Microsporogenesis of peach (*Prunus persica* L. Batsch) varieties

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Summary: Bud dormancy during winter is a critical factor in peach production in Hungary. The yield is determined basically by the survival rate of flower buds during winter frosts and by their ability to develop normal floral organs. It is important to investigate the genetic basis of slow floral development during dormancy for the purpose of breeding peach varieties with better winter hardiness. The aim of the present research was to examine microsporogenesis in 14 peach varieties during three successive winters in a Hungarian germplasm collection and to study the effectiveness of this method in variety evaluation. There were significant differences in the dynamics of microsporogenesis both between the varieties and between the years. Of the varieties, 'Mayfire', bred in California, possessed the quickest pollen development rate. The microsporogenesis of 'Piroska', a Hungarian local variety, was the slowest. Rapid floral bud development was observed in 'Aranycsillag', 'Springcrest' and 'Venus'. A medium developmental rate was characteristic of 'Babygold 6', 'Fairlane', 'Michelini' and 'Red June', while development was slow in 'Champion', 'Early Redhaven', 'Redhaven', 'Harko' and 'Mariska'. Based on these results, the study of microsporogenesis represents a reliable method for the phenological description of peach varieties during dormancy. The application of this method makes it possible to identify varieties and landraces with slow flower bud development, suggesting better winter hardiness.

Key words: flower bud development, microsporogenesis, peach

Introduction

Hungary is situated in the northern zone of peach production. The yield is determined basically by the survival rate of flower buds during winter frosts and by their ability to develop normal floral organs. It is important to investigate the genetic basis of slow floral development during dormancy for the purpose of breeding peach varieties with better winter hardiness.

The flower bud development and microsporogenesis of peach varieties were investigated earlier by Draczinsky (1958), Bubán (1992) and Ramina et al. (1995). When studying pollen development on the northern boundary of peach production Draczinsky (1958) found large differences between the varieties in the time of pollen formation. In Hungary Bubán (1992) carried out detailed studies on peach flower bud development during paradormancy. In addition, he conducted histological research during the winter, and observed the appearance of pollen mother cells with two nuclei within the anthers as early as in February. The experiments of Ramina et al. (1995) in Italy gave a good example of the much quicker pollen developmental rate characteristics of the Mediterranean regions compared to the continental climates.

In this experiment the major aim was to evaluate the microsporogenesis of 14 peach varieties, and to study the effectiveness of this method in variety evaluation.

Material and method

Samples for the tests were taken from the germplasm collection of an experimental plantation located near Szigetcsép, 30 km south of Budapest.

The following varieties were tested:

- Hungarian local varieties: *Piroska, Mariska, Aranycsillag*
- Variety originating from Canada: *Harko*
- Varieties originating from the temperate zone of the USA: *Babygold 6, Champion, Early Redhaven, Redhaven, Springcrest*
- Varieties originating from California: *Fairlane, Mayfire, Red June*
- Varieties originating from Italy: *Michelini, Venus*

The anther primordia were removed from flower buds developing in the middle of long shoots, and were dyed with carmine acetic acid. From each sample 6–8 flower buds were used for the examinations. The preparations were examined under the microscope and the pollen development was characterized by classifying them into one of the following six developmental stages:

1. **archesporium stage** – homogeneous, undifferentiated tissue,
2. **string stage** – the developing pollen mother cells form strings,

3. **pollen mother cell stage** – the pollen mother cells are separated,
4. **tetrad stage** – each mother cell is divided into 4 haploid cells,
5. **microspore stage** – microspores are released from the tetrads,
6. **pollen stage** – complete pollen grains can be seen in the anthers.

The transition between the developmental stages took place gradually and the whole process usually took several days. For the purpose of comparison the day when 50% of the microspores were already in the next phenological stage was considered to be the beginning of that stage.

Results

The process of microsporogenesis in the peach varieties tested during three subsequent winters is presented in *Figures 1, 2* and *3*.

