PROTECTION OF GENETIC RESOURCES OF POMOLOGICAL PLANTS AND SELECTION OF GENITORS WITH TRAITS VALUABLE FOR SUSTAINABLE FRUIT PRODUCTION

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WINTER-HARDY APRICOTS AND PEACHES WITH GOOD FRUIT QUALITY IN LATVIA

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A B S T R A C T

Although apricots and peaches are primarily a crop grown in warm countries, they have also been grown in Latvia for the last few decades. The first Latvian breeders to introduce and breed apricots and peaches were P. Upitis at the Horticultural Plant Breeding Experimental Station at Dobele and V. Varna at the Botanical Gardens of the University of Latvia, who started their breeding programs in the late 1940s.

Upitis' material is still used in the breeding program at Dobele. There are two approaches to breeding winter-hardy apricots. The first involves developing hybrids that blossom late, and the second involves developing hybrids with flower buds that have a very long deep dormancy period. The breeding program at Dobele has developed several new apricot hybrids. 'Lasma', 'Daiga', 'Dzintars', 'Ritausma' and 'Velta' blossom late and yield regularly. 'Lasma' also has a long dormancy period. PU-16749 has a long dormancy period and yields at least some fruits every year. 'Lasma', 'Daiga' and 'Velta' have good fruit quality and were registered in Latvia in 1999. The other hybrids will be used to breed for winter hardiness.

The breeding program at the Botanical Gardens of the University of Latvia has developed several apricot and peach hybrids which are relatively winter-hardy and productive in Latvia's climate. The apricot hybrids 'Jausma' and 'Rasa' and the peach hybrids 'Maira' and 'Viktors' are the most promising and were registered in Latvia in 2004.

Key words: *Prunus armeniaca* Mill., *Prunus persica* L., winter hardiness, fruit quality, breeding

INTRODUCTION

Although apricots and peaches are primarily a crop grown in warm countries, they have also been grown in Latvia for the last few decades. Current varieties are not reliable enough for commercial production. Nevertheless, they are grown in more and more home orchards every year because the fruits are delicious and aromatic and contain valuable minerals, carotenoids, pectins and vitamins.

The main factor limiting the range of apricot cultivation is winter hardiness. Although apricots and peaches can survive quite cold winter temperatures, they are frequently damaged by frosts and cold spells which occur after periods of warm weather in the spring. This often happens in regions with unstable, unpredictable temperatures, such as Latvia.

The critical temperature for apricot culture is -20°C, at which more than 60% of the generative buds are damaged (Smykov, 1989). Commercial apricot production is possible only in areas where temperatures drop to -20°C in fewer than 20% of the winters. Commercial apricot production in risky in areas where temperatures drop to -20°C in 20 to 40% of the winters. Commercial apricot production is not feasible in areas where temperatures drop to -20°C in more than 40% of the winters.

In Latvia, commercial apricot and peach production are not possible because temperatures drop to -20°C almost every winter. Latvian breeders have succeeded at developing cultivars and hybrids which survive temperatures as low as -30°C during the deep dormancy phase. However, once the dormancy phase ends, temperatures of only -10°C can be enough to damage flower buds and reduce yield.

The main factor contributing to overall winter hardiness in apricots is the winter hardiness of the flower buds (Klavina and Strazinska, 1986; Moore and Ballington, 1989; Smykov, 1989; Strazinska, 1999). Apricot yields are determined by the hardiness of the generative buds, the length of the deep dormancy period of the buds, and how the buds react to winter thaws and subsequent low temperatures.

At Dobele, the apricot breeding program has focused on developing varieties which flower late and have a very long deep dormancy period.

The apricots grown in Latvia are smaller than the apricots grown in warmer countries. For example, the average weight of Latvian apricots ranges from 21 to 30 grams, with a maximum weight of about 50 grams. The average weight of apricots from Hungary, Rumania, Greece, Italy, France and Turkey is 35 grams, with a maximum weight of about 85 grams (Akca and Sen, 1999; Auergon et al., 1999; Draganesku and Cociu, 1999; Szabo et. al., 1999). However, the flavor of several Latvian apricot cultivars Latvian is comparable to the flavor of apricots grown in warmer countries.

At Dobele, the goal of the apricot breeding program has been to develop varieties with firm, free-stone fruits weighing from 40 to 55 grams, with sweet, juicy, aromatic flesh, low acidity, and a soluble solids content of over 20%.

MATERIAL AND METHODS

Apricot breeding has been carried out at the Dobele Horticultural Plant Breeding Experimental Station and the Botanical Gardens of the University of Latvia since the late 1940s. The apricot hybrids at Dobele were developed by P. Upitis using material from the mountains of Central Asia. The apricot hybrids at the Botanical Gardens were developed by V. Varna using material from the Ukraine, Belarus, the Voronezh district of Russia, and from Horog in the Pamir Mountains. Both Upitis and Varna used *Prunus armeniaca* L. (Strazinska, 1999).

