Seed genotypes for harvesting seeds in the production of generative rootstocks for peach cultivars

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Abstract

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Six novel peach genotypes, designated BN-1, BN-3, BN-4, BN-7, BN-8 and BN-45, were assessed for usefulness as sources of seeds for production of generative rootstocks for peach cultivars. The genotypes BN-8 and BN-1 were the most intensely flowering, while the most abundantly and regularly fruiting genotype was BN-8, which also produced the smallest stones. The smallest fruits and the highest seed yields were produced by the genotypes BN-8 and BN-7. All of the genotypes under assessment produced seeds with higher germination capacities compared with the two control cultivars, Mandżurska and Siberian C, with the seeds of the genotypes BN-8, BN-4 and BN-3 exhibiting the most significantly elevated germination capacities. The most stones with two seeds were produced by the genotypes BN-45 and BN-3; however, produced a smaller fruit crop than did BN-8. Considering the characteristics assessed, the best as a seed source trees was genotype BN-8.

Keywords: breeding; *Prunus persica*; winter hardiness; stratification; germination capacity

Peach [*Prunus persica* (L.) Batsch] is the most important stone fruit species in the world. According to FAOSTAT (2013), the world production of peaches in recent years has reached 21.5 mil. tonnes. The cultivated varieties of peach require the use of rootstocks, which is a very important component of the fruit tree. The rootstocks commonly used for peach cultivars worldwide are generative rootstocks, usually peach seedlings (Room 1983; Rubio-Cabetas 2012). The seedlings are produced from seeds that can be obtained (i) from local peach trees growing in the wild, such as the Vineyard peach that grows in most Balkan countries or the Tennessee Natural and Indian Peaches that grow in North America; (ii) cultivated varieties, the fruit of which are typically processed by the food industry, such as the cvs Halford and Lovel that grow in Canada and the USA; and (iii) specifically selected peach seed genotypes, such as Montclar, which is grown in Europe, Siberian C and Harrow Blood, which are grown in Canada, and Rutgers Red Leaf and Nemared, which are grown in the USA (Room 1983, Layne 1987; Reighard, Loreti 2008; Nikolić et al. 2010).

To be considered a valuable seed source, peach trees should bear fruit regularly and abundantly; thus, they must produce large number of fruit annually, from which stones (seeds) can be harvested for production of generative rootstocks. However, peach is a demanding species in terms of temperature. In Polish climatic conditions, the flower buds of peach trees are often damaged by low subzero temperatures in winter or by spring frosts (Szymajda et al. 2013a). As a result, after some winters, peach trees do not bear any fruit (seeds) or produce very poor yields. Therefore, in countries located in seasonally colder zones with the temperate climates, peach seed orchards should be established with genotypes whose trees are sufficiently winter-hardy to ensure annual fruit bearing and the continuity of seed supplies. The trees of such genotypes should be tolerant to the damage of their flower buds as caused by not only low subzero temperatures during endodormancy but also by temperature fluctuations during ecodormancy. They should also be able to withstand spring frosts, which can damage flower buds and blooming flowers as well as young fruitlets. To address these issues, extensive research is currently underway in Poland with the goal of obtaining seed genotypes for use as rootstock seed sources in the northernmost areas of peach cultivation, such as central Europe.

The aim of this study was to assess the usefulness of several peach genotypes selected in Poland as source trees for seeds and to evaluate these seeds.

MATERIAL AND METHODS

Experimental location and plant materials. The study was conducted at the Research Institute of Horticulture in Skierniewice (central Poland) from 2008 to 2013. The plant material consisted of *Prunus persica* seed trees (genotypes) denoted by the symbols BN-1, BN-3, BN-4, BN-7, BN-8 and BN-45, which were selected at this institute. The control cultivars were *P. persica* Mandżurska and *P. persica* Siberian C, which are widely used in Poland as seed trees for harvesting seeds in the production of generative rootstocks for peach cultivars. Short descriptions of the control cultivars are provided by Layne (1987), Jakubowski (2000) and Czynczyk (2012).

The genotypes BN-1, BN-3, BN-4, BN-7 and BN-45 were selected from a population of seedlings produced from the seeds of cv. Mandżurska (Jakubowski 1991), whereas the genotype BN-8 was selected from a population of seedlings obtained from the seeds of cv. Rakoniewicka, which is a local seed peach cultivar. The selection work on the seed genotypes under assessment in this study was initiated in the late 1970s and early 1980s by Dr. Tadeusz Jakubowski. Detailed measurements and observations were performed on three trees of each seed genotype. All genotypes and control cultivars were grafted onto seedlings of the seed peach cv. Mandżurska and planted at the Experimental Orchard in Dąbrowice (central Poland) in the spring of 2006.

Parameters assessed:

Flowering time (*full bloom*) – the date at which approximately 50% of the flower buds on the tree had reached the open flower stage.

Fruit-ripening time – the date at which approximately 10% of the fruit had undergone skin colour changes from green to whitish or cream, which was accompanied by softening of the flesh and easy separation of the fruit stalk from the fruit-bearing shoot.

