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THE ESTIMATION OF FROST DAMAGE OF SOME PEACH AND SWEET CHERRY CULTIVARS AFTER WINTER 2005/2006

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A B S T R A C T

The winter 2005/2006 was the most severe in Lower Silesia during last 18 years. In January, the temperature fell to –25°C, which could damage peach and sweet cherry trees. A survey was done to estimate frost damages on sweet cherry cultivars: 'Octavia', 'Johanna', 'Bianca', 'Regina' and 'Viola', planted in 1994, and 'Karina', 'Kordia', 'Merton Premier', 'Regina' and 'Summit', planted in 1999. For peach, ten-year-old trees of cultivars: 'Inka', 'Redgold', 'Redhaven', 'Early Redhaven', 'Suncrest' and four-year-old: 'Tenira', 'Early Redhaven', 'Cresthaven' and 'Harnaś' were studied. The extent of frost damage was evaluated on excised shoots following Hołubowicz's method. At the beginning of May, the visual inspection of blooming and fruit set was done in order to estimate the extent of frost damage on generative parts of trees.

The frost at –25°C caused limited damages only in sweet cherry trees. Generally, younger trees were more susceptible to frost than the older ones. The high rate of frost damages was noted on 'Summit' cv. and the lowest on twelve-year-old 'Regina' trees. The frost at –25°C caused very strong damage of one-year-old shoots on peach trees. The visual observation of peach trees at the beginning of May showed a high ability for regeneration of destroyed shoots. The frost at –25°C damaged all flower buds in peach trees whereas sweet cherry blossomed very abundantly and fruit set amounted to 14-58%.

Key words: peach, sweet cherry, cultivar, frost damage, winter

INTRODUCTION

The major factor limiting the cultivation of sweet cherry and peach in Poland is minimal temperature in the winter and spring frosts. In winter, stem, branches and shoots of peach trees are killed at temperatures –25°C and lower, while flower buds are damaged at –20°C (Hołubowicz, 2000). Every few years, frosty winters destroy flower buds and even whole trees (Jakubowski, 1986). The cultivation of sweet cherry is risky too, although serious damages in this species occur at temperature –30°C, which destroys buds and even whole trees (Rozpara, 2003).

From 1989 to 2004, the weather was favourable for yielding of different cultivars of sweet cherry and peach trees in the conditions of Lower Silesia. In the last 47 years, the dangerous winters for sweet cherry and peach trees did not appear often – minimal temperature at –25°C was recorded during five winters only (Fig. 1). The most dangerous were 1984/85 and 1986/87 seasons. In some years, minimal temperature in the winter dropped to –15°C. The last winter (2005/2006) was the first so dangerous for sweet cherry and peach production during last 18 years (Gudarowska and Szewczuk, 2004).

The aim of the presented study was to estimate the damages to vegetative and generative parts of peach and sweet cherry trees after the winter of 2005/2006.

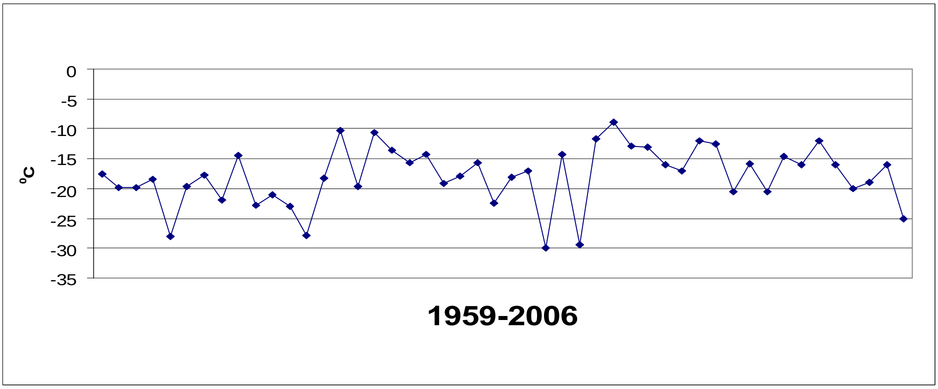

Figure 1. Minimal winter temperatures at the Experimental Station in Samotwór near Wrocław during 1959-2006

