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PRODUCTIVITY, FRUIT QUALITY AND STORABILITY OF SWEET CHERRY CULTIVARS

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1. INTRODUCTION

1.1. International situation of sweet cherry production

The total sweet cherry production of the world ranges between 1.4 and 1.6 million tons. Regarding the growing area, Europe has a leading role as more than 50% of sweet cherry is produced here. The second most important continent is Asia, where, due to the continuously increasing production potential of Turkey, the amount of production exceeded one-fourth of the world production. Most of the sweet cherry in North-America is produced by the USA, where four states produce a total amount of 200 000 tons in the order of Washington, California, Oregon and Michigan. Chile and Argentina have also become significant in the southern hemisphere, where modern, intensive management systems have been set up from European and North-American investments enabling a steadily increasing winter export of sweet cherry due to the lower production costs. The growing areas of the countries most significant in growing, export and import are presented in Figure 1. In the next years, the following tendency can be expected: the total growing area in 2010 will be the same as today. Orchards planted after 2005 will bring significant yields only after 2010, therefore, a significant increase in the produced amount can be expected between 2010 and 2015.

1.2. Situation of the Hungarian sweet cherry production

Based on the most recent data, the average amount of sweet cherry produced in Hungary is around 10-12 thousand tons. The total area of new orchards planted between 1998 and 2005 with governmental support is 750 ha, out of which the intensive orchards with a plant density above 1000 trees/ha make up for only 3.3%. Unfortunately, in most orchards the ”semi-intensive” spacings of 7 x 5 m and 6 x 4 m were applied. In recent years, the cultivars planted on the largest areas were (in decreasing order): cv.’Katalin’, clones of cv. ’Germersdorfi’, cvs. ’Linda’, ’Kordia’, ’Bigarreau Burlat’, ’Szomolyai fekete’, ’Van’ and ’Margit’. In addition to these, the following foreign cultivars were also planted by the Hungarian producers: cvs. ’Sunburst’, ’Stella’, ’Regina’, ’Valerij Cskalov’, ’Sylvia’, ’Sweetheart’ and ’Krupnoplodnaja’.

2. OBJECTIVES

The aims of our work were the development of the production of some sweet cherry cultivars and the scientific foundation and development of postharvest technology. In our experiments, we aimed to carry out the following tasks:

- Determining the frost sensitivity of flower buds in 11 cultivars using a method applied only in other species before.
- Assessment of the flowering and yields of new cultivars previously not grown and studied in Hungary.
- Determining the pollinators of cv. Regina
- Evaluation of the fruit quality parameters of cultivars previously not grown and studied in Hungary.
- Study of the effect of different storage conditions on the spread of *Monilinia laxa* infection on six cultivars.

3. MATERIALS AND METHODS

3.1. Experimental site and plant material

The orchard at Nagykutas was planted in 2003 with a spacing of 4 x 0.85 m. 15 cultivars were planted on *Prunus mahaleb* rootstock: 'Canada Giant', 'Celeste', 'Chelan', 'Ferrovia', 'Germersdorfi Rigle', 'Katalin', 'Karina', 'Kordia', 'Linda', 'Regina', 'Sam', 'Sandra Rose', 'Sunburst', 'Sylvia' and 'Techlovan'. The two main cultivars of the orchard were cvs. 'Katalin' and 'Regina', every 12th tree in the rows is a pollinator. The soil type of the orchard is brown forest soil with heterogenous spots. The structure of the upper layers is loose and slightly compacted in some places. The water management and water holding capacity of the soil are good. The physical type of the soil is sandy loam, with more loamy layers in some places. The plasiticity index according to Arany is 35. The pH is slightly acidic. The applied production technology, except for irrigation, satisfies the requirements of intensive production. Trees are pruned twice in a year, in the winter and after harvest. The applied crop protection technology fully complies with the rules of integrated crop protection. Fertilizers are applied as foliar fertilizers 10-12 times and soil fertilitzation is performed 2-3 times annually.

The orchard at Siófok was planted in 1999 with a spacing of 6 x 4 m. Six cultivars were planted on *Prunus mahaleb* rootstock: 'Bigarreau Burlat', 'Germersdorfi 3',

'Germersdorfi 45', 'Katalin', 'Linda' and 'Van'. The cultivars are arranged in a block design. The soil of the orchard is calcareous chernozem. The basic rock is loess sand, on which sandy loam layers were formed. The structure of the upper layers is crumb, slightly compacted. The water management and water holding capacity of the soil are good. The depth of the fertile layer is 140-150 cm. The pH of the soil is slightly basic. The physical soil type is sandy loam, with loamy parts in some places. The plasticity index according to Arany is 39. The applied production technology is less intensive as compared to Nagykutas. Trees are pruned once a year during the winter. Integrated crop protection is applied in the orchard, fertilization is applied as soil fertilization.

The soil of the orchard at Vignola is brown forest soil. The water management and water holding capacity of the soil are good. The depth of the fertile layer is 90-100 cm, the pH value of the soil is slightly basic. The orchard was planted in 2002 with a spacing of 4 x 1.5 m on Gisela 5 rootstock. The studied cultivar was cv. 'Regina'.

3.2. Methods

At the climate chamber treatment, the materials were treated at given temperatures for four hours following a pre-cooling. Details of the experiment are included in *Table 1*.

Table 1: Dates of artificial frozing and the applied treatment temperatures (Budapest, 2004-2007)

Date/Treatment	Treatment I. (°C)	Treatment II. (°C)	Treatment III. (°C)
10.12.2004	-17	-19	-20
10.01.2005	-17	-18	-19
11.02.2005	-19	-21	-22
16.03.2005	-18	-20	-21
18.12.2005	-22	-23	-24
16.01.2006	-22	-23	-24
20.02.2006	-18	-19	-20
20.03.2006	-16	-17	-18
22.12.2006	-20	-22	-24
09.01.2007	-19	-21	-23
20.02.2007	-18	-19	-20
14.03.2007	-17	-18	-19

Bud density

The assessments were done during the winter of 2004/2005 and in the spring of 2005. For the assessments, one-year old fruit-bearing parts of different lengths (0-10 cm, 10-20 cm, 20-40 cm and above 40 cm) were collected from dormant trees. Ten shoots of

each type fruit-bearing parts were examined per cultivar. Shoot and bud densities were determined by counting. Values of bud density were given as buds/cm.

Flower phenology and fruit set

We considered the beginning of flowering to be the date when 10% of the flowers on a tree are already open. In full bloom, 80% of all the flowers are open, while the end of flowering is the date when 90% of the petals have fallen. At determining flower set, the amount of flowers on a tree was rated on a scale from 0 to 10. In the free- and self-fertilization study, 5-5 shoots were selected for each cultivar in four repetitions. In the spring of 2007, cross-pollination experiments were carried out at the experimental orchard of the University of Bologna at Vignola. During the experiment the previously castrated flowers of cv. 'Regina' were pollinated by the pollen of 14 cultivars.

Fruit quality

When determining fruit size, the methods used in the international literature were applied. Fruit diameter (x), fruit height (z), and fruit width (y) were measured using a digital vernier caliper (*Kinex, Atest, Czech Republic*). Fruit weight was measured using a digital scale (*Radwag WPS 210/C/2, Radom, Poland*). For determining the soluble solids content, digital rephractometers were used (*Atago, PAL series, Japan*). The differences between the cultivars were determined by one-way analysis of variance.