Intensity of tree flowering and fruiting – assessed on a 1–9-point rating scale as follows: 1 – lack of flowering or fruiting, 3 – poor flowering or fruiting, 5 – moderate flowering or fruiting, 7 – abundant flowering or fruiting, and 9 – very abundant flowering or fruiting.

Mean fruit weight (g) – determined using 5 samples of 20 ripe fruit each. The samples were randomly collected at fruit-ripening time from all trees being assessed from the outer portion of the crown at half of their heights.

Mean weight of one dried stone (g) – determined using 5 samples of 20 stones each. For each genotype, the samples were obtained randomly from a batch of seeds prior to stratification.

Number of stones obtained from one tonne of fruit – calculated as the ratio of the weight of one tonne of fruit in grams (1,000,000 g) and the mean fruit weight (g).

Number of dried stones per kilogram – calculated by dividing the weight of one kilogram of dried stones (1,000 g) by the average weight of one dried stone (g).

Seed germination capacity – the percentage of seeds of a given genotype that germinated during stratification in relation to the total number of stones undergoing the treatment. For each genotype (combination), a total of 500 stones were used in five replications. A replication was represented by a bag containing 100 stones.

Number of stones with two seeds – expressed as the percentage of stones with two seeds; these seeds were counted during the inspections and after the stratification treatment. To determine the number of stones with two seeds among the stones whose seeds had not germinated, the stones were cracked open with a table vice after stratification.

Weather history – during the winter months (December–March) and spring months (April–May) from 2008 to 2012, min. and average air temperatures were recorded at a height of approximately 1.8 m above the ground (Table 1).

Statistical analysis. The analyses of the data that were obtained over the course of the study were performed using a repeated measures model. The sphericity assumption was assessed with the Mauchly's test. If sphericity was violated, adjustments were performed with the Greenhouse-Geisser correction. Multiple comparisons of the means were performed using the Duncan's procedure at $P \leq 0.05$. The analyses were performed with the Statistica software package vers. 10 (StatSoft, Inc., Tulsa, USA).

The stones for the study were collected successively from ripe fruit that had fallen to the ground and showed no signs of decay. The remains of the flesh were removed by washing the stones repeatedly under running water. Stones floating on the surface of the water (indicating poorly developed seeds) were discarded. Next, the stones were dried and stored in paper bags at ambient conditions at approximately +20°C. The stratification treatment began in mid-December of each year of the study. Before stratification, the stones were disinfected by soaking in a 0.5% solution of the fungicide Captan 50 WP (Arysta LifeScience North America Co., San Francisco, USA) (suspension, 50% captan) for 24 hours. The disinfected stones were then mixed with a moist substrate at a volume ratio of 1:3 (one part stones to three parts substrate). The substrate for stratification was a mixture of peat and sand at a 3:1 volume ratio (three parts peat to one part sand). To facilitate their access to air, the stones mixed with the substrate were packed in perforated plastic bags and then placed in an incubator for seed stratification at approximately +4°C. The first four inspections of the stones (to allow fresh air to enter the bags and to assess the moisture content of the substrates) were conducted at 20, 40, 60 and 80 days from the beginning of stratification. Subsequent inspections were performed every 10 days, and the stones with germinating seeds were removed and counted each time. A seed was regarded as having germinated if a 5–10 mm long radicle could be observed emerging from the cracked stone.

RESULTS AND DISCUSSION

During each winter preceding our assessment, large drops in temperature occurred. The lowest recorded values were as follows: –23.0°C (January 6, 2009), –28.1°C (January 26, 2010), –22.3°C (February 22, 2011), and –23.3°C (February 3–4, 2012) (Table 1). Despite these severe winter frosts, all of the trees of the seed genotypes under assessment bloomed abundantly (Table 2). According to SZEWCZUK et al. (2007, 2010), substantial damage to peach flower buds during winters in Poland occurs following a drop in temperature up to –24°C and –26°C. In addition to the flower buds, the peach trees themselves were also reported to suffer from damage during some Polish winters (JAKUBOWSKI 1986). We have previously shown that in central Poland, severe freezing of peach flower buds occurs when the temperatures fall to –23.0°C (SZYMAJDA et al. 2013a). This indicates that the degree of damage to peach flower buds depends not only on sharp drops in temperature but also on temperature fluctuations during the winter season, causing the trees to lose their cold-hardiness, and on the individual cultivars. In our study, a particularly dangerous drop in temperature occurred on February 22, 2011 (–22.3°C). At that time, the flower buds may have completed endodormancy, which typically ends in December under the climatic conditions of central Poland (JAKUBOWSKI 1993). During the days in which temperatures rose above +4.4°C (RICHARDSON 1974), the flower buds began accumulating heat units, which caused them to become less resistant to frost. Abundant tree flowering was indicative of the high winter hardiness of the genotypes tested.

