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Evaluation of dormancy break in some selected peach (*Prunus persica*) cultivars

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Abstract

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The evaluation of dormancy break based on the number of flower buds in bloom was performed in years 2011–2013 (January–April) for 15 peach cultivars compared to the control cv. Redhaven. Based on the date of endogenous dormancy break the evaluated peach cultivars could be classified into three groups consisting of: (1) cultivars with an early break of dormancy, (2) cultivars with a medium-early break of dormancy and (3) cultivars with a late break of dormancy. For individual cultivars, the duration of the dormancy period was influenced by meteorological conditions existing in a given year.

Keywords: *Prunus persica* (L.) Batsch; endogenous dormancy; length of dormancy; flower buds

Similarly to apricot and almond trees, peaches are sensitive to frost damage, especially during spring months when abrupt drops in air temperatures may occur. In winter, buds are already dormant so they are usually not damaged by frosts. This means that dormancy is one of the most important adaptation mechanisms that enable the survival of perennial plants in winter periods of low temperatures (Taylor 2008; Leida 2012). The process of dormancy thus determines how the woody fruit species can survive during the winter season and early spring without any damage to shoots and, above all, flower buds (Allona et al. 2008). The final number of flowers that remain after budding or (better to say) the density of their setting is an important factor that influences the fruit-bearing of peach trees. The process of the development of flower buds in individual genotypes and cultivars is genetically fixed. Certain changes in the character of the development of flower buds can be caused by the manner of cultivation, environmental conditions and by some other factors, e.g. age of the orchard, health condition of trees, rootstock, growing technology etc. (Hauagge, Cummins 1991; Fan et al. 2010).

Dormancy has been studied and reviewed by many authors. Lang et al. (1987) defined several stages of dormancy, viz. paradormancy, endodormancy and ecodormancy. Both exogenous and endogenous factors that influence this process were studied and analysed in many research studies. As far exogenous factors were concerned, effects of day length and temperature were investigated while studies on effects of endogenous factors were focused on the role of growth regulators, regulation of the cell cycle, water, chromatin modification etc. (Arora et al. 2003; Horvath et al. 2003; Rohde, Bhalerao 2007; Allona et al. 2008). At present, the research is focused on genetic and molecular aspects of dormancy and deals with mechanisms that regulate both endodormancy and the

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process of dormancy break (Bassett et al. 2006; Horvath 2009; Prassinos et al. 2011; Yamane et al. 2011). This means that the process of dormancy represents a domain that still offers possibilities to discover new finding and new facts.

In peach trees, the dormancy of flower buds has also been studied and reviewed by many authors. Bonhomme et al. (1997) characterised the dormancy of flower buds from biological and biochemical points of view, Basconsuelo et al. (1995) and Reinoso et al. (2002) described in detail those morphological and anatomical changes of flower buds that took place in the course of the dormancy process. Chavarria et al. (2009) studied the effect of temperature on the course of dormancy.

Endogenous dormancy (endodormancy), or also a deep vegetative rest, is a rest of woody plants caused by internal, endogenous causes inside the bud itself. At the moment of entering into endogenous dormancy, the level of intrinsic growth inhibitors, most importantly abscisic acid (ABA) in peach buds increases. In contrast, the break of dormancy is characterised by a decrease in ABA level (Ramina et al. 1995). In principle, the end of dormancy is determined by the environmental conditions. After the break of dormancy, buds begin to grow and this growth is accompanied by activities of some specific hormones and an increased rate of cell division (Horvath et al. 2003). According to Neméth and Szalay (2012), there are differences in the development of flower buds on short (0–20 cm) and long (40–80 cm) annual shoots of peach trees. In short annual shoots, the period of endodormancy of floral buds is shorter than in the long ones.

In peach trees, the break of dormancy can be influenced by the application of some endogenous phytohormones, particularly gibberellins (Luna et al. 1991; Basconsuelo et al. 1995).

The aim of this study was to evaluate the date of the dormancy break in some peach cultivars and to evaluate the course of this process in individual years of study.

MATERIAL AND METHODS

Plant material. As experimental plant material 15 cultivars from the gene fund of peach trees existing in the collection of the MENDELU Faculty of Horticulture in Lednice were selected (Table 1). The cv. Redhaven was selected as the Control.