Storage

In the artificial Monilia inoculation treatment in 2005 and 2006, the susceptibility of the fruit of six cultivars to *Monilinia laxa* during storage was examined (*Table 2*). By using fruits previously inoculated by *Monilinia laxa,* a compound was made under laboratory conditions, the skin of fruits was injured before the treatment, thereby, we imitated fruit injuries (e.g. cracking, pests, hail). The fruit samples were artificially inoculated using a *Monilinia laxa* solution of 10^5 concentration. The infected fruit were then kept at room temperature until the start of the experiment in order to help the quick spread of the pathogen. In the experiment, stalkless fruit of cvs. 'Celeste', 'Sylvia' and 'Katalin' and fruit of cvs. 'Sunburst', 'Ferrovia' and Regina' with stalk were used which did not receive any pesticide treatment previously. The fruits picked by hand were selected after immediate transport and the uninjured fruit were prepared for storage. Before storage, an infected fruit was placed between the others in the middle of both the plastic boxes

and the papers. The ratio of Monilia infected fruit, that is the spread of the infection, was assessed weekly. Multifactoral analysis of variance was applied for statistical evaluation.

Table 2: Description of the artificial Monilia infection experiment during storage

Code of treatment	Storage method	Storage temperature (°C)	Other applied treatment
I.	plastic box	3±1	-
II.	plastic box	3±1	3 pieces of randomly placed cracked fruits
III.	sheet of paper	3±1	-
IV.	sheet of paper	3±1	3 pieces of randomly placed cracked fruits
V.	plastic box	20±1	-
VI.	plastic box	20±1	3 pieces of randomly placed cracked fruits
VII.	sheet of paper	20±1	-
VIII.	sheet of paper	20±1	3 pieces of randomly placed cracked fruits

3.3. Weather

The weather of the different years is described based on the measurement of the National Meteorological Service. 2004 was more rainy and had higher mean temperature than the average. The differences in temperature of the months as compared to normal values ranged between a tight interval, as regards precipitation the (mainly positive) differences were larger. 2005 was somewhat colder and 20% rainier than the average of many years, but the monthly values of precipitation were highly variable. In 2006, the temperature was 0.6°C higher, while precipitation was less than the average of many years, however, the monthly values of both parameters were very variable. The evaluation of the data from 2007 has not been done yet by the National Meteorological Service, therefore, detailed analyses are available only for the daily minimum and maximum temperatures.

4. RESULTS

4.1.1. Frost tolerance of flower buds in artificial freezing tests

In the complex evaluation of cultivars, the results of the different examinations performed at different dates and temperatures were taken into consideration. For the characterization of the cultivars according to their frost sensitivity, the above described percentage evaluation was used. In order to avoid false conclusions due to the different

growing site, condition and age, the different cultivars were evaluated separately for the two growing sites (*Table 3a and 3b*).

Based on the experiments at Nagykutas, the six cultivars can be classified into three groups. The only cultivar belonging to the first group is cv. 'Regina', which proved to be the most resistant to artificial freezing. The second group consists of three cultivars: 'Kordia', 'Ferrovia' and 'Katalin'. These cultivars are of medium frost tolerance. Cv. 'Kordia' proved to be the most tolerant during true dormancy while cv. 'Ferrovia' was most tolerant at the beginning of dormancy and during the post-dormancy period. For cv. 'Katalin' good frost tolerance was observed at the end of the examination period, in February and March, in the starting period the sensitivity of the cultivar was relatively high. The more sensitive cultivars (cvs. 'Sunburst' and 'Celeste' in our study) belong to the third group.

In the experiments at Siófok, four groups could be differentiated for the six studied cultivars. Cv. 'Linda' was the most resistant to frost especially in December and January that is during true dormancy. Cvs. 'Katalin', 'Germersdorfi 45' and 'Germersdorfi 3' belong to the second group with average frost sensitivity. Cv. 'Katalin' proved to have a good frost tolerance in the last stage of dormancy and during the post-dormancy period in the spring similarly to cv. 'Germersdorfi 45'. The frost tolerance of cv. 'Germersdorfi 3' shows an opposite pattern to that of the two others. Cvs. 'Bigarreau Burlat' and 'Van' had similar frost sensitivity during true dormancy, a statistically significant difference was observed during post-dormancy. In this period, cv. 'Bigarreau Burlat' proved to be much more sensitive.

Table 3a: Summary of the three-year frost tolerance study at Nagykutas (2004 - 2006)*

	Nagykutas				
Date/ Cultivar	**December**	**January**	**February**	**March**	**Mean**
Celeste	29,5 b	26,8 b	30,5 bc	46,2 bc	33,3 c
Ferrovia	19,1 a	12,9 a	32,2 c	41,2 b	26,4 b
Katalin	27,8 b	21,4 b	22,0 b	39,6 b	27,7 b
Kordia	21,4 a	6,7 a	25,8 b	49,6 c	25,9 b
Regina	20,4 a	10,2 a	15,3 a	30,5 a	19,1 a
Sunburst	35,5 c	19,7 b	29,3 bc	52,3 c	34,2 c

**different letters in the same column indicate significant difference at p=0.05*

Table 3b: Summary of the three-year frost tolerance study at Siófok (2004 - 2006)*

Date/ Cultivar	Siófok				
	December	January	February	March	Mean
B. Burlat	29,6 ab	34,8 c	35,1 d	68,8 c	42,1 c
Germ. 3	19,1 a	18,8 ab	17,5 c	44,5 b	25,0 b
Germ. 45	24,0 a	17,1 ab	5,7 a	39,8 b	21,7 b
Katalin	27,9 ab	20,7 b	12,5 b	24,2 a	21,3 b
Linda	22,8 a	11,0 a	5,5 a	26,4 a	16,4 a
Van	36,1 b	34,5 c	45,1 e	82,1 d	49,5 d

**different letters in the same column indicate significant difference at p=0.05*

4.1.2. Bud density

There were significant differences between the cultivars in bud density. The difference between some cultivars exceeded 50%. The highest flower bud density was measured on cv. 'Bigarreau Burlat'. The cultivar had the highest values in all size categories. Cv. 'Germersdorfi 3', similarly to cv. 'Germersdorfi 45', was in the second half of the rank in all size categories except for one case. For cv. 'Katalin', the measured values were around the average of the six cultivars in all size categories. Cv. 'Linda' had one of the lowest bud densities among the studied cultivars. Cv. 'Van' showed the second highest bud density in the case of 40 cm shoots, but for longer fruit-bearing parts, the number of flower buds drastically reduced and was the lowest for the studied cultivars. For shoot buds, there were large differences as compared to flower buds. For 0-10 cm shoots, the highest values were measured for the two Germersdorf clones and cvs. 'Katalin' and 'Van'. Cvs. 'Bigarreau Burlat' and 'Linda' were statistically different from the above ones. In the case of fruit-bearing parts of 10-20 cm length, cvs, 'Van' and 'Germersdorfi 3' had a high shoot bud number. Cv. 'Van' was in the first place also for shoots of 20-40 cm length, while cv. 'Linda' had the smallest number of shoot buds in this category. In the case of fruit-bearing shoots longer than 40 cm, no significant differences could be observed between the cultivars. It can be stated that the shorter the fruit-bearing part, the relative number of flower buds on it is the higher, that is the number of flower buds per cm is inversely proportional with the length of the fruit bearing part. In the experiment at Nagykutas, the data of fruit-bearing parts of 0-10cm showed that cv. 'Ferrovia' had the highest flower bud density, however, in the next size category this

cultivar had the lowest number of flower buds per cm. Cv. ’Katalin’ had the highest flower bud density. In the size category of 20-40 cm, the lowest and highest number of flower buds was observed again on cv. ’Ferrovia’ and cv. ’Katalin’, respectively. In the category above 40 cm, no statistically significant differences were observed. In the case of shoot buds, such great differences could not be observed as in the case of flower buds. A considerable difference was observed only for shoots of 0-10 cm length, where the highest (0.48 shoot bud/cm) and lowest (0.28 shoot bud/cm) bud density values were observed for cv.’Ferrovia’ and cv. ’Kordia’, respectively.

