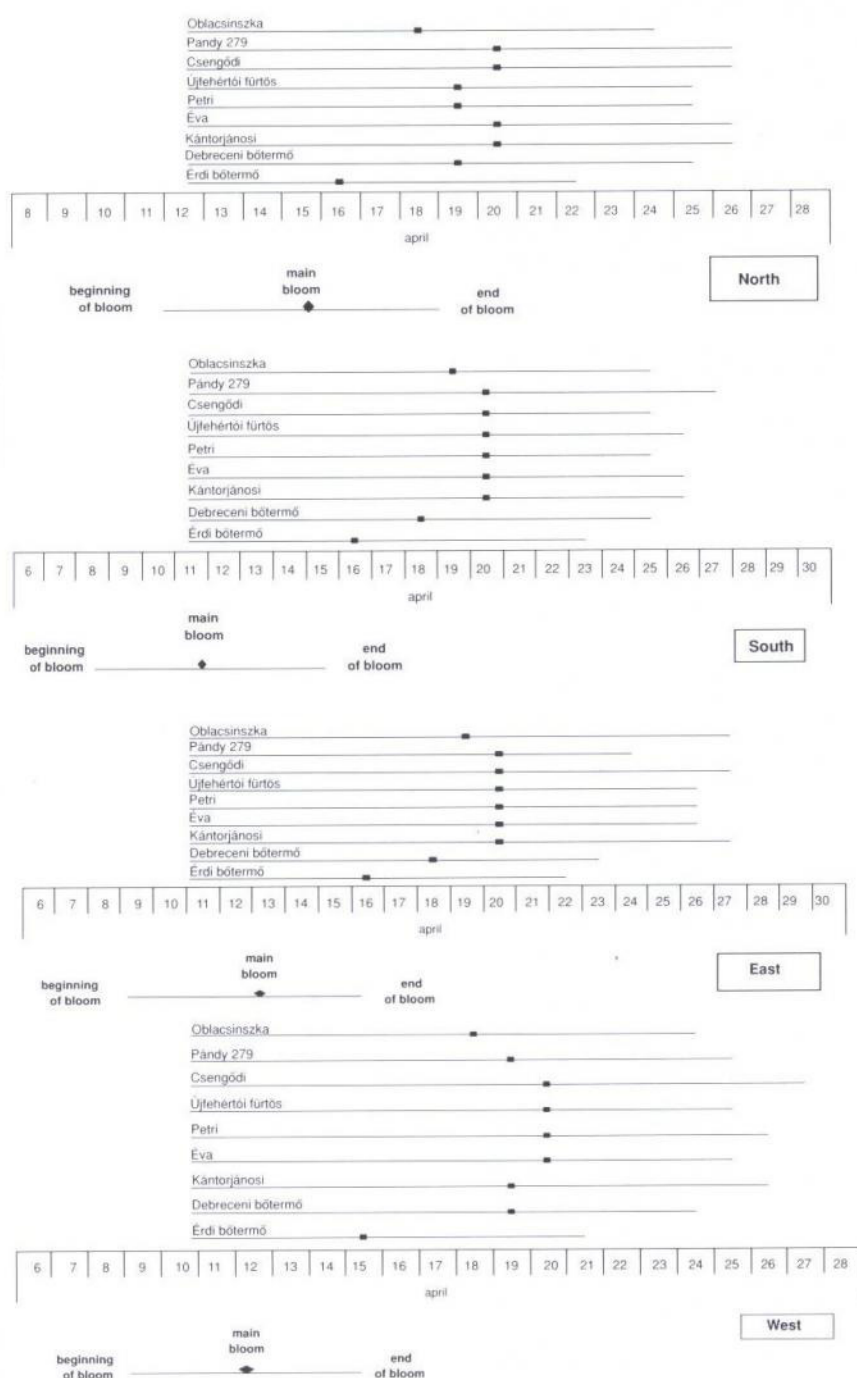


Figure 1. The blooming process of sour cherry cultivars (Újfehértó 2008) (Source: Szabó, 1989)

(e.g. types of the *Pándy* group) are unsafe yielders and should consider appropriate pollinisers which are synchronous with them.

In 1993, *Mathe et al.* developed a flowering index suitable for the characterization of the course of flowering (including the flowering dynamics) of apple which called Index-V. *Figure 2* shows the values of V- indices for all sour cherry cultivars in four directions of tree branches.

Flowering is a phenotypic related process which environmental factors like temperature, radiation, humidity etc. in addition to genotypic cues, have considerable effects on the progressive procedure of blooming up to initial of fruit set. So, collation of fruit tree blooming under different environmental situations could disclose the unknown effects of environment on the process of blooming. V-Indices results (*figure 2*) illustrated that *Érdi bőtermő* started to bloom two days earlier than other varieties (10th of April in north and 9th in the rest of east, west and south directions) which could not be remarkable from the viewpoint of flowering overlap with other cultivars. Results of *Ansari & Davarynejad (2008)* during 2005 and 2006 showed that *Érdi bőtermő* sour cherry cultivar is an early blooming cultivar under Iran climatic conditions too. On that experiment *Érdi bőtermő* cultivar started to bloom at 10th and 4th of April respectively during 2005 and 2006 which shows the effect of environmental conditions on the blooming time of varieties under different climatically conditions.