This gene fund (collection) of *P. persica* L. was established in 2001, thus the surveyed trees were 14 years old. Trees were trained to a slender spindle and were spaced 5 × 1.5 m apart. They were routinely treated with standard, registered preparations to inhibit and/or kill diseases and insect pests – peach leaf curl (*Taphrina deformans*), powdery mildew (*Sphaerotheca pannosa*), brown rot (*Monilinia laxa*) and aphids.

Lednice is situated in the maize-growing region at an altitude of 176 m a.s.l. According to Quitt's classification (Quitt 1971) it belongs to the T4 climatic region characterised by very warm, dry and long summers, warm springs and autumns, short, mild and dry to very dry winters and with a very short duration of snow cover. Within the period of 1961–1990, the basic climatic parameters were as follows: average annual temperature 9.2°C, average humidity 76.1%, average annual sum of precipitations 479.7 mm and average annual sum of solar radiation 1,747.3 hours. Within the period of experimental years 2011–2013, the corresponding parameters were 10.5°C, 71.5%, 398.4 mm and 1,978.6 hours, respectively. A survey of maximum and minimum temperatures recorded in individual study years and for the 30-year average is presented in Fig. 1. All climatic data were recorded in the meteorological station (model AKS2n – automated climatological station II. type) of Mendeleum (MENDELU Faculty of Horticulture) in Lednice.

Assessment of the break of dormancy. In all experimental years, sampling of one-year old shoots started at the beginning of January (i.e. on January 4, 2011; January 12, 2012 and January 10, 2013) and was performed at weekly intervals until

Table 1. List of 15 experimental cultivars and the Control cv. Redhaven utilized to study the course of dormancy for peach (*Prunus persica* L.), Lednice, Czech Republic, 2011–2013

Benedicte (France)	Neve (Italy)	Ruby Prince (USA)	Venus (Italy)
Fantasia (Italy)	**Redhaven** (USA)	Spring Belle (Italy)	W 13 (China)
Fidelia (Italy)	Royal Glory (USA)	Super Queen (Italy)	W 14 (China)
Krymčanin (Ukraine)	Rubinovyj 7 (Ukraine)	Symphonie (France)	W 43 (China)

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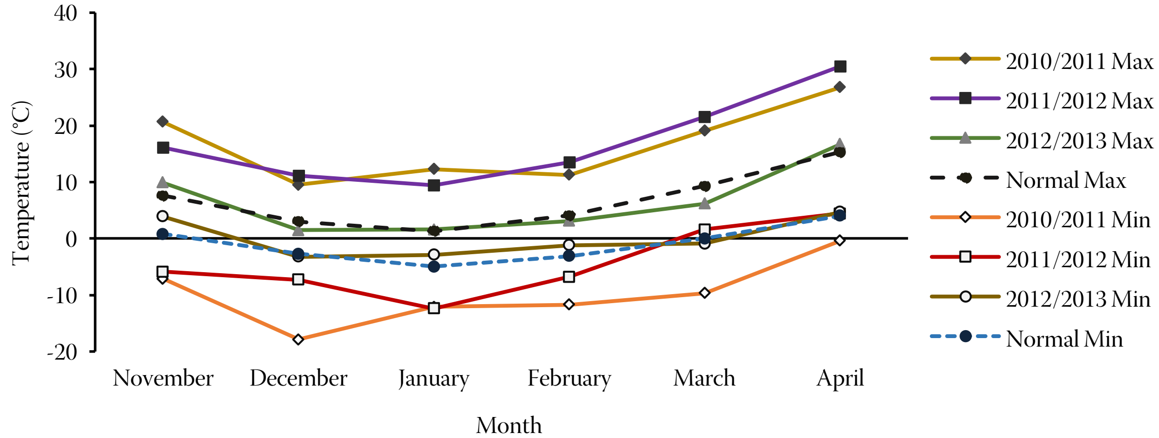

Fig. 1. Maximum and minimum temperatures recorded at the station Mendeleum (MENDELU, Faculty of Horticulture), Lednice, Czech Republic, 2010–2013

March 1, 2011; February 9, 2012 and February 22, 2013. The latter dates represent the individual end of the dormancy period for cultivars under study. Shoots were sampled in morphologically similar parts of tree crowns, always on the same cardinal point and at the height of approximately 1.5 m. Each sample consisted of three annual shoots with at least 30 buds). The total number of flower buds was counted at the moment of sampling. Shoots were then placed into vessels containing water and held at the room temperature (20–23°C). Numbers of flowers (i.e. stage F according the methodology of Fleckinger and Grisvard (Vachůn 2003) and numbers of rosy buds (stages D and E) were counted two weeks later. The day of endogenous dormancy break was defined as the date of annual shoot sampling when 50 and more percent of flowers and rosy buds (i.e. in phenological stages D, E and F) were recorded after two weeks. The average length of dormancy was then calculated for all cultivars under study. The length of dormancy is a parameter that represents an average of values recorded within the whole study period and is related to the January 1 of the corresponding year.