4.1.3. Flower phenology observations

Nagykutas

In 2005, the earliest start of flowering among the studied cultivars was recorded for cv. ’Celeste’ at Nagykutas. The first flowers of cvs. ’Ferrovia’, ’Kordia’ and ’Sunburst’ appeared also early. Based on the data of 2005, the cvs. ’Chelan’, ’Synfony’, ’Canada Giant’, ’Linda’ and ’Sandra Rose’ are of early-medium flowering. Cvs. ’Kavics’, ’Regina’, ’Sam’ and ’Techlovan’ were classified as medium-late flowering ones, while cvs. ’Germersdorfi Rigle’, ’Karina’ and ’Sylvia’ were of late flowering. Due to the weather conditions during flowering in 2005, the difference between cultivars in the beginning of the main phase of flowering was only 5 days, while the difference in the end of flowering was 7 days. This was due to the cold and rainy weather during the second half of flowering resulting in a prolonged flowering. The length of flowering was 13 days which can be considered an average length. Due to the high temperatures at the beginninh of April in 2006, a rapid flowering occurred, therefore, this year was not suitable for a proper study of the differences between the cultivars in flowering time. We could only conclude that cvs. ’Celeste’, ’Chelan’, ’Canada Giant’, ’Ferrovia’, ’Katalin’, ’Kordia’, ’Linda’, ’Sylvia’ and ’Sunburst’ started flowering earlier than cvs. ’Kavics’, ’Sam’, ’Sandra Rose’, ’Synfony’, ’Techlovan’, ’Germersdorfi Rigle’, ’Karina’ and ’Regina’. The differences in the beginning and the end of flowering in 2006 were only 3 and 4 days, respectively. In 2007, the start of flowering was early at Nagykutas due to the very different winter and spring weather as compared to the usual weather. Weather during flowering was normal, therefore, the extreme temperature values of the previous period did not have an effect on the length of flowering. The differences observed in the previous two years between the cultivars were also recorded this year.

It was apparent especially for the late flowering cultivars as the differences between them remained more obvious than for cultivars with early flowering.

Siófok

When analyzing the results of 2005, it can be stated that cv. 'Bigarreau Burlat' was the first to cultivar to start flowering, which is in agreement with literature data. Cv. 'Bigarreau Burlat' was followed by cv. 'Van', which was also flowering early. The other four cultivars, which can be classified as medium-late flowering based on the data of 2005, started flowering later. The difference between the earliest and latest start of flowering was four days. The difference between cultivars observed in the beginning of the flowering also remained for the end of flowering. Cv. 'Bigarreau Burlat' was the first to finish flowering followed by cv. 'Van'. The average length of flowering in 2005 was 12 days. The differences in the beginning of flowering in 2006 were much higher as compared to those of the previous year, but these differences disappeared by the end of the flowering due to the warm and dry weather. Similarly to 2005, cv. 'Bigarreau Burlat' was the first to start flowering followed by cv. 'Van'. Cv. 'Katalin' started to flower especially late in 2006, almost one week later than the first cultivar. At the main stage of flowering the differences were smaller. Regarding the end of flowering, the order of cultivars remained the same as at the beginning of flowering, however, the differences were much smaller. In 2007, the flowering of sweet cherry cultibars started earlier than in the previous years. This was due to the high temperatures in early spring, which resulted in an earlier start of the vegetation period. The flowering of sweet cherry started 4-5 days earlier in 2007 than usual and this difference has remained the same until the end of flowering megmaradt.

4.1.4.1. Cross-pollination of cultivars

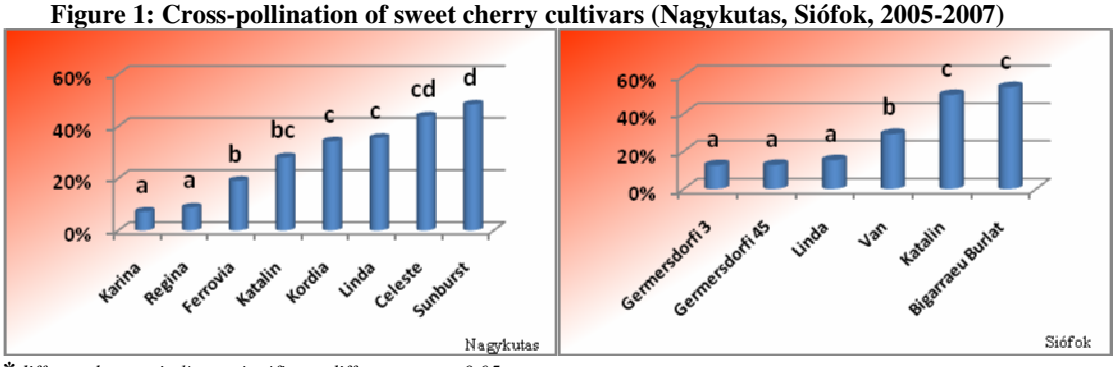
At Nagykutas, the best cross-pollination results were measured on two self-fertile cultivars, 'Celeste' and 'Sunburst', where fruit set was above 40% in the average of two years, which resulted in a very high yield. High cross-pollination values were measured also for cvs. 'Katalin' and 'Linda' among the not self-fertile cultivars. The worst cross-pollination values were recorded for cvs. 'Regina' and 'Karina' with average values of 5% and 6%, respectively. The worst fertilization values on fruit-bearing parts of 0-10 cm length were obtained for cvs. 'Regina', 'Karina', 'Ferrovia' and 'Katalin'. Cross-pollination on all these cultivars was below 20%. On the other hand, this value was

above 40% for the other four cultivars. In the size category of 10-20 cm similar values were obtained, fre fertilization values above 50% were recorded on 3 cultivats (’Linda’, ’Celeste’ and ’Kordia’). For fruit-bearing shoots of 10-20 cm length, even cv. ’Katalin’ showed an average value (25.2%). Very low values were measured in the case of cvs. ’Ferrovia’ and ’Regina’ (7.1% and 7.4%). In the 20-40 cm category, the highest cross-pollination values were observed on cvs. ’Linda’, ’Kordia’ and ’Sunburst’. Very low values were measured for cvs. ’Ferrovia’ and ’Regina’. In the case of fruit-bearing shoots longer than 40 cm, cvs. ’Katalin’, ’Celeste’, ’Kordia’ and ’Sunburst’ were characterized by high fruit set data, while the cross-pollination values of cvs. ’Ferrovia’, ’Regina’ and ’Karina’ were low. The fertilization of the free-pollinated flowers was varying between the studied cultivars. The cultivars were classified into groups based on their cross-pollination values:

low	–	fruit set below 20%
medium	–	fruit set between 20 and 30%
high	–	fruit set above 30%

The degree of cross-pollination was low on cvs. ’Karina’, ’Regina’ and ’Ferrovia’ at Nagykutas. A medium-level cross-pollination was measured for cv. ’Katalin’. The fertilization of free-pollinated flowers was high for the self-sterile cvs. ’Kordia’ and ’Linda’ and the self-fertile cvs. ’Celeste’ and ’Sunburst’. Based on the experiments at Siófok, cvs. ’Germersdorfi 3’, ’Germersdorfi 45’ and ’Linda’can be characterized by low cross-pollination values. The fertilization of the free-pollinated flowers of cv.’Van’ was medium. Cvs. ’Katalin’ and ’Bigarreau Burlat’ can be classified into the high fruit set group with their cross-pollination values higher than 40% (*Figure 1*).