Average duration of four side flowering period showed the minimum flowering period in *Csengődi* cultivar which lasted 11 days from the beginning of the blooming (*Table 1*). Duration of flowering period in *Pándy 279* cultivar was highest (14.5 days)

among the cultivars which show the most diversity in the length of flowering period. Totally, four side branches selected for observations did not show differences in duration and time of flowering except north side flowers showed some irregularity in the time of main bloom in comparison with other sides (Figure 1).

Microphenology of flowering

Before discussing the receptivity of flowers, it is worth mentioning that the flowering period is variable and temperature related. According to Davarynejad (1993)

Phenology in the case of flowers refers to the viability of reproductive organs of flowers which can be called microphenology of flowers. There is not enough information on microphenology of flowering of fruit trees which could be useful in gathering precise biography of subsequence distribution of different flowering stages that is applicable for defining suitable pollinisers and optimized time of putting beehives in the field. Ansari & Davarynejad (2008) applied similar experiment on 3 Hungarian sour cherry cultivars (Érdi bőtermő, Érdi jubileum and Cigány meggy) under Iran climatic conditions. Results of this experiment follow out the conclusions of that experiment.

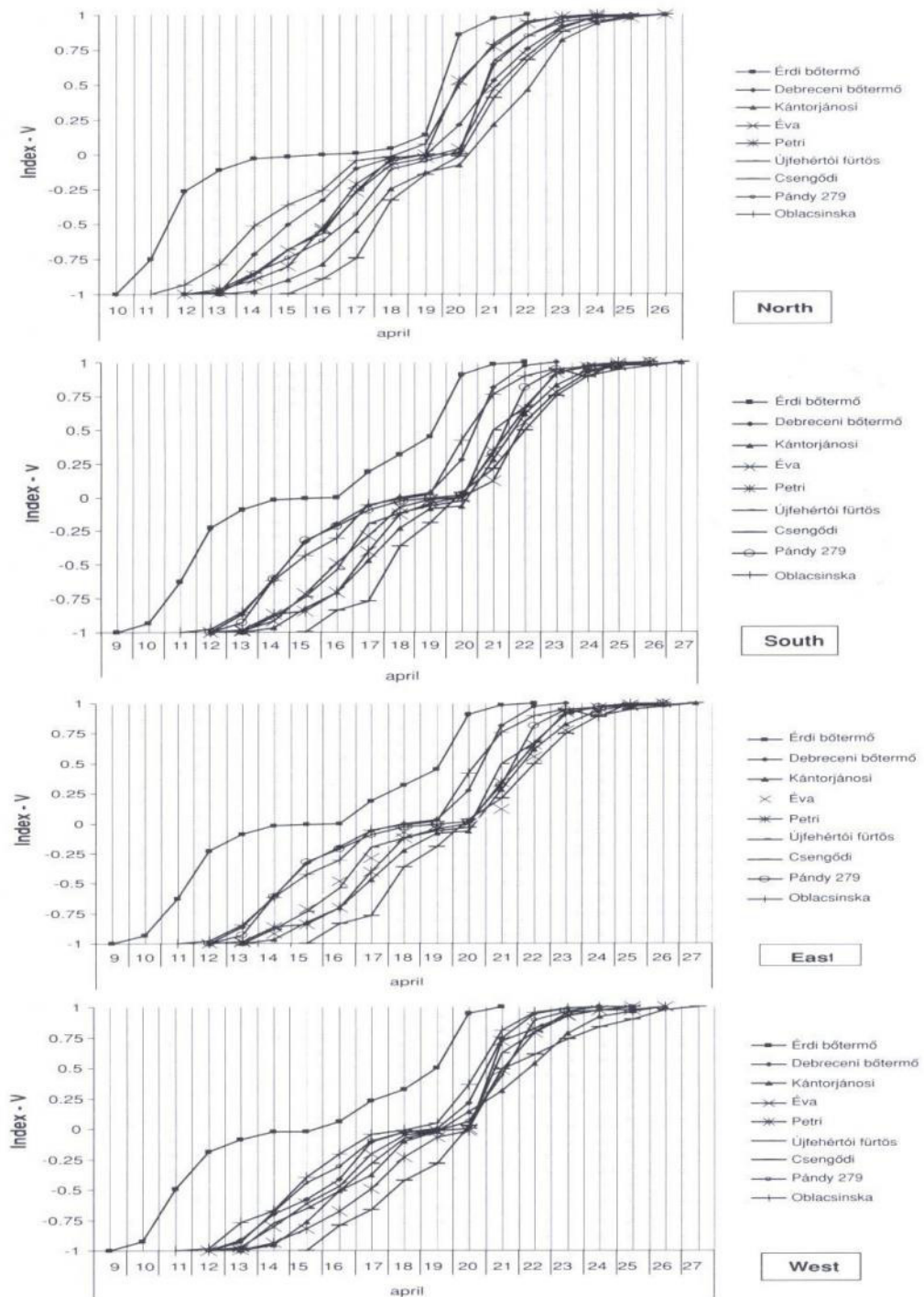


Figure 2. The V-indices of sour cherry cultivars (Újfehértó 2008)

On that experiment microphenological stages of flowering of sour cherries including *Érdi bőtermő* were taken under consideration under Iran climatically condition. Although pollen shedding occurred in the range of stigma viability, but the overlap of the two phenomenon's was not good. Overcast weather condition under Iran climatic conditions caused irregular distribution of pollen shedding in the range of *Érdi bőtermő* secretory activity of stigma in comparison with present experiment which *Érdi bőtermő* shows normal behavior of reproductive organs activities.