Statistical analysis. The obtained experimental results were processed statistically by means of a 2-way Analysis of Variance (ANOVA) and Fisher's F-test ($P \leq 0.05$) using the StatSoft software Statistica 10 (StatSoft, Inc., Tulsa, USA). Significantly different means were separated using converting the test statistics to calculate the probability scale and probability P, that quantifies the probability of realization of the value of the test statistics if the null hypothesis is true. So the rule for formulation of conclusion following: if the P-value is less than the significance level α (α error), the null hypothesis H_0 was rejected. Symbolically, the conclusion can be used: $P < 0.05$ – statistically significant difference, $P < 0.01$ – statistically highly significant difference and $P > 0.05$ – no significant difference.

RESULTS AND DISCUSSION

Dates of the endogenous dormancy break of flower buds are presented in Table 2. The length of dormancy is expressed as the number of days elapsing since the beginning of the corresponding year.

In 2011, altogether eight samplings of annual shoots were performed. The first break of dormancy was recorded for the cv. W 13; in this case altogether 59.2% of flowering and rosy buds were recorded already on January18. Cv. W 13 was followed by cvs Royal Glory (65%), Benedicte (54.7%) and Fidelia (52%). On February 2, the break of dormancy was recorded for three cvs, viz. Symphony (79.8%), Rubinovyj 7 (76.2%) and Neve (61.4%); one week later (February 15) for cv. Ruby Prince (63.3 %). For the control cv. Redhaven the break of dormancy was recorded on February 22, as well as for cvs W 14 (79.3%), Krymchanin (64.4 %), Venus (60.9%), W 43 (53.3%) and Fantasia (51.5 %). The last ones recorded (March 1) were for cvs Spring Belle (80.8%) and Super Queen (52.2%).

The year 2012 was characterised by rapid break of dormancy and for that reason sampling was performed on only five dates. The end of deep dormancy was observed as early as on January 12 for six

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Table 2. Duration (days) and date of dormancy break for 15 experimental peach cultivar and the control cv. Redhaven (Mendeleum – MENDELU, Faculty of Horticulture, Lednice, Czech Republic, 2011–2013)

Cultivar	Dormancy length (since January 1)				Date of dormancy break (day. month.)			
	2011	2012	2013	Mean	2011	2012	2013	Mean
W 13	18	19	24	20	18. 1.	19. 1.	24. 1.	20. 1.
Royal Glory	32	12	17	20	1. 2.	12. 1.	17. 1.	20. 1.
Benedicte	32	12	24	23	1. 2.	12. 1.	24. 1.	23. 1.
Fidelia	38	12	24	25	1. 2.	12. 1.	24. 1.	23. 1.
Symphony	38	33	–	36	7. 2.	2. 2.	–	5. 2.
Rubinovyj 7	38	12	17	22	7. 2.	12. 1.	17. 1.	22. 1.
Neve	38	12	24	25	7. 2.	12. 1.	24. 1.	25. 1.
Ruby Prince	47	12	31	30	15. 2.	12. 1.	31. 1.	30. 1.
W 14	54	33	39	42	22. 2.	2. 2.	8. 2.	11. 2.
Krymchanin	54	26	39	40	22. 2.	26. 1.	8. 2.	8. 2.
Venus	54	19	31	35	22. 2.	19. 1.	31. 1.	3. 2.
W 43	54	33	53	47	22. 2.	2. 2.	22. 2.	15. 2.
Fantasia	54	19	39	37	22. 2.	19. 1.	8. 2.	6. 2.
Redhaven	**54**	**19**	**24**	**32**	**22. 2.**	**19. 1.**	**24. 1.**	**1. 2.**
Spring Belle	60	26	24	37	1. 3.	26. 1.	24. 1.	6. 2.
Super Queen	60	40	–	50	1. 3.	9. 2.	–	19. 2.