Figure 1: Cross-pollination of sweet cherry cultivars (Nagykutas, Siófok, 2005-2007)



**different letters indicate significant difference at p=0.05*

4.1.4.2. Self-fertilization of cultivars

The degree of self-fertilization was studied on all cultivars between 2005 and 2007. In agreement with former literature data, fruit set was observed only on self-fertile cultivars (’Celeste’ and ’Sunburst’). No fruit set was observed in the other cultivars. The degree of fertilization was different for the two self-fertile cultivars. The fertilization percentage was around 10% in all three years, the number of set fruit was slightly higher on cv. ’Sunburst’ than on cv. ’Celeste’ in all years of the experiment. The difference between the two cultivars was significant in 2005 and 2007.

4.1.4.3. Controlled cross-pollination

When analyzing the obtained results, we could state that most of the cultivars involved in the experiment were not suitable for a proper pollination of cv. ’Regina’. There were two exceptions, cvs. ’Sam’ and ’Skeena’, where the ratio of mature fruit was above 20% that is the amount of fruit from pollination by these two cultivars was sufficient for ensuring a high yield. The suitability of three other cultivars, ’Sylvia’, ’Giorgia’ and ’Badacsony’, for pollinating cv. ‘Regina’ was of medium level with fertilization values of 15.0%, 13.4% and 11.0%, respectively.

4.2. Fruit quality

The studied cultivars were classified into groups based on their fruit diameter. When determining the categories, we used a different approach than the previously applied one, as we are convinced that the most recent market requirements and the new cultivars call for a change. Our categories were as follows:

very small fruit size	-	fruit diameter below 20 mm
small fruit size	-	fruit diameter between 20 and 24 mm
medium fruit size	-	fruit diameter between 24 and 26 mm
large fruit size	-	fruit diameter between 26 and 28 mm
very large fruit size	-	fruit diameter above 28 mm

Cvs. ’Kordia’, ’Chelan’, ’Bigarreau Burlat’ and ’Van’ have a small fruit size. Cvs. ’Celeste’, ’Ferrovia’, ’Linda’, ’Sunburst’ and ’Sylvia’ have medium fruits. Cvs. ’Canada Giant’, ’Karina’, ’Katalin’, ’Sam’, ’Sandra Rose’, ’Germersdorfi 45’ and ’Linda’ produce large fruits. Fruit of cvs. ’Regina’ and ’Germersdorfi 3’belong to the very large fruit size category (*Table 4.a/b*).

Table 4/a: Fruit quality parameters of sweet cherry cultivars (Nagykutas, 2005-2007)*

CULTIVAR	Fruit diameter (mm)	Fruit height (mm)	Fruit width (mm)	Fruit mass (g)
Canada Giant	27,09e	26,04e	22,11cd	8,96d
Celeste	24,64c	20,94a	21,04b	7,38b
Chelan	23,74b	21,81b	19,97a	6,25a
Ferrovia	25,58d	23,78d	22,20cd	8,17c
Karina	26,40de	24,22de	21,88c	8,71d
Katalin	26,60e	25,45e	23,25e	9,78e
Kordia	22,85a	22,74c	19,55a	6,24a
Linda	24,69c	22,63c	21,34b	8,00c
Regina	28,11f	26,72f	23,29e	11,12f
Sam	26,11de	23,80d	21,81c	8,20c
Sandra Rose	26,59e	21,64b	22,58d	8,56cd
Sunburst	25,33cd	22,61c	22,05cd	8,06c
Sylvia	25,63d	23,39cd	21,89c	8,32cd

**different letters in the same column indicate significant difference at p=0.05*

Table 4/b: Fruit quality parameters of sweet cherry cultivars (Siófok, 2005-2007)*

CULTIVAR	Fruit diameter (mm)	Fruit height (mm)	Fruit width (mm)	Fruit mass (g)
Bigarreau Burlat	23,93a	22,05b	19,47a	6,56a
Germersdorfi 3	28,55c	26,19d	24,58c	11,13c
Germersdorfi 45	27,72c	25,65d	24,06c	10,43c
Katalin	26,36b	25,82d	23,10b	9,59b
Linda	26,39b	23,74c	22,59b	9,43b
Van	23,85a	21,21a	20,27a	6,83a

**different letters in the same column indicate significant difference at p=0.05*

Table 5: Fruit width and fruit height values calculated from the observed data of the studied cultivars expressed in proportion to fruit diameter (Nagykutas and Siófok, 2005-2007)

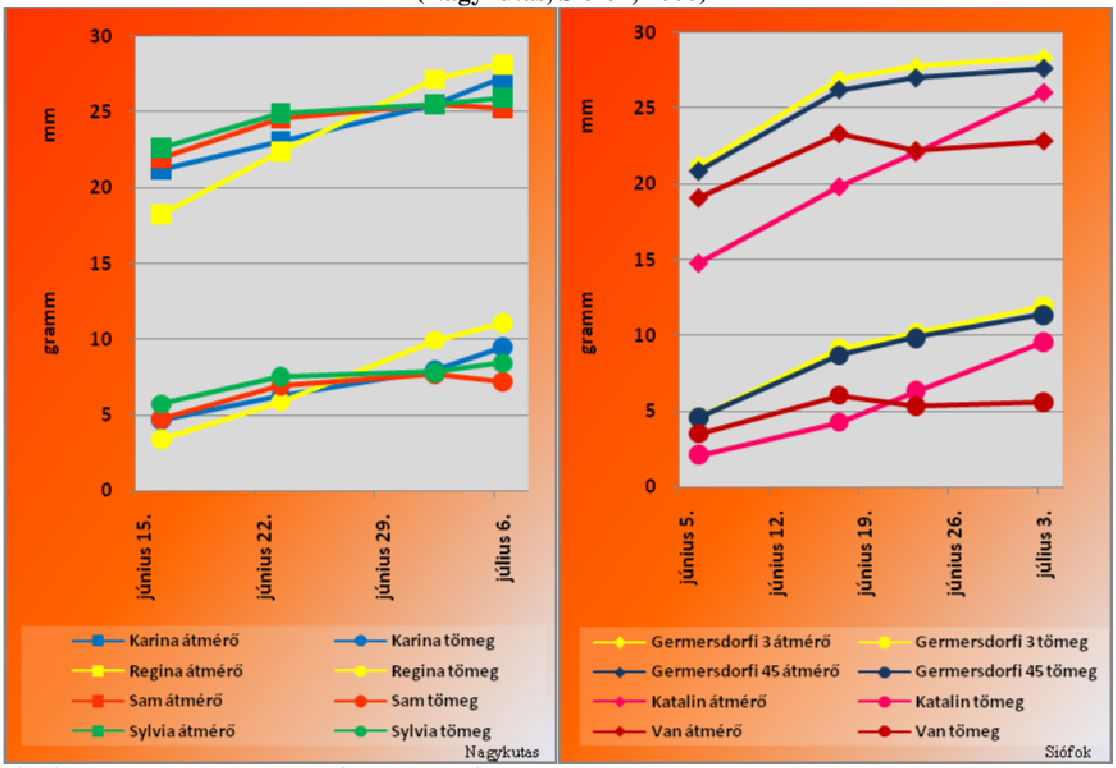
Cultivar	Fruit height*	Fruit width**	Orchard
Canada Giant	0,816	0,961	
Celeste	0,854	0,850	
Chelan	0,841	0,918	N
Ferrovia	0,868	0,930	A
Karina	0,829	0,917	G
Katalin	0,874	0,957	Y
Kordia	0,856	0,995	K
Linda	0,864	0,916	U
Regina	0,828	0,950	T
Sam	0,835	0,912	A
Sandra Rose	0,849	0,814	S
Sunburst	0,870	0,893	
Sylvia	0,854	0,912	
Bigarreau Burlat	0,814	0,921	S
Germersdorfi 3	0,861	0,917	I
Germersdorfi 45	0,868	0,925	Ó
Katalin	0,876	0,980	F
Linda	0,856	0,900	O
Van	0,850	0,889	K