During the days of present experiment we don't have rainfall. As *Figure 3* illustrates, pollen shedding phenomenon occurred in the range limitation of secretory activity of stigmas in all five varieties. Distribution of pollen shedding over the secretory activity of stigmas is almost good. In all five cultivars maximum pollen shedding occurred about the high temperature part of the day. Pollen shedding is naturally a mechanical phenomenon and affected by environmental factors. In all five cultivars, pollen shedding started only after flower opening.

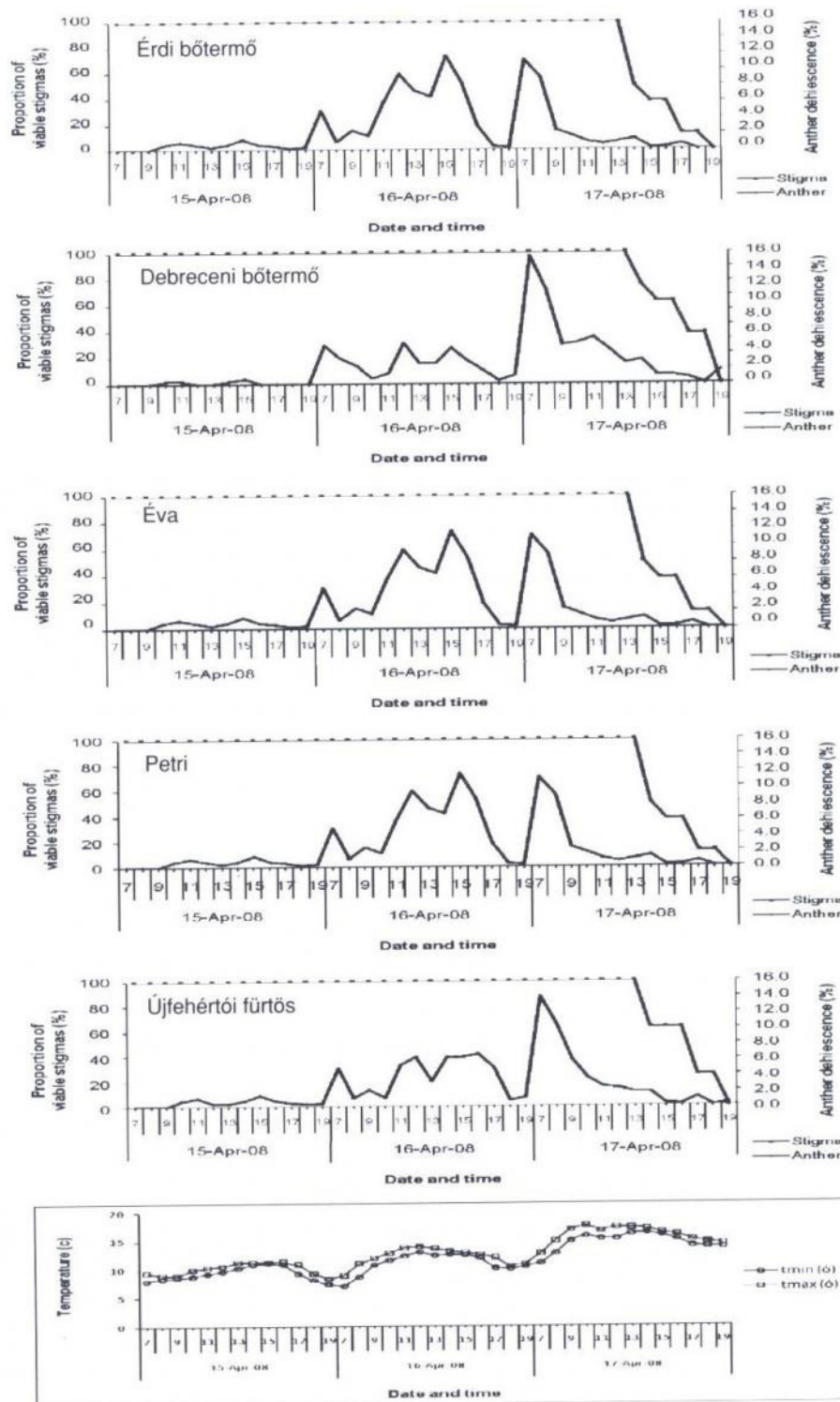


Figure 3. Reproductive organ activity of Hungarian sour cherry cultivars

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