The examination of the varieties revealed that the rate of pollen development is genetically determined, since the relative order of the varieties was almost the same each year. However, this hereditary trait was influenced by the weather significantly, as manifested in the considerable differences between the years. The appearance of the string stage is the first sign of the continuation of floral bud development. It represents the beginning of tissue differentiation within the anthers, indicating the end of endodormancy. In 1997–98 this string stage could be observed by the end of December in the earliest varieties ('Mayfire', 'Springcrest'), while in the latest variety, 'Piroska', this stage did not occur until the end of January. In the other two winters the first signs of tissue differentiation could not be observed until January 20. The largest difference between the earliest and the latest varieties in the appearance of the string stage (40 days) was observed in the winter of 1998/99, while during the other two winters this difference was 30 days. The formation of pollen mother cells occurred between Jan. 8 and Feb. 15 in 97/98, between Feb. 5 and Mar. 9 in 98/99, and between Jan. 25 and Feb. 25 in 99/00 depending on the varieties. As the bloom time approached the differences between the varieties in the phenological stages showed a continuous decrease. The tetrad stage, considered to be an important stage in floral bud development, occurred earliest, between Jan. 25 and Feb. 20, in the winter of 1997/98. In the other two winters this stage could be observed between the beginning of February and the middle of March. Each year the tetrad stage was followed by a fairly long intermediate phase (microspore stage) and the pollen grains developed in the anthers 10–14 days before the beginning of blooming.

Among the peach varieties, the slowest rate of pollen development was found in the case of *'Piroska'* and *'Champion'*. These are downy varieties with white flesh, sold for fresh consumption. Among the freshly consumed varieties with yellow flesh, *'Redhaven'* and *'Early Redhaven'* showed slow flower bud development, as did the nectarine variety *'Harko'*. The microsporogenesis of

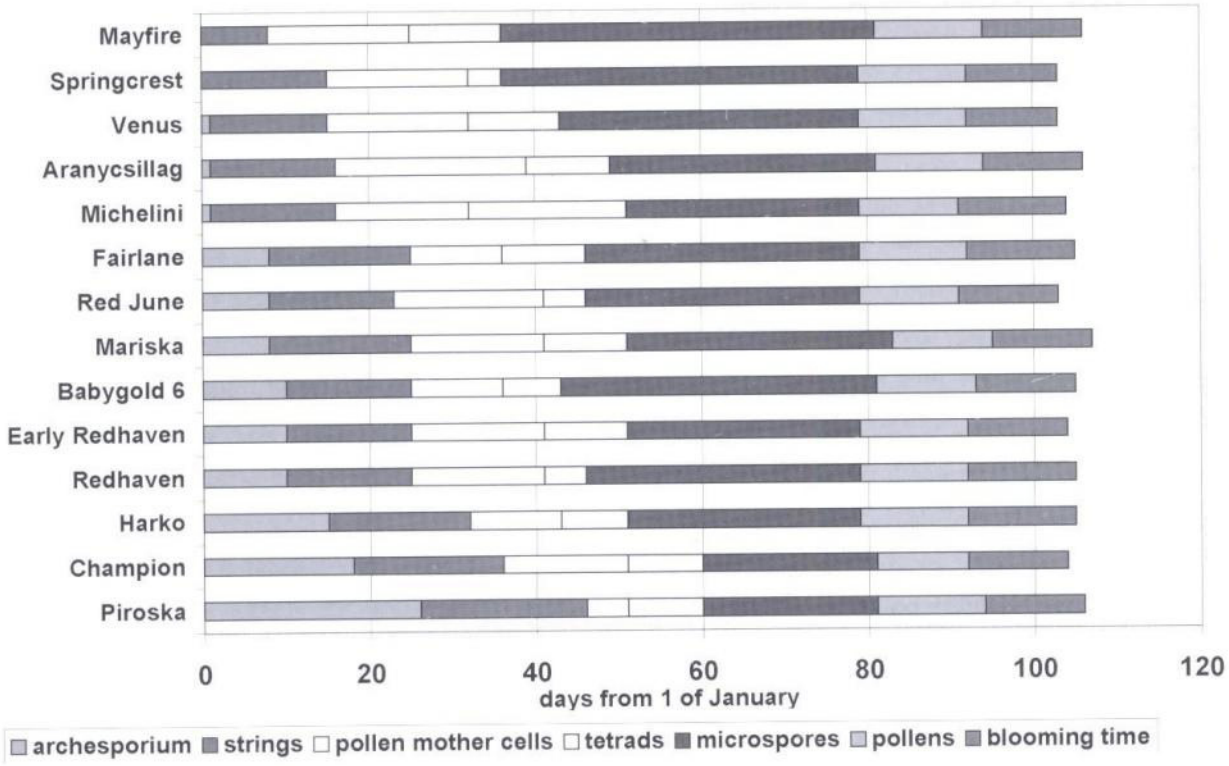

Figure 1 Process of microsporogenesis of peach varieties (Szigetcsép 1997/1998)