Because the climate in Latvia is not favorable for apricot growing, the main breeding technique used was mass screening of local open-pollinated seedlings. Methodical hybridization with carefully selected parental forms was used less often because the weather during apricot blossoming season is often inclement.

Peach breeding in Latvia was started in 1938 by V. Varna, who grew seedlings from open-pollinated Italian peaches with large fruits. After twenty years of work, he developed ‘Latvijas Persiks’, which belongs to the North China peach group. In Latvia, ‘Latvijas Persiks’ is only moderately winter-hardy, but has been used in later breeding work.

The main breeding technique used in the peach breeding program at the Botanical Gardens of the University of Latvia was controlled crossing. Seedlings from the Botanical Gardens were planted in a greenhouse together with southern varieties such as ‘Vezuvius’, ‘Nikitny’, and ‘Nektarin Belii’. The hybrid seeds from various combinations were then planted in an open field. About 2% of the seedlings survived until they could bear fruit. Later, another technique was used in which the hybrid seeds were grown in pots and not transferred outdoors until they were three years old. This produced seedlings with good, mature shoots. 98% of the seedlings survived until they could bear fruit (Strazinska, 1999). Today, the collection of peach cultivars and hybrids at the Botanical Gardens includes fourth and fifth generation seedlings.

Winter hardiness in apricots was studied at Dobele from 1992 to 1997. The material studied consisted of third, fourth and fifth generation seedlings descended from open-pollinated seedling planted in 1959. The fourth and fifth generation seedlings were mostly open-pollinated seedlings of the most promising genotypes.

The following criteria were applied in selecting the most winter-hardy apricot hybrids:

- Late blossoming period;
- Very long deep dormancy period;
- Low percentage of frozen buds in harsh winters; and
- High yield.

To determine the length of the deep dormancy period, branches were cut and put into a warm room for forcing. This was done starting from the second decade of January, and lasted as long as necessary depending on weather conditions and bud development. The dates of flower bud break were recorded.

Weather conditions varied widely from year to year of the study, which lasted from 1992 to 1999. This provided abundant data for comparison.

The winter of 1992/93 was relatively mild. Air temperatures from January to March were stable and never fell below -15°C. From the first decade April, the daily mean temperatures were over +7°C. During the apricot blossoming period, the daily mean temperatures ranged from +3 to +18°C. Marked daily temperature fluctuations occurred only a few times. Once, the temperature reached +21.2°C during the day, and +2°C at night. Another time, the temperature reached +18°C during the day, and -2°C at night.

In the winter of 1993/94, January was rather warm (about -10°C), and was followed by a very cold February (-21.5°C in the first decade, and -29.6°C in the second decade). The third decade of February and the first decade of March were also colder than normal.

The winter of 1994/95 was mild and without significant temperature fluctuations. The lowest monthly air temperatures were -14°C January, -8.6°C in February, and -5.5°C in March. During the apricot blossoming period in the third decade of April, there were severe temperature fluctuations and snow that did not melt for three days.

The winter of 1995/96 was a typical, stable, continental winter with cold temperatures continuing from the end of December to the end of March. The minimum temperature in February was -36.4°C. Weather conditions were almost ideal during the apricot blossoming period from the end of April to the beginning of May. Most days were sunny with temperatures ranging from +11 to +14°C, without large daily fluctuations.

In the winter of 1996/97, January was cold with temperatures down to -26°C when the apricots were in the deep dormancy period. Mean daily temperatures ranged from -14 to -2°C in February and from -11 to -1°C in March. The first and second decades of April were 2 to 3°C below the normal, though some nights the temperature dropped to -12 to -9°C and snow fell. This had negative effect on flower bud development. At the beginning of the third decade of April, the temperature was about 0°C, but rose to +10 to +12°C by the end of the decade when the apricot blossoming period began. In the first decade of May, the mean air temperature ranged from +7 to +12°C, without large daily fluctuations.

The most promising apricot and peach seedlings were selected on the basis of morphology and phenology, fruit quality, and disease resistance. A total of twenty criteria were used in selecting apricots. The criteria were based on descriptor lists approved by IPGRI (1984) and UPOV (1979) for apricots, and by IPGRI (1985) and UPOV (1995) for peaches. Local reference cultivars were used for comparison.

Eating quality was estimated on the basis of soluble solids content (°Brix).