MATERIAL AND METHODS

The study of winter damage of peach and sweet cherry trees was carried out in the spring of 2006 at the Fruit Experimental Station belonging to Agricultural University of Wrocław. The Station is located 3 km northwest from the city, at the altitude of 131 m above sea level. This region, called Lowland of Lower Silesia, has the following climatic conditions: average yearly temperature +8.3°C, the coolest month – January with average monthly temperature –1.4°C, the warmest month – July with average monthly temperature +17.6°C, average length of vegetative season – 220-227 days, average sum of rainfall – 592 mm, date of the first autumn frost – October 22nd, date of the last spring frost – April 18th.

The experimental material were 5 sweet cherry cultivars planted in 1994: 'Octavia', 'Johanna', 'Bianca', 'Regina' and 'Viola' and five cultivars planted in 1995: 'Karina', 'Kordia', 'Merton Premier', 'Regina' and 'Summit'. The cultivars were budded on *Prunus avium* rootstock, except of 'Kordia', which was budded on 'Colt' rootstock. Each treatment was represented by four replications – plots of five sweet cherry trees (20 trees of each cultivar). In the case of peach, ten-year-old trees of cultivars: 'Inka', 'Redgold', 'Redhaven', 'Early Red-haven' and 'Suncrest' and four-year-old: 'Tenira', 'Early Redhaven', 'Cresthaven' and 'Harnaś' were studied. The peach trees were grafted on *Prunus persica mandshurica* rootstock. The experiment with peach trees was conducted in a randomized block design with four replications with different number of trees. In case of the older peach trees, the analyses were done on 118 trees of 'Inka', 28 trees of 'Redgold', 54 trees of 'Suncrest', 26 trees of 'Redhaven' and 79 trees of 'Early Redhaven'. To estimate young peach tree damages, 97 trees of 'Tenira', 51 trees of 'Early Redhaven', 29 trees 'Cresthaven' and 72 trees of 'Harnaś' were used (total number of peach trees – 554). In order to evaluate the extent of frost damage, Hołubowicz's method was used (Iwasziniec and Hołubowicz, 1997). One-year-old shoots of peach and sweet cherry trees were excised and kept for 14 days in water at room temperature. Then, the rate of damage was estimated on the longitudinal section of shoots of each cultivar according to the five-point scale, where: 1 – no damage and 5 – all tissues dead (Tab. 1). For tests, 20 representative shoots of each cultivar were used (5 shoots from 4 trees each cultivar cut from central part of a tree).

At the beginning of May, the visual inspection of whole peach trees was carried out. In this part of study, all peach trees were estimated according to 10-point scale, where: 1 indicated 10% shoots in the crown destroyed and 10 - 100% shoots destroyed by winter frost. In order to estimate the extent of frost damage to generative parts of tree, the intensity of blooming was noted as well as fruit set. The intensity of blooming was estimated according to

Table 1. The estimation of frost damage of one-year-old shoots in 5-point scale

Scale	Description of frost damage
1	Undamaged shoot
2	Light damage of shoot butt and punctual change of colour of soft and heart wood
3	The most of shoots destroyed, heart and soft wood are dark and punctual necrosis observed on cambium and bark
4	Only some parts of cambium and phloem are alive and buds, wood and hear are damaged
5	All tissues are destroyed

6-point scale, where 0 indicated lack of flowers, 1 – single flowers on the tree, 2 – several flowers on the tree, 3 – mean abundance of blossoming, 4 – abounding blossoming, 5 – very abounding blossoming (all branches abundantly covered with flowers).

For evaluating fruit set rate on sweet cherry trees, 50 flowers on two branches were counted two times on four trees of each cultivar.

Results were worked out by analysis of variance followed by Duncan's multiple range t-test for mean separation at $P \leq 0.05$.

RESULTS AND DISCUSSION

The analysis of one-year-old shoots, according to Hołubowicz's test, showed that temperature –25°C didn't cause a strong damage in sweet cherry trees (Tab. 2). Only younger trees were moderately susceptible to frost. The highest extent of frost damage was noted on 'Summit' cv. (Tab. 3) and the lowest on twelve-year-old 'Regina' trees (Tab. 2).