**$SD_{1\%}$=0,0112 represents significant differences between cultivars*

*** $SD_{1\%}$=0,0248 represents significant differences between cultivars*

By using the three parameters describing the size of a fruit, a table was prepared for the characterization of fruit shape. When determining fruit shape, fruit diameter was considered as the basic unit and the fruit witdh and height values were given as a proportion of this value. The obtained results are presented in *Table 5*.

Figure 2: Changes in fruit diameter and weight during the ripening of sweet cherry (Nagykutas, Siófok, 2006)*



***átmérő – diameter; tömeg – mass; június – June; július – July**

Similarly to 2005, fruit growth during ripening was also studied in 2006. As demonstrated by *Figure 2*, a significant change was observed in fruit size and fruit weight in all cultivars during the three-week period. The largest difference was observed for the late-maturing cv. 'Regina', however, a considerable increment was observed also after the ideal maturity stage in several cultivars. However, it should be noted that the increase in size and weight was not always accompanied by an improvement of other fruit quality parameters. Flesh firmness of over-ripened fruit started to reduce in most cultivars, but the higher soluble solids content can be mentioned as a positive feature.

The year had a significant effect on the soluble solids content of cultivars in all year, therefore, the values of the cultivars were given as the average of three years. In this way, the year effect is reduced and the cultivars are characterized more precisely (*Table 6*).

Table 6: Dry matter content of sweet cherry cultivars (Siófok és Nagykutas, 2005-2007)

Cultivar	Orchard	Brix (%)	Cultivar	Orchard	Brix (%)
Canada Giant	*Nagykutas*	14,0	*Sam*	*Nagykutas*	14,3
Celeste		16,6	*Sandra Rose*		15,4
Chelan		16,6	*Sunburst*		15,0
Ferrovia		15,3	*Sylvia*		13,5
Karina		14,3	*Bigarreau Burlat*	*Siófok*	13,5
Katalin		16,1	*Germersdorfi 3*		17,4
Kavics		15,4	*Germersdorfi 45*		17,7
Kordia		16,1	*Katalin*		17,3
Linda		14,8	*Linda*		19,4
Regina		15,1	*Van*		17,3

4.3. The effect of storage on brown rot infection of fruit

The length of the storage period had a significant effect on the spread of brown rot infection, however, the effect differed between cultivars and treatments. In the average of treatments, only 4.6% of the fruit of cv. 'Regina' were infected by brown rot after seven days of storage, with this value, it was the most resistant cultivar. Cv. 'Sunburst' also showed low infection, the value of 6.5% was not significantly different from that of cv. 'Regina'. Cv. 'Celeste' was the most susceptible to brown rot. Significant differences were observed between fruit stored with and without stalk (7.1% and 26.8%), however, this was mainly due to the bad results of cv. 'Celeste'. The two treatment temperatures also had an effect on the spread of brown rot infection. During storage at the lower temperature, only 6.9% of the fruit were infected, while at room temperature, the ratio of infected fruit was 27.1%. Afert one week of storage, no significant differences could be observed between the samples stored in boxes and on paper sheets at either temperature. On the contrary to our expectations, the presence of cracked fruit did not influence the spread of brown rot infection (*Table 7*).

After two weeks of storage, the least susceptible cultivar was cv. 'Regina', where the degree of infection was only 8.8% in the average of the treatments. Three other cultivars were also showing a slower spread of infection, these were cvs. 'Sunburst', 'Ferrovia' and 'Katalin'. Less than 20% of the fruit were infected in these cultivars. The values of cv. 'Celeste' remained high, which proved a further spread of the infection. The difference in the level of infection between the fruit stored with and without stalk increased with storage exceeding 20%. Temperature had a stronger effect on the spread of brown rot infection than the above treatment. The difference in the infection between

fruit stored at 3±1°C and 20±1°C was higher than 30%. There was no significant difference in the infection between fruit stored in boxes and on paper sheets. No difference was observed due to the presence of cracked fruit either (*Table 8*).

After 21 days of storage, the lowest infection was still recorded on fruit of cv. 'Regina'. The rate of infection was the lowest, 3.4% also in the case of this cultivar. Low values of spread were measured also in the case of cvs. 'Sunburst' and 'Celeste'. However, while this meant a low infection level for the former one, the latter showed the worst results among the six cultivars. The percentage of infection was 22.5% and 52.3% for fruit stored with and without stalk, respectively, that is the diference was almost 30%. The difference between fruit stored at different temperatures furtjer increased, the number of infected fruit was three times higher at 20±1°C than at the lower temperature. After three weeks of storage, a significant difference was observed between the fruit samples stored in boxes and on paper sheets in the treatment at room temperature. No effect of cracked fruit could be detected (*Table 9*).

At the last assessment date, the lowest and highest infection values were measured for cvs. 'Regina' and 'Sunburst' and cvs. 'Sylvia' and 'Celeste', respectively. While 22.4% of the fruit were infected in the case of cv. 'Regina', three-fourth of the fruit were infected by brown rot in the case of cv. 'Celeste'. The difference in infection between the fruit stored with and without stalk did not increase as compared to the previous assessment. The same can be stated about the effect of the two treatment temperatures. This was also valid for the brown rot infection of fruit stored in boxes and on paper sheets at a lower temperature, however, the difference between fruit stored in boxes and on paper sheets increased at room temperature. On the contrary to the above, an effect of cracked fruit could be detected, infection was lower where fruit were uninjured as compared to the treatment where cracked fruit were also present (*Table 10*).