Readhaven – Control

cvs, viz. Royal Glory (85.5%), Ruby Prince (64%), Fidelia (63.6%), Rubinovyj 7 (63.1%), Neve (58.5%) and Benedicte (51.7%). One week later (January 19) the break of dormancy was recorded for four cvs, viz. W 13 (74.6%), Venus (5%), Redhaven (53.8%) and Fantasia (53.3%). On January 26, break of dormancy was recorded for cvs Spring Belle (76.7%) and Krymchanin (59.1%) and one week later (February 2) for Symphonie (69.9%), W 43 (55%) and W 14 (54%). Cv. Super Queen was the last one (54.7%), on February 9, 2012.

This early break of dormancy of dormancy was caused above all by weather conditions that existed to the end of 2011. In November, standard air temperatures were recorded but in December there was an increase to unusually high temperatures. In this month, there were only two days with temperatures below the freezing point (December 19 and 20); in other December days the temperatures were above zero and ranged from 0.1 to 8.1°C. As compared with the long-term average (1961–1990), the difference was as much as 2.9°C.

In 2013, there were eight dates of shoot sampling. The first break of endogenous dormancy was recorded on January 17 for cvs Royal Glory (62.4%) and Rubinovyj 7 (52.5 %). One week later (January 24) the end of dormancy was recorded for five tested cvs, viz. Neve (64.1%), Spring Belle (53.4%), Fidelia (53.1%), W 13 (51.9%), Benedicte (51.4%) and for the Control Redhaven (51.4%). The break of dormancy was recorded in cvs Ruby Prince (66%) and Venus (52%) on January 31. One week later (February 8) the end of endogenous dormancy was recorded for cvs Krymchanin (70.2%), Fantasia (62%) and W 14 (61.7%). Dormancy break for the last cultivar, W 43 (59.1%), was observed on February 22.

The average duration of dormancy in individual peach cultivars is presented in Fig. 2; this variable is expressed as number of days elapsing after the January 1 of the corresponding year. From this point of view, the shortest periods of endogenous dormancy were recorded in cvs W 13 and Royal Glory (20 days) while the longest one was found out in the cv. Super Queen (50 days). Within individual cultivars, the range of average duration of endogenous dormancy was relative; the greatest differences were found for cvs Fantasia, Redhaven, Ruby Prince, Spring Belle and Venus. This phenomenon was caused by an early break of dormancy in 2012

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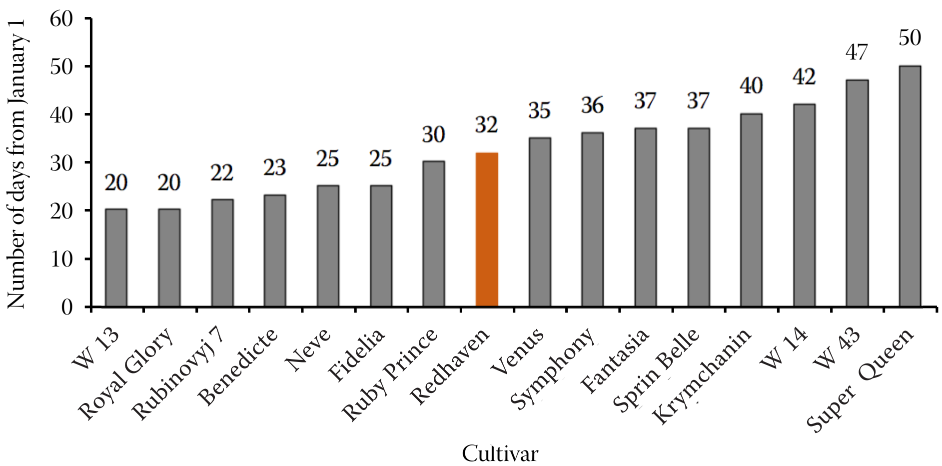

Fig. 2. Average length of the dormancy period for 16 peach (*Prunus persica* L.) cultivars at the station Mendeleum (MENDELU, Faculty of Horticulture), Lednice, Czech Republic, 2010–2013

and a too delayed break of dormancy in 2011; in both years, the break was influenced by weather.

Basing on the obtained data it was also possible to evaluate cultivars under study with regard to the uniformity of dormancy break in individual years of study. Cvs Symphonie and W 13 showed the greatest uniformity of all because their differences in the date of dormancy break were only 5 and, 6 days, respectively. In other cultivars these differences were greater and ranged from 20 to 36 days.