RESULTS AND DISCUSSION

In Latvia, apricots are not more widely grown because they do not reliably bear fruit, even though the flower bud set is usually abundant. The main factor limiting the productivity of apricot trees in colder climates is the short deep dormancy period (Strazinska, 1999). The blossoming period and the length of the deep dormancy period vary widely from cultivar to cultivar. Most cultivars have a deep dormancy period that ends at the end of January or the beginning of February. Apricots go through a forced dormancy period after the deep dormancy period ends. Depending on the weather in a given year, this forced dormancy period could end as early as the end of January or as late as the end of March (Kaufmane, 1998).

The hybrids selected during this study had very long deep dormancy periods and were not significantly damaged by thawing and subsequent freezing during the third decade of January or the first and second decades of February. 'Lasma' and 'PU-16749' had modest yields even after a winter in which January was warm (-10 to +5°C) and the second decade of February was very cold with temperatures down to -29°C.

The other main factor limiting the productivity of apricot trees in colder climates is the early blossoming period. In Latvia, apricots usually blossom in the third decade of April or the first decade of May. In this study, the earliest blossoming period started on April 18, and the latest blossoming period started on May 10. Depending on the weather, the blossoming period lasts from 12 to 17 days in most years, and can last up to 22 days if the weather is exceptionally cool during the blossoming period.

The delicate blossoms can be damaged if the temperature falls to -0.5 to 3°C during the blossoming period, depending on the genotype (Akca and Sen, 1999; Draganesku and Cociu, 1999; Solovyova, 1967; Strazinska, 1999). The amount of damage also depends on how long the temperature stays below this critical temperature. If the temperature drops to -2.5 to -2°C for only one or two days, the sepals and petals are damaged by frost, but the pistils remain intact. A modest yield is still possible.

Large fluctuations in daily temperature can do even more damage. In 1993, when the weather during the blossoming period was generally favorable, night temperatures dropped to -2°C at one point, damaging 20 to 100% of the flower buds, depending on genotype. Nevertheless, most genotypes at Dobele had good yields that year. Yields may not be significantly reduced even if 20 to 60% of

T a b l e 1 . Characteristics of the best Latvian apricot cultivars

Cultivar/ hybrid	Average fruit weight [g]	Average seed weight [g]	Soluble solids content [%]	Skin color	Firmness	Shape	Separation of stone from flesh	Harvest*	Blossoming period
'Lasma'	27.6 ± 0.9	1.7 ± 0.1	18.2 ± 1.4	light orange	medium firm	rounded	semi-freestone	mid-season	mid-season
'Daiga'	33.6 ± 2.1	2.5 ± 0.2	23.2 ± 1.5	orange	firm	elongated	freestone	late mid-season	mid-season
'Velta'	39.8 ± 1.8	2.3 ± 0.2	22.8 ± 1.6	orange	medium firm	rounded	freestone	mid-season	mid-season
'Ritausma'	23.2 ± 1.8	1.6 ± 0.2	19.4 ± 1.7	dark orange	firm	rounded	freestone	late mid-season	early
'Dzintars'	37.3 ± 2.0	1.9 ± 0.1	20.4 ± 1.9	light orange	medium firm	rounded	freestone	late	late mid-season
'Jausma'	37.2 ± 1.6	2.3 ± 0.1	23.4 ± 1.6	orange	medium soft	rounded	clingstone	late	mid-season
'Rasa'	30.7 ± 1.0	2.1 ± 0.1	20.5 ± 1.4	orange	firm	elongated	freestone	mid-season	late mid-season
'Vita'	25.6 ± 0.7	1.8 ± 0.1	22.6 ± 1.5	yellow	medium soft	rounded	freestone	mid-season	early
'Veldze'	24.9 ± 1.0	1.6 ± 0.1	23.8 ± 1.4	orange-yellow	medium soft	rounded	freestone	mid-season	early
PU-16749	13.6 ± 0.6	1.7 ± 0.1	16.7 ± 1.4	yellow	medium firm	rounded	semi-freestone	late mid-season	early
PU-20955	26.8 ± 1.4	1.8 ± 0.1	18.6 ± 1.8	orange-yellow	medium firm	rounded	freestone	early mid-season	mid-season
PU-15029 ('Krista')	24.6 ± 0.2	1.8 ± 0.1	22.2 ± 1.7	orange-yellow	firm	rounded	freestone	early mid-season	mid-season

* early – third decade of July or first decade of August
mid-season – first or second decade of August
late mid-season – second or third decade of August

the flowerer buds are damaged, especially on trees which have an abundant set of flower buds (Klavina and Strazinska, 1986; Solovyova, 1967).

Based on the percentage of flower bud damage in 1997, the hybrids most tolerant to large fluctuations in daily temperature were 0240329 (20%), 0240851 (32%), and PU-20955 (35%). These hybrids can be used as donors of winter hardiness in future breeding programs.

Regardless of weather conditions, 'Lasma', 'Daiga', 'Ritausma', 'Dzintars', and 'U- 08248' blossomed later than the other hybrids and cultivars in every year of the study. They bore fruit in even the least favorable years.