Table 7: Rate of infected fruits affected by treatments after 7 days*

After 7 days of storage		3±1°C				20±1°C					
		box		flat		box		flat			
		no cracked fruit added	3 cracked fruits	no cracked fruit added	3 cracked fruits	no cracked fruit added	3 cracked fruits	no cracked fruit added	3 cracked fruits		
with stem	Regina	1,4a	1,5a	2,4a	2,4a	0,0a	2,0a	9,5a	17,5a	*4,6a*	***7,1a***
	Ferrovia	2,7a	3,1a	2,7a	5,0ab	12,5a	18,6a	17,4a	20,1a	*10,3a*	
	Sunburst	2,2a	4,9a	3,4a	7,8b	9,8a	0,0a	6,2a	17,7a	*6,5a*	
without stem	Katalin	1,7a	1,6a	2,7a	7,6b	16,0a	12,4a	24,5b	21,5a	*11,0a*	***26,8b***
	Sylvia	3,3a	2,9a	3,5a	6,0ab	29,5b	41,1b	24,1b	29,4a	*17,5a*	
	Celeste	25,8b	22,6b	27,0b	20,4c	96,6c	99,0c	58,3c	66,8b	*52,1b*	
		6,2x	*6,1x*	*7,0x*	*8,2x*	*27,4x*	*28,9x*	*23,3x*	*28,8x*	**	
		6,1x		**7,6**x		**28,1**x		**26,1**x		***	
		6,9x				**27,1**y				****	

Table 8: Rate of infected fruits affected by treatments after 14 days*

After 14 days of storage		3±1°C				20±1°C					
		box		flat		box		flat			
		no cracked fruit added	3 cracked fruits	no cracked fruit added	3 cracked fruits	no cracked fruit added	3 cracked fruits	no cracked fruit added	3 cracked fruits		
with stem	Regina	1,4a	1,5a	2,4a	4,6a	0,0a	6,3a	19,2a	35,0a	*8,8a*	***13,6a***
	Ferrovia	7,0a	6,5a	5,0a	8,4a	22,6a	26,5a	29,2a	38,8a	*18,0ab*	
	Sunburst	3,2a	6,6a	5,0a	9,3a	17,7a	32,0a	12,0a	25,9a	*14,0ab*	
without stem	Katalin	2,5a	3,5a	2,7a	7,6a	24,9a	25,8a	29,0a	40,0a	*17,0ab*	***36,5b***
	Sylvia	5,9a	5,5a	5,7a	10,1a	43,3b	56,5b	54,9c	60,5b	*30,3b*	
	Celeste	32,2b	35,0b	32,0b	27,3b	99,0c	100,0c	83,3d	88,0c	*62,1c*	
		8,7x	*9,8x*	*8,8x*	*11,2x*	*34,6x*	*41,2x*	*37,9x*	*48,0y*	**	
		9,2x		**10,0**x		**37,9**x		**43,0**x		***	
		9,6x				**40,4**y				****	

**different letters in the same column indicate significant difference at p=0.05*
***different letters in pair in the same row indicate significant difference at p=0.05*
**** different letters in pair in the same row indicate significant difference at p=0.05*
***** different letters in pair in the same row indicate significant difference at p=0.05*

Table 9: Rate of infected fruits affected by treatments after 21 days*

After 21 days of storage		3±1°C				20±1°C					
		box		flat		box		flat			
		no cracked fruit added	3 cracked fruits	no cracked fruit added	3 cracked fruits	no cracked fruit added	3 cracked fruits	no cracked fruit added	3 cracked fruits		
with stem	Regina	1,4a	4,7a	2,4a	7,7a	0,0a	7,2a	28,0a	46,2ab	*12,2a*	
	Ferrovia	9,4a	14,5a	7,2a	12,3ab	67,7b	74,9bc	30,8a	42,5a	*32,4b*	***22,5a***
	Sunburst	5,9a	9,9a	6,6a	11,5a	34,6a	57,7b	23,8a	33,4a	*22,9ab*	
without stem	Katalin	6,1a	4,2a	2,7a	9,4a	92,7bc	93,2c	55,5b	58,6b	*40,3b*	
	Sylvia	11,9a	13,0a	10,0a	19,8b	91,9bc	94,6c	64,7b	64,2b	*46,3b*	***52,3b***
	Celeste	40,9b	45,5b	40,7b	35,2c	100,0c	100,0c	100,0c	100,0c	*70,3c*	
		12,6x	*15,3x*	*11,6x*	*16,0x*	*64,5x*	*71,3x*	*50,5x*	*57,5x*	**	
		14,0x		**13,8**x		**67,9**x		**54,0**x		***	
		13,9x				**60,9**y				****	

Table 10: Rate of infected fruits affected by treatments after 28 days*

After 28 days of storage		3±1°C				20±1°C					
		box		flat		box		flat			
		no cracked fruit added	3 cracked fruits	no cracked fruit added	3 cracked fruits	no cracked fruit added	3 cracked fruits	no cracked fruit added	3 cracked fruits		
with stem	Regina	8,6a	15,0a	6,2a	14,9ab	10,3a	23,6a	42,3ab	58,4b	*22,4a*	
	Ferrovia	14,2a	19,1a	7,2a	13,1ab	95,2c	95,2b	32,5a	43,2a	*40,0b*	***30,1a***
	Sunburst	8,6a	16,3a	6,6a	12,2ab	38,3b	80,1b	24,6a	36,0a	*27,8ab*	
without stem	Katalin	8,4a	5,9a	2,7a	11,8a	100,0c	99,1b	61,2b	61,5b	*43,8bc*	
	Sylvia	16,4a	18,8a	27,1b	23,1b	100,0c	100,0b	69,9b	69,0b	*53,0c*	***57,4b***
	Celeste	46,1b	59,4b	49,5c	48,2c	100,0c	100,0b	100,0c	100,0c	*75,4d*	
		17,1x	*22,4y*	*16,6x*	*20,6x*	*74,0x*	*83,0y*	*55,1x*	*61,4x*	**	
		19,7x		**18,6**x		**78,5**x		**58,2**y		***	
		19,1x				**68,4**y				****	

**different letters in the same column indicate significant difference at p=0.05*
***different letters in pair in the same row indicate significate difference at p=0.05*
**** different letters in pair in the same row indicate significate difference at p=0.05*
***** different letters in pair in the same row indicate significate difference at p=0.05*

5. CONCLUSIONS AND SUGGESTIONS

The experiments covered different areas, accordingly the conclusions and suggestions refer to different processes of sweet cherry production.

Based on our results obtained in the artificial freezing treatment, cvs. ’Regina’ and ’Linda’ can be recommended for growing in Hungary due to their excellent frost tolerance. On the contrary, the planting of cvs. ’Celeste’, ’Sunburst’, ’Bigarreau Burlat’ and ’Van’ should be avoided in areas endangered by frost.

The flower bud densitiy values assessed on the different cultivars and fruit-bearing parts (in addition to growth type) have an essential role in determining the method and strength of pruning. In our opinion, the large differences observed between the cultivars influence the amount of yield and also yield safety.

Results of our flower phenology observations can be utilized well in the planning of orchards. We evaluated foreign cultivars that are new to Hungary, therefore, the flower phenology characteristics have not been known before. The cross-pollination experiments on cv. ’Regina’, similarky to the flower phenology and fertilization experiments, ease the planning of orchards and cultivar associations in the future.