In each year, the course of dormancy is significantly influenced by weather conditions. A comparison of temperatures recorded in individual years revealed diametrical differences. i.e. the year 2011 was comparable with the year 2013 but the year 2012 was quite different. For 2012 the recorded temperatures for December 2012 were already unusually high; the average temperature was 0.7°C and there were only two frosty days with temperatures below zero. January 2012 was also unusually warm and the average temperature was 1.3°C. This relatively mild winter shortened the period of dormancy and was manifested in all cultivars under study.

Statistical analysis revealed significant differences in the length of dormancy among cvs W 43 – W 13 (*P* = 0.0301), W 43 – Benedicte (*P* = 0.0466), W 43 – Royal Glory (*P* = 0.030) and W 43 – Rubinovyj 7 (*P* = 0.0438), Super Queen – W 13 (*P* = 0.0289), Super Queen – Benedicte (*P* = 0.0429), Super Queen – Royal Glory (*P* = 0.0289) and Super Queen – Rubinovyj 7 (*P* = 0.0406). The longest and the shortest periods of dormancy were detected in these cultivars. Differences in the length of dormancy among other cultivars were not significant. Among the years under study (i.e. 2011, 2012 and 2013) the differences in the length of dormancy were statistically highly significant (*P* = 0.0000; *P* = 0.000 and *P* = 0.0028, respectively). This indicated that in individual years the length of dormancy was rather different.

As far as the end of the endogenous dormancy is concerned, peach cultivars under study can be classified into three groups. In Control cv. Redhaven, the February 1 was detected as the date of dorman-

Table 3. Classification of 16 cultivars on the basis of dormancy break in 2011–2013 (Mendeleum – MENDELU, Faculty of Horticulture, Lednice, Czech Republic)

Group	Cultivar
Cultivars with an early break of dormancy 1–2 weeks before the Redhaven	W 13
	Royal Glory
	Rubinovyj 7
	Benedicte
	Fidelia
	Neve
Cultivars with a medium break of dormancy	Ruby Prince
	Redhaven
	Venus
	Symphony
	Fantasia
	Spring Belle
	Krymchanin
Cultivars with a late break of dormancy 1–2 weeks after Redhaven	W 14
	W 43
	Super Queen

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cy break. The classification of individual cultivars into the aforementioned groups was then based on the number of weeks of detection of dormancy break either before or after the date of the February 1. In cultivars with an early break of dormancy this phenomenon was detected one or two weeks before cv. Redhaven. This group included the cvs W 13, Royal Glory, Rubinovyj 7, Benedicte, Fidelia and Neve. Cultivars classified into the group showing an intermediate break of dormancy (i.e. those in which the end of dormancy was detected in the same week as in the cv. Redhaven) were as follows: Ruby Prince, Venus, Symphony, Fantasia, Spring Belle and Krymchanin. Finally, the group of cultivars with a delayed break of dormancy (i.e. one or two weeks after the cv. Redhaven) involved cultivars W 14, W 43 and Super Queen.

Results obtained in years 2011–2013 indicate that the date of the break of endogenous dormancy is different not only among individual cultivars but also within the same cultivars in different years of study. These differences are caused by many factors, above all by weather conditions existing in individual years; however, effects of some other factors (e.g. rootstock, pedigree, health condition of trees etc.) are also important.

CONCLUSION

The obtained results indicate that the dates of endogenous dormancy break show differences not only among cultivars but also within individual cultivars in different years. This is markedly influenced by different weather conditions existing in individual years. Nevertheless, according to the date of endogenous dormancy break it was possible to classify the studied peach cultivars into three groups: (1) *Cultivars with an early break of dormancy* (W 13, Royal Glory, Rubinovyj 7, Benedicte, Fidelia, and Neve) that finish this period 1–2 weeks before the control cv. Redhaven; (2) *Cultivars with an intermediate break of dormancy* (Ruby Prince, Redhaven, Venus, Symphonie, Fantasia, Spring Belle and Krymchanin) that finish this period in the same week as the control cv. Redhaven and (3) *Cultivars with a delayed break of dormancy* (W 14, W 43 and, Super Queen that finish the period of their dormancy 1–2 weeks after the control cv. Redhaven.

In *P. persica, s*tudies on the development of flower buds are important not only from the viewpoint of breeding and selection but also with regard to their distribution and growing under specific climatic regions. It is also necessary to know the reaction of flower buds to temperatures and other endogenous and exogenous factors.

From the viewpoint of local breeding and selection priorities, cvs W 43 or Super Queen can be recommended because they showed the longest period of dormancy. From the viewpoint of practical growing the cultivars that showed a stable date of dormancy break can be recommended (e.g. W 13 or Royal Glory).