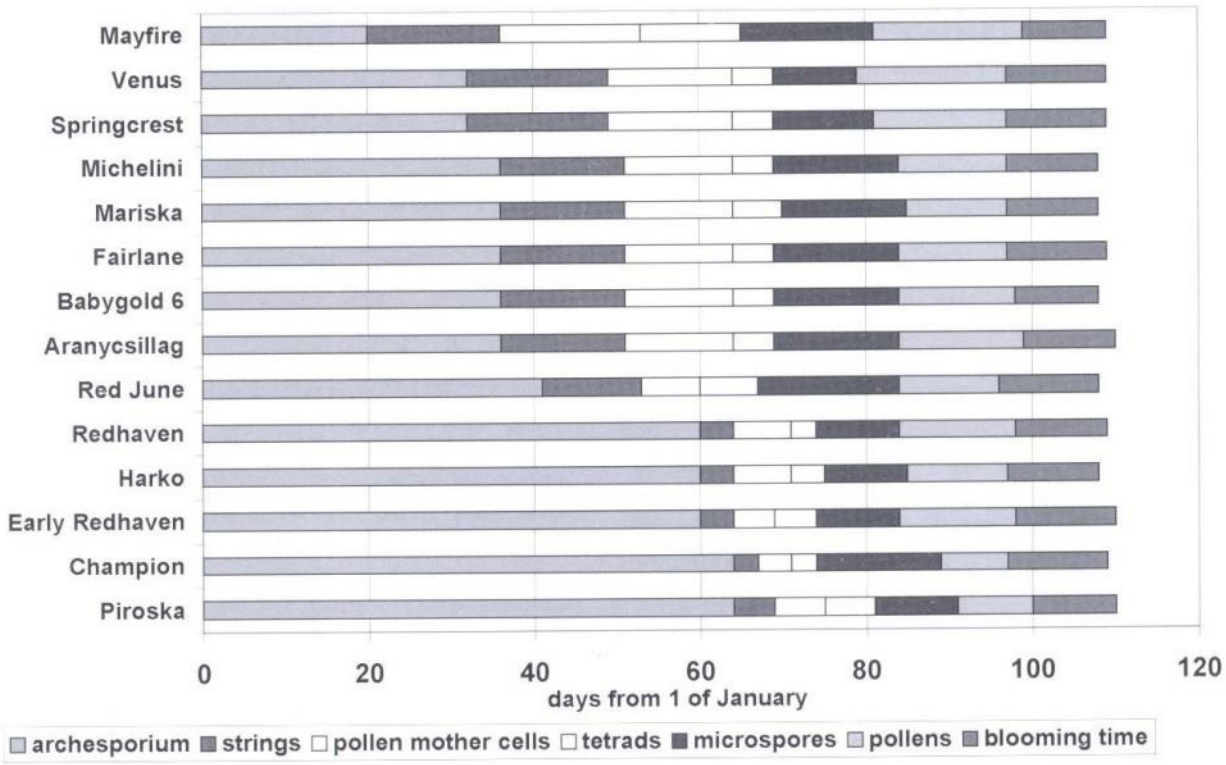

Figure 2 Process of microsporogenesis of peach varieties (Szigetcsép 1998/1999)