An important achievement is that during our three-year experiments, the fruit quality of 18 cultivars (some of which are new to Hungary) was evaluated under intensive growing conditions. In our opinion, this can contribute to the restructuring of the outdated cultivar assortment of Hungarian sweet cherry production as the experiments were carried out on Prunus mahaleb rootstock, which is most frequently used in Hungary. Our examinations proved that some cultivars produce large and attractive fruit in all years, while there are cultivars which can only produce small fruit under our ecological conditions or due to their genetic traits.

The study of the spread of artificial brown rot infection has great importance for those participating in the distribution of fruit. Our results show the susceptibility of fruit to brown rot infection, in storage with and without stalk, cooled or at room temperature.

6. SUMMARY

1. In our experiments at Nagykutas, we found that the studied six cultivars can be classified into three groups based on their frost tolerance. The first group consists of cv. 'Regina', which proved to be the most resistant to artificial freezing. The members of the second group are cvs. 'Kordia', 'Ferrovia' and 'Katalin'. These cultivars have medium frost tolerance. The sensitive cultivars belong to the third group, cvs. 'Sunburst' and 'Celeste' were such in our study. In the experiment at Siófok, four groups were made. The most tolerant cultivar was cv. 'Linda' which showed very good results in December and January. The second group is that of cultivars with medium frost tolerance including cvs. 'Katalin', 'Germersdorfi 45', and 'Germersdorfi 3'. Cvs. 'Bigarreau Burlat' and 'Van' showed great frost sensitivity during true dormancy, the frost tolerance of cv. 'Bigarreau Burlat' was especially low during post-dormancy.

2. In the experiments at Nagykutas, the highest flower bud density on fruit-bearing parts of 0-10 cm was measured on cv. 'Ferrovia', but in the next size category, the same cultivar had the lowest number of flower buds per cm. Cv. 'Katalin had the highest flower bud density. In the size category of 20-40 cm, the lowest and highest values were measured again on cv. 'Ferrovia' and cv. 'Katalin' respectively. In the category above 40 cm, no significant differences were observed between the cultivars. At Siófok, the difference between certain cultivars was higher than 50%. Here, the largest flower bud density was measured on cv. 'Bigarreau Burlat'. It had the highest values in all size categories. Cv. 'Germersdorfi 3', similarly to cv. 'Germersdorfi 45', was in the second half of the rank in all size categories except for one case. For cv. 'Katalin', the measured values were around the average of the six cultivars in all size categories. Cv. 'Linda' had one of the lowest bud densities among the studied cultivars. Cv. 'Van' showed the second highest bud density in the case of 40 cm shoots, but for longer fruit-bearing parts, the number of flower buds drastically reduced and was the lowest for the studied cultivars.

3. At Nagykutas, the highest cross-pollination was observed for the two self-fertile cultivars, 'Celeste' and 'Sunburst', the fruit set for these exceeded 40% in the average of the two years resulting in very high yields. Among the not self-fertile cultivars, cvs. 'Katalin and 'Linda' showed high cross-pollination with fruit set values of 28% and 40% in the average of two years. Cvds 'Regina' and 'Karma' had the lowest cross-

pollination values with 5 and 6%, respectively. At Siófok, low cross-pollination values were measured for cvs. 'Germersdorfi 3', 'Germersdorfi 45' and 'Linda', while cv. 'Van' showed medium values. Cvs. 'Katalin' and 'Bigarreau Burlat' had high cross-pollination values. Self-fertilization in cvs. 'Sunburst' and 'Celeste' was 10±4% in all three years, the number of set fruit was higher in cv. 'Sunburst' than in cv. 'Celeste' in all years.

4. When analyzing the obtained results, we could state that most of the cultivars involved in the experiment were not suitable for a proper pollination of cv. 'Regina'. There were two exceptions, cvs. 'Sam' and 'Skeena', where the ratio of mature fruit was above 20% that is the amount of fruit from pollination by these two cultivars was sufficient for ensuring a high yield.

5. Regarding fruit diameter, the most important parameter in fruit quality, the highest values were measured in the order of cvs. 'Regina', 'Canada Giant', 'Katalin' and 'Sandra Rose', while cvs. 'Kordia' and 'Chelan' produced the smallest fruit. In the case of fruit weight, cvs. 'Regina', 'Katalin', 'Canada Giant' and 'Karina' had higher than average values. Based on the assessments at Siófok, we could state that cvs. 'Bigarreau Burlat' and 'Van' produce fruit with the smallest size and weight, while the highest values were measured in cvs. 'Germersdorfi 3' and 'Germersdorfi 45'.

6. The length of the storage period had a significant effect on the spread of brown rot infection, however, the effect differed between cultivars and treatments. In the average of treatments, only 4.6% of the fruit of cv. 'Regina' were infected by brown rot after seven days of storage, with this value, it was the most resistant cultivar. , Cv. 'Celeste' was the most susceptible to brown rot, in this cultivar the degree of infection was higher than 50% after only one week of storage in the average of the treatments. A significant difference was observed between the cultivars stored with and without stalk. The two treatment temperatures also had an influence on the spread of brown rot infection. No significant differences were found between the samples stored in boxes and on paper sheets at either treatment temperature. On the contrary to our expectations, the presence of cracked fruit did not have a significant effect on the spread of brown rot infection.

7. NOVEL SCIENTIFIC RESULTS

- Via artificial freezing *in vitro*, we determined the frost tolerance of 11 cultivars grown under intensive conditions by using a method formerly not applied for sweet cherry.
- We asssessed the flower bud and shoot bud densities on the different fruit-bearing parts of sweet cherry cultivars.
- Under intensive production, we recorded the characteristics of flowering and fertilization in sweet cherry cultivars new to Hungary and we determined the fruit set of the free-pollinated flowers on the fruit-bearing shoots of different length for eight cultivars. We determined the ideal pollinators of cv. 'Regina'. Among the cultivars included in the experiment, cvs. 'Sam and 'Skeena' proved to be suitable pollinators for cv. 'Regina'.
- We set up a database, suitable for cultivar selection and preparing cultivar descriptions, from the major fruit quality parameters for cultivars not known in Hungary yet which can be suggested for future production. We described the fruit shape of the examined cultivars under Hungarian conditions.
- For six cultivars, we determined the role of storage temperature, stalk removal at harvest, spatial location and cracked fruit in the spread of brown rot infection during storage.

8. PUBLICATIONS

THURZÓ, S. – RACSKÓ, J. – DANI, M. – DRÉN, G. (2006): Cseresznyefajták gyümölcsminősége félintenzív termesztéstechnológia mellett. Agrártudományi Közlemények 22:76-79.

THURZÓ, S. – SZABÓ, Z. – HOLB, I. – NAGY, J. – FARKAS, E. – DRÉN, G. – RACSKÓ, J. – DANI, M. – NAGY, P. T. – KINCSES, S.-né – VERES, ZS. – NYÉKI, J. (2005): Cseresznyefajták gyümölcsminősége szuperintenzív ültetvényben. Agrártudományi Közlemények, 17:75-81.

THURZÓ, S. - RACSKÓ, J. - DANI, M. - DRÉN, G. - HOLB, I.J. - SOLTÉSZ, M. - NYÉKI, J. - SZABÓ, Z. (2005): Virágrügysűrűség és terméskötődés cseresznyefajták különböző hosszúságú termővesszőin. Kertgazdaság különkiadás: A fajtaválaszték fejlesztése a kertészetben, 79-82.