Winter-hardy genotypes seldom have good fruit quality. Longer deep dormancy periods and later blossoming periods are typical of wild apricot genotypes, which generally have small fruits of inferior quality (Acka and Sen, 1999).

The breeding programs at the Horticultural Plant Breeding Experimental Station at Dobele and the Botanical Gardens of the University of Latvia have developed several apricot genotypes cultivars and hybrids which are relatively adapted to the Latvian climate and have good or satisfactory fruit quality (Tab. 1). Average fruit weight ranges from 13.6 to 39.8 g, average seed weight ranges from 1.6 to 2.5 g, and soluble solids content ranges from 14 to 24%. Most have attractive fruits with good separation of the stones from the flesh.

T a b l e 2. Characteristics of the best Latvian peach cultivars

Cultivar	Average fruit weight [g]	Skin color	Blush	Flesh color	Firmness	Harvest *	Resistance to *Taphrina deformans*
'Maira'	85.7 ± 7.4	yellow	large	white-cream	medium soft	early	low
'Viktors'	84.7 ± 5.2	yellow	medium	white	soft	mid-season	medium
'Ziemeļu Persiks'	67.7 ± 4.3	greenish-cream	medium	white	soft	late	high
'Zelda'	65.0 ± 2.1	greenish-cream	large	white-cream	soft	late mid-season	medium
'Rita'	82.3 ± 7.2	cream-yellow	large	yellow-greenish	soft	late	medium
'Latvijas Persiks'**	97.7 ± 1.5	cream-yellow	medium	yellow	medium	late	medium

* early – third decade of July or first decade of August
mid-season – first or second decade of August
late mid-season – second or third decade of August
late – third decade of August or first decade of September

** can be grown only in a greenhouse

The most promising new apricot cultivars were ‘Lasma’, ‘Daiga’, ‘Velta’, which were registered in Latvia in 1999, and ‘Jausma’ and ‘Rasa’, which were registered in 2004.

Peaches have a long vegetative period and a short deep dormancy period. In peaches, winter hardiness is determined by many factors, including rootstock, temperature and humidity during the previous summer, yield, frequency of winter thaws, temperatures during critical developmental periods in the spring, and disease resistance (Strazinska, 1999).

The breeding program at the Botanical Gardens of the University of Latvia has developed several promising peach cultivars and hybrids (Tab. 2). They are relatively winter-hardy, with good yields of good quality fruit. They are generally resistant to leaf curl (*Taphrina deformans*), the most important peach disease in Latvia. Average fruit weight ranges from 60 to 100 g. Most of these peach cultivars and hybrids have good separation of the stones from the flesh.

The most promising new peach cultivars were ‘Maira’ and ‘Viktors’, which were registered in Latvia in 2004.

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HODOWLA MROZOODPORNYCH I DOBRYCH JAKOŚCIOWO ODMIAN MORELI I BRZOSKWINI NA ŁOTWIE

Edite Kaufmane i Gunars Lacis

STRESZCZENIE

Chociaż morele i brzoskwinie pochodzą z południowych rejonów, uprawiane są na Łotwie od dawna. Pierwszymi propagatorami ich uprawy oraz hodowcami byli: V. Varna z Ogrodów Botanicznych Uniwersytetu Łotewskiego oraz P. Upitis ze Stacji Hodowli Roślin Ogrodniczych w Dobele (Dobele HPBES). Rozpoczęli oni prace hodowlane w końcu lat 40. ubiegłego wieku. Prace te są obecnie kontynuowane w Stacji Dobele opierając się na materiale hodowlanym P. Upitis. Hodowla moreli prowadzona jest w dwu kierunkach, to jest uzyskania późno kwitnących mieszańców oraz mieszańców o długim okresie spoczynku. Wyselekcjonowano 5 późno kwitnących regularnie owocujących odmian: 'Lasma', 'Daiga', 'Dzintars', 'Ritausma' i 'Velta' oraz o wydłużonym okresie spoczynku – 'Lasma' i klon PU-16749, które plonują corocznie. Odmiany 'Lasma', 'Daiga' i 'Velta' rodzą owoce dobrej jakości i zostały wpisane do Rejestru w 1999 roku. Pozostałe klony będą wykorzystane w dalszych pracach hodowlanych.

W wyniku wieloletnich prac hodowlanych prowadzonych w Ogrodzie Botanicznym Uniwersytetu Łotewskiego uzyskano mrozoodporne odmiany moreli i brzoskwini. Najlepsze z nich to morele 'Jausma' i 'Rasa' oraz brzoskwinie 'Maira' i 'Victors'. Odmiany te wpisano do Rejestru w 2004 roku.

Słowa kluczowe: morela, brzoskwinia, mrozoodporność, jakość owoców, hodowla