In the case of peach trees, the temperature –25°C during winter 2005/2006 caused very strong damage of one-year-old shoots (Tab. 4, 5). Among four-year-old trees, cultivars 'Early Redhaven' and 'Harnaś' were much more damaged by frost than 'Tenira' (Tab. 5).

The visual observation of peach trees at the beginning of May indicated the high ability for regeneration of destroyed peach shoots (Tab. 6, 7). The sweet cherry trees started vegetative growth without any symptoms of frost damage.

The frost at –25°C damaged all flower buds on peach trees, which resulted lost of the crop in 2006 season. This confirmed the results obtained by Jakubowski (2005) in Dąbrowice (Central Poland), where the temperature fall to –25°C in the winter 2002/2003. The obtained results confirmed previous observations that flower buds are more sensitive to low temperatures than leaf buds and are damaged at –20°C, while leaf buds tolerate frost at –25°C (Hołubowicz, 2000; Szewczuk, 2000).

The young sweet cherry trees blossomed very abundantly and fruit set was 14-58%. Among the older trees, cultivar 'Bianca' had the highest fruit set – 56% and cultivars

T a b l e 2 . Frost damage of one-year-old shoots of sweet cherry trees in winter 2005/2006, according to Hołubowicz's test

Cultivar	Degree of frost damage in 1-5 scale**
	Trees planted in 1994
Octavia	1.7 ab*
Johanna	1.7 ab
Bianca	1.8 ab
Regina	1.5 a
Viola	2.0 b

*The means followed by the same letter do not differ significantly P≤0.05 according to Duncan's multiple range t-test
**1 – no damage and 5 – all tissues dead

T a b l e 3 . Frost damage of one-year-old shoots of sweet cherry trees in winter 2005/2006, according to Hołubowicz's test

Cultivar	Degree of frost damage in 1-5 scale**
	Trees planted in 1999
Karina	2.1 a*
Kordia	2.5 b
Merton Premier	2.2 ab
Regina	2.2 ab
Summit	3.0 c

*,**For explanation, see Table 2

T a b l e 4 . F r o s t damage of one-year-old shoots of peach trees in winter 2005/2006, according to Hołubowicz's test

Cultivar	Degree of frost damage in 1-5 scale**
	Ten-year-old trees
Inka	4.1 a*
Redgold	4.5 a
Redhaven	4.3 ab
Early Redhaven	4.2 ab
Suncrest	4.1 a

*,**For explanation, see Table 2

T a b l e 5 . Frost damage of one-year-old shoots of peach trees in winter 2005/2006, according to Hołubowicz's test

Cultivar	Degree of frost damage in 1-5 scale**
	Four-year-old trees
Tenira	3.9 a*
Early Redhaven	4.3 b
Cresthaven	4.2 ab
Harnaś	4.5 b

*, **For explanation, see Table 2

T a b l e 6 . Frost damage of shoots in peach trees crown in winter 2005/2006

Cultivar	Degree of frost damage in 1-10 scale**
	Ten-year-old trees
Inka	1.0 a*
Redgold	1.2 a
Redhaven	1.2 a
Early Redhaven	1.4 a
Suncrest	1.2 a

*means followed by the same letter do not differ significantly at P≤0.05 according to Duncan's multiple range t-test
**1 – 10 % shoots destroyed; 10 – 100% shoots destroyed by winter frost.