THURZÓ, S. - HERMÁN, R. - DRÉN, G. - SZABÓ, Z. - RACSKÓ, J. - DANI, M. - SOLTÉSZ, M. - KIRÁLY, K. - NYÉKI, J. (2005): Cseresznyefajták fagytűrőképessége. Kertgazdaság, 37(4):23-29.

THURZÓ, S. – DRÉN, G. – RACSKÓ, J. (2004): Cseresznyefajták szabadtermékenyülésének és gyümölcsminőségének összehasonlító vizsgálata. Acta Agraria Debreceniensis, 16:295-299.

SOLTÉSZ, M. - NYÉKI, J. - SZABÓ, Z. - GONDA, I. - LAKATOS, L. - RACSKÓ, J. - **THURZÓ, S.** - DANI, M. - DRÉN, G. (2005): Alkalmazkodási stratégia az alföldi gyümölcstermelésben a globális gazdasági és klímaváltozás nyomán. "AGRO-21" Füzetek, Klímaváltozás-Hatások-Válaszok. 45:16-28.

SZABÓ, Z. - NYÉKI, J. - DANI, M. - DRÉN, G. - **THURZÓ, S.** - TORNYAI, J. - RACSKÓ, J. - LAKATOS, L. - GONDA, I. - SOLTÉSZ, M. - KIRÁLY, K. - SZALAY, L. - SZÉL, I. (2005): A 2005. januári és februári hőmérsékletingadozás hatása a csonthéjasok virágrügyeire. "AGRO-21" Füzetek, Klímaváltozás-Hatások-Válaszok. 45:159-171.

THURZÓ, S. – DRÉN, G. – DANI, M. – HLEVNJAK, B. – HAZIC, V. – SZABÓ, Z. – RACSKÓ, J. – HOLB, I.J. – NYÉKI, J. (2006): Fruit bearing shoot characteristics of apricot and sweet cherry cultivars in Hungary. Inter. Journ. Hort. Sci. 12(2)107-110.

NAGY, P.T. – **THURZÓ, S.** – VÁGÓ, I. – HOLB, I.J. (2007): Effect of foliar application of K and Ca on leaf and fruit contents in a sweet cherry orchards. Cereal Research Communications. 35(2):817-820.

NAGY, P.T. – **THURZÓ, S.** – KINCSES, I. – SZABÓ, Z. – NYÉKI, J. (2007): Effect of boron fertilization on annual fluctuation of B in sweet cherry leaves and fruit quality. Colar Conference, 149-155.

SOLTÉSZ, M. - NYÉKI, J. - SZABÓ, Z. - LAKATOS, L. - RACSKÓ, J. - HOLB, I. - **THURZÓ, S.** (2006): Az éghajlat- és időjárás-változás alkalmazkodási stratégiája a gyümölcstermelésben. A klímaváltozás és a magyarországi kertgazdaság. „Agro-21" Kutatási Programiroda, Vahava-projekt, Budapest, 11-101.

THURZÓ, S. – NYÉKI, J. – DRÉN, G. – DANI, M. – RACSKÓ, J. – PEDRYC, A. – HERMÁN, R. – SOLTÉSZ, M. – SZABÓ, Z. (2006): A csonthéjas gyümölcsfajok és fajták téli fagytűrése. XII. Növénynemesítési Tudományos Napok : 2006. március 7-8., Magyar Tudományos Akadémia Székháza, Budapest : összefoglalók / szerk. Veisz Ottó.

THURZÓ, S. – SZABÓ, Z. – HERMÁN, R. – PEDRYC, A. – SOLTÉSZ, M. – BALÁZS, G. – NYÉKI, J. (2007): Evaluation of frost tolerance of sweet and sour cherry varieties in artificial freezing tests. 8th International Symposium on Modelling in Fruit Research and Orchard Management, Einsiedeln, Switzerland. Abstracts, 28.

THURZÓ, S. – BALMER, M. – HILSENDEGEN, P. – SILVA, A.P. – GONCALVES, B. – SIMON, G. (2007): Platzempfindlichkeit von Süß- und Sauerkirschsorten an verschiedenen Standorten in Deutschland, Portugal und Ungarn. 44. Gartenbauwissenschaftliche Tagung, Erfurt. Kurzfassungen der Vortrage und Poster. 59.

THURZÓ, S. – DRÉN, G. – ZAHERI, S. – SZABÓ, Z. – SOLTÉSZ, M. – KOCSISNÉ MOLNÁR, G. – NYÉKI, J. (2006): Sweet cherry fruit quality in a Hungarian super-intensive orchard. International Conference of „Perspectives in European Fruit Growing" on Horticulture Faculty in Lednice 2006. Proceedings, 41-43.

THURZÓ, S. – SZABÓ, Z. – NYÉKI, J. – SOLTÉSZ, M. – NAGY, J. – RACSKÓ, J. – DRÉN, G. – VERES, ZS. – SZABÓ, T. – HOLB, I. (2005): Some fruit bearing shoots characteristics of nine sweet cherry cultivars in Hungary. Abstract book, 5th International Cherry Symposium. Turkey, Bursa, Abstracts, 123.

THURZÓ, S. – SZABÓ, Z. – RACSKÓ, J. – DRÉN, G. – DANI, M. – HOLB, I. – NYÉKI, J. (2006): Süßkirschen-Sortenevaluierung unter superintensiven Anbauverhältnissen. 43. Gartenbauwissenschaftliche Tagung, 22-25. Februar 2006, Potsdam. Kurzfassung der Vorträge und Poster, 97.

THURZÓ, S. – SZABÓ, Z. – DANI, M. – RACSKÓ, J. – DRÉN, G. – NYÉKI, J. (2006): Frostwiderstandfähigkeit der Süß- und Sauerkirschenblütenknospen. 43. Gartenbauwissenschaftliche Tagung, 22-25. Februar 2006, Potsdam. Kurzfassung der Vorträge und Poster, 112.

SOLTÉSZ, M. – DRÉN, G. – **THURZÓ, S.** – SZABÓ, Z. – LAKATOS, L. – RACSKÓ, J. – GONDA, I. – SZABÓ, T. – NYÉKI, J. (2007): Adaptation strategy for climate and weather change in Hungarian fruit growing. 44. Gartenbauwissenschaftliche Tagung, Erfurt. Kurzfassungen der Vortrage und Poster. 139.

THURZÓ, S. – GRANDI, M. – LAGEZZA, L. – LUGLI, S. – SANSAVINI, S. (2007): Pollenadók kiválasztása a Regina cseresznyefajta számára. Kertészet és Szőlészet, 56:41.

THURZÓ, S. – NAGY, P.T. – DRÉN, G. – GONCALVES, B. – DA SILVA, A.P. –ROSA, E. (2006): A portugál gyümölcstermesztők is hasonló cipőben járnak. Kertészet és Szőlészet, 55:51-52

THURZÓ, S. - SZABÓ, Z. - MAJOR, M. (2005): Téli fagykárok és a rügysűrűség alakulása cseresznye és meggyültetvényekben. Kertészet és Szőlészet, 54:17.

THURZÓ, S. – SZABÓ, Z. – SOLTÉSZ, M. – NYÉKI, J. (2007): Süßkirschensortenevaluierung. Monatsschrift, Magazin für den Gartenbau-Profi. 95:150.

Ask and it will be given to you; seek and you will find;
knock and the door will be opened to you.
For everyone who asks receives; he who seeks finds;
and to him who knocks, the door will be opened.
Matthew 7:7-8

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