References

Allona I., Ramos A., Ibáñez C., Contreras A., Casado R., Aragoncillo C. (2008): Review. Molecular control of winter dormancy establishment in trees. Spanish Journal of Agricultural Research, 6: 201–210.

Arora R., Rowland L.J., Tanino K. (2003): Induction and release of bud dormancy in woody perennials: a science comes of age. Horticultural Science, 38: 911–921.

Basconsuelo S., Reinoso H., Lorenzo E., Bottini R. (1995): Dormancy in peach (*Prunus persica* L.) flower buds. Plant growth regulation, 16: 113–119.

Bassett C.L., Wisniewski M.E., Artlip T.S., Norelli J.L., Renaut J., Farrell R.E. (2006): Global analysis of genes regulated by low temperature and photoperiod in peach bark. Journal of the American Society for Horticultural Science, 131: 551–563.

Bonhomme M., Rageau R., Richard J.P., Gendraud M. (1997): Dormancy of peach floral buds: biological and tentative biochemical approaches. Acta Horticulturae (ISHS), 441: 167–174.

Chavarria G., Herter F.G., Raseira M.D.C.B., Rodrigues A.C., Reisser C., Silva J.B.D. (2009): Mild temperatures on bud breaking dormancy in peaches. Ciência Rural, 39: 2016–2021.

Fan S., Bielenberg D.G., Zhebentyayeva T.N., Reighard G.L., Okie W.R., Holland D., Abbott A. G. (2010): Mapping quantitative trait loci associated with chilling requirement, heat requirement and bloom date in peach (*Prunus persica*). New Phytologist, 185: 917–930.

Hauagge R., Cummins J. N. (1991): Genetics of length of dormancy period in Malus vegetative buds. Journal of the American Society for Horticultural Science, 116: 121–126.

Horvath D.P. (2009): Common mechanisms regulate flowering and dormancy. Plant Science, 177: 523–531.

Horvath D.P., Anderson J.V., Chao W.S., Foley M.E. (2003): Knowing when to grow: signals regulating bud dormancy. Trends Plant Science, 8: 534–540.

doi: 10.17221/154/2014-HORTSCI

Lang G.A., Early, J.D., Martin G.C., Darnell R.L. (1987): Endo-, para-, and eco-dormancy: physiological terminology and classification for dormancy research. Horticultural Science, 22: 371–377.

Leida C.A. (2012): Molecular aspects of dormancy in peach (*Prunus persica* [L.] Batsch). [Ph.D. Thesis.] University of Valencia, Spain.

Luna V., Reinoso H., Lorenzo E., Bottini R., Abdala G. (1991): Dormancy in peach (*Prunus persica* L.) flower buds. Trees, 5: 244–246.

Németh S.Z., Szalay L. (2012): Quantitative parameters of peach and apricot flower bud development. Acta Horticulturae (ISHS), 962: 253–259.

Prassinos C., Rigas S., Kizis D., Vlahou A., Hatzopoulos P. (2011): Subtle proteome differences identified between post-dormant vegetative and floral peach buds. Journal of Proteomics, 74: 607–619.

Quitt E. (1971): Klimatické oblasti Československa. Praha, Academia.

Ramina A., Colauzzi M., Masia A., Pitacco A., Caruso T., Messina R., Scalabrelli G. (1994): Hormonal and climatological aspects of dormancy in peach buds. Dormancy and the related problems of deciduous fruit trees, 395: 35–46.

Reinoso H., Luna V., Pharis R.P., Bottini R. (2002): Dormancy in peach (*Prunus persica*) flower buds. V. Anatomy of bud development in relation to phenological stage. Canadian Journal of Botany, 80: 656–663.

Rohde A., Bhalerao R.P. (2007): Plant dormancy in the perennial context. Trends Plant Science, 12: 217–223.

Taylor K. (2008): Frost Injury in Peaches, University of Georgia.

Vachůn Z. (2003): Phenophases of blossoming and picking maturity and their relationships in twenty apricot genotypes for a period of 6 years. Horticultural Science (Prague), 30: 43–50.

Yamane H., Ooka T., Jotatsu H., Hosaka Y., Sasaki R., Tao R. (2011): Expressional regulation of PpDAM5 and PpDAM6, peach (*Prunus persica*) dormancy-associated MADS-box genes, by low temperature and dormancy-breaking reagent treatment. Journal of Experimental Botany, 62: 3481–3488.

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