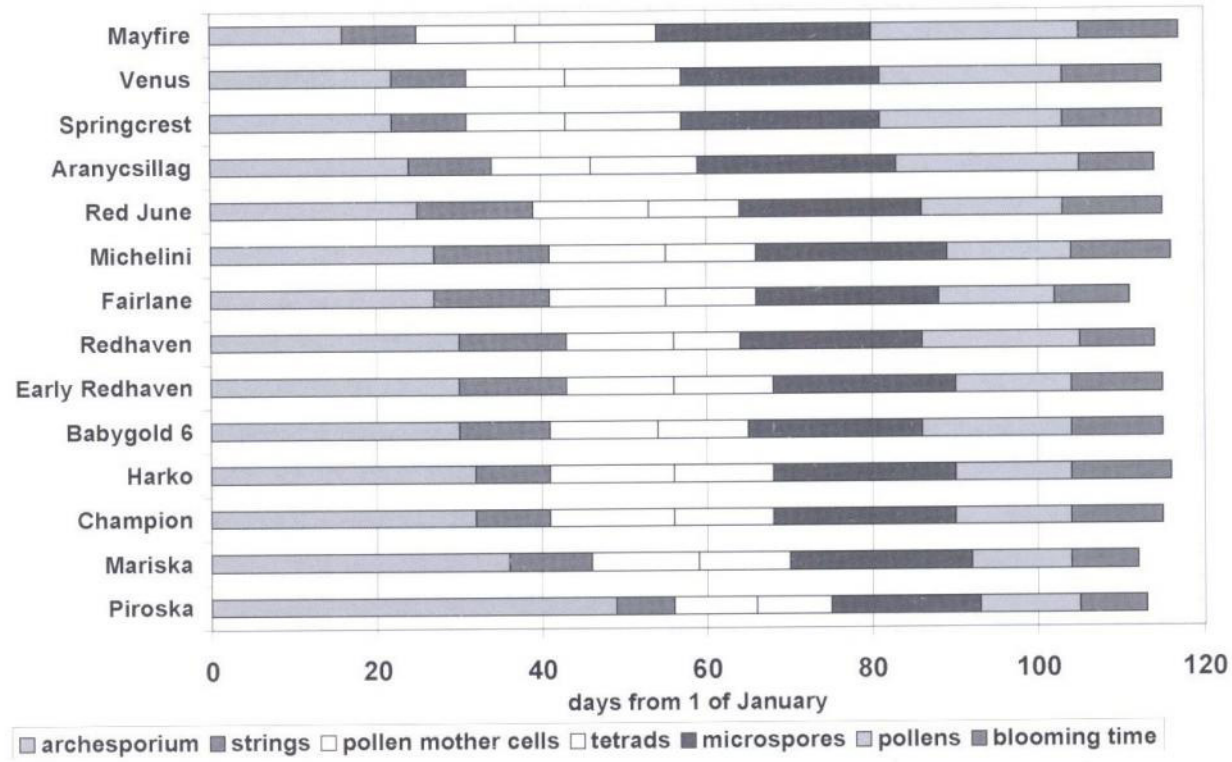

Figure 3 Process of microsporogenesis of peach varieties (Szigetcsép 1999/2000)

'Venus', *'Springcrest'* and *'Mayfire'* was very fast. The remaining varieties had an average rate of bud development. In all three winters tissue differentiation in the anthers started about one month later in *'Piroska'* than in *'Mayfire'*. As blossoming approached the difference between the varieties in the date when a given developmental phase was reached decreased, but in the tetrad stage a 20–30-day difference was still observed.

Conclusions

There is only a limited number of data available on the floral bud development of peach varieties which can be grown under Continental climatic conditions. This is especially true for the newly introduced varieties, several of which are widely used in new plantations. Examinations on the older varieties have already proven the large differences that may exist in floral bud development among varieties (Draczinsky, 1958). The rate of floral bud development shows a strong correlation with the cold requirement, which in itself is also an extremely variable factor among the peach varieties (Childers, 1983; Timon, 1992, 2000). Varieties with a higher cold requirement and a slower bud developmental rate have better winter and cold hardiness than varieties with a rapid developmental rate. This is chiefly due to their longer dormancy, which gives their tissues better frost tolerance. In Hungary, as in all countries lying on the northern boundary of peach production, only cold-hardy varieties with longer dormancy can be grown economically. To identify and select these varieties the application of simple and reliable methods is very important. Based on the present results, microsporogenesis represents a reliable method for the phenological description of peach varieties during the winter. The application of this method makes it possible to identify varieties and landraces with slow flower bud development indicating better frost hardiness. As the temperature significantly influences the developmental rate of microsporogenesis, causing tremendous yearly differences, accurate results can only be achieved by studying the varieties over several years. It is also important to include varieties with known characteristics as controls in these studies.

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