Table 7. Frost damage of shoots in peach trees crown in winter 2005/2006

Cultivar	Degree of damage by frost in 1-10 scale**
	Four-year-old trees
Tenira	1.6 a*
Early Redhaven	1.9 a
Cresthaven	1.3 a
Harnaś	1.5 a

*, **For explanation, see Table 6

T a b l e 8 . The intensity of blooming and fruit set in sweet cherry trees in the spring of 2006

Cultivar	Intensity of blooming in 1-5 scale	% of fruit set
Trees planted in 1994		
Octavia	4.9 a*	25 a
Johanna	4.7 a	18 a
Bianca	4.8 a	56 c
Regina	4.8 a	19 a
Viola	4.8 a	43 b

*The means followed by the same letter do not differ significantly at P ≤ 0.05 according to Duncan's multiple range t-test

T a b l e 9 . The intensity of blooming and fruit set in sweet cherry trees in the spring of 2006

Cultivar	Intensity of blooming in 1-5 scale	% of fruit set
Trees planted in 1999		
Karina	4.9 b*	14 a
Kordia	4.6 b	27 a
Merton Premier	3.9 a	27 a
Regina	4.9 b	19 a
Summit	3.8 a	58 b

*For explanation, see Table 8

T a b l e 1 0 . Mean decade temperatures (°C) during November 2005 - January 2006 in Smotwór near Wrocław (South-western Poland)

Temperature	November 2005			December 2005			January 2006	
	decade			decade			decade	
	I	II	III	I	II	III	I	II
Mean decade temperature in 2005/2006	7	3	-0.6	1.2	1.8	-0.6	-2.7	-5.4
Mean multi-year temperature	3.6	3.6	3.6	0.7	0.7	0.7	-0.9	-0.9

'Johanna' and 'Regina' – the lowest (18-19%, Tab. 8). In the case of younger sweet cherry trees, the highest fruit set was noted for 'Summit' – 58% (Tab. 9).

The obtained results confirm previous observations that sweet cherry trees survive the temperature –25°C, if the trees are in the deep dormancy during the high frost. The analysis of the weather conditions from November 2005 to the second decade of January 2006 indicate the gradual fall of temperature. Due to that, the trees correctly acquired high resistance to low temperatures. The temperature fall to –25°C in the third decade of January appeared after long period with low temperatures, when the trees were dormant and hardened.

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OCENA USZKODZEŃ MROZOWYCH KILKU ODMIAN CZEREŚNI I BRZOSKWINI PO ZIMIE 2005/2006

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STRESZCZENIE

Zima 2005/2006 okazała się jedną z najmroźniejszych w ostatnich kilkudziesięciu latach. W styczniu 2006 roku temperatura w okolicach Wrocławia spadła do –25°C. Mogło to spowodować przemarznięcie części wegetatywnych i generatywnych brzoskwini i czereśni. W Stacji Doświadczalnej AR we Wrocławiu przeprowadzono ocenę wpływu niskich temperatur zimą na pędy jednoroczne, całe drzewa oraz części generatywne wybranych odmian brzoskwiń i czereśni, w różnym wieku. Przed rozpoczęciem wegetacji przeprowadzono test przeżyciowy według Hołubowicza. Na początku maja przystąpiono do oceny uszkodzeń drzew brzoskwiń po zimie. W czasie kwitnienia zanotowano obfitość kwitnienia i policzono procent zawiązanych owoców.

Temperatura –25°C nie spowodowała dużych uszkodzeń jednorocznych pędów czereśni. Najwyższy stopień uszkodzeń ocenianych jako graniczna wartość przeżywalności zanotowano dla 7-letnich drzew odmiany ‘Summit’. Najmniejszy stopień uszkodzeń wystąpił na 12-letnich drzewach odmiany ‘Regina’. U drzew brzoskwini temperatura –25°C spowodowała duże uszkodzenie pędów jednorocznych, bez względu na odmianę i wiek. Na drzewach 4- i 10-letnich tylko nieliczne partie miazgi i łyka pozostały żywe, natomiast drewno i rdzeń były zabite. Średnio zmarzło kilkanaście procent pędów w koronie, reszta wznowiła wegetację dobrze regenerując uszkodzenia. Całkowicie natomiast przemarzły kwiaty wszystkich ocenianych odmian, co spowodowało brak plonu. Badane odmiany czereśni kwitły obficie lub bardzo obficie. Drzewa zawiązały od 14 do 58% owoców. Najwięcej (> 50%) zawiązała odmiana ‘Summit’, a wśród drzew starszych odmiany ‘Viola’ i ‘Bianca’.

Słowa kluczowe: brzoskwinia, czereśnia, odmiana, mróz, uszkodzenia, zima