In three out of the four years of the study, spring frosts also occurred just before the full blooms (Table 1). These occurred on April 20, 2009 (–4.0°C), April 25, 2010 (–2.5°C), and April 20, 2011 (–1.5°C). In all three cases, at the time of the frost, many buds

Table 1. Minimum and average monthly temperatures (°C) during winter and spring months (Dąbrowice 2008–2012)

Year	December		January		February		March		April		May	
	min.	avg.	min.	avg.	min.	avg.	min.	avg.	min.	avg.	min.	avg.
2008/2009	–8.6	1.1	–23.0	–3.1	–16.5	–1.2	–9.1	2.4	–4.0	10.0	6.7	12.5
2009/2010	–21.4	–1.3	–28.1	–8.3	–14.8	–2.2	–11.2	3.3	–2.5	8.8	2.8	12.4
2010/2011	–19.2	–6.1	–10.5	–0.6	–22.3	–4.3	–12.9	3.1	–1.5	10.1	–1.5	13.6
2011/2012	–9.8	2.4	–18.0	–1.2	–23.3	–6.5	–7.7	4.8	–4.9	9.0	–0.1	14.7

Table 2. Flowering and fruiting of peach trees of the genotypes tested (Dąbrowice 2009–2012)

Genotype	Flowering time					Flowering intensity^z					Ripening time					Fruiting intensity^z				
	2009	2010	2011	2012	avg.	2009	2010	2011	2012	avg.	2009	2010	2011	2012	avg.	2009	2010	2011	2012	avg.
Mandżurska	22.04	27.04	22.04	24.04	24.04	4	7	3	7	5.3	09.09	16.09	03.09	03.09	08.09	5	8	4	7	6.0
Siberian C	20.04	27.04	22.04	24.04	23.04	3	6	3	4	4.0	06.09	16.09	01.09	03.09	07.09	3	7	3	7	5.0
BN-1	21.04	26.04	20.04	24.04	23.04	5	7	5	7	6.0	03.09	10.09	30.08	02.09	04.09	5	7	6	8	6.5
BN-3	21.04	27.04	21.04	24.04	23.04	4	7	4	7	5.5	08.09	12.09	30.08	03.09	06.09	5	7	4	7	5.8
BN-4	21.04	27.04	21.04	24.04	23.04	4	7	3	7	5.3	08.09	12.09	30.08	02.09	05.09	6	7	5	8	6.5
BN-7	22.04	26.04	21.04	24.04	23.04	4	8	3	7	5.5	05.09	12.09	30.08	03.09	05.09	4	7	4	8	5.8
BN-8	21.04	27.04	22.04	24.04	23.04	7	6	5	5	5.8	09.09	08.09	30.08	03.09	05.09	8	8	6	7	7.3
BN-45	21.04	27.04	21.04	24.04	23.04	3	7	3	5	4.5	11.09	16.09	01.09	04.09	08.09	3	7	4	8	5.5
Average	–	–	–	–	–	4.3	6.9	3.6	6.1	–	–	–	–	–	–	4.9	7.3	4.5	7.5	–

^{z}1–9 rating scale: 1 – no flowering or fruiting, 3 – poor, 5 – moderate, 7 – abundant, 9 – very abundant; avg. – average

were already at the open flower stage and were thus vulnerable to damage. In 2011, another frost (–1.5°C) occurred on May 4, a few days after the full bloom. Despite the unfavourable weather conditions, the trees of the tested genotypes produced abundant fruit crops, and the genotypes BN-8, BN-1 and BN-4 were the best fruit-bearers (Table 2). The abundant fruiting of the trees of these genotypes indicates the tolerance of their flowers to spring frosts and their ability to set fruit under adverse temperature conditions.

Differences between the genotypes in relation to the characteristics under consideration varied throughout the years of the study (Table 3). The weather patterns in the individual years significantly affected the values of the parameters analysed. In 2009 and 2011, the occurrences of winter frosts and spring frosts resulted in lower flowering and fruiting intensities compared with those in 2010 and 2012 (Table 2).

In addition to regular annual fruiting, peach seed trees are expected to produce abundant fruit crops and, consequently, seed-carrying stones. High yields of a large number of small fruits are preferable. Over the four years of the study, the smallest fruits were produced by the genotypes BN-8 and BN-7 on average, for which the average weights were 47.7 g and 49.2 g, respectively (Table 4).

An abundant crop of small fruit allows for the acquisition of a large number of stones (seeds). One tonne of fruit from each of the genotypes BN-7 and BN-8 yielded the most stones on average over the four years of the study (Table 4). These results indicate that out of all of the genotypes tested, BN-7 and BN-8 produced the highest seed yields at the seed orchard. The numbers of seeds per tonnes of fruit varied each year. The larger crops of small fruit in 2010 and 2012 resulted (to a large extent) in higher yields of stones per tonne of fruit in comparison with the yields in 2009 and 2011. This indicates that the damage to flower buds caused by winter and spring frosts occurring in Poland reduces the fruiting intensities and increases the weights of the fruit produced. Consequently, lower seed yields are obtained from the fruit genotypes in the years of low fruiting intensity compared with those in the years of high fruiting intensity (Table 4).

The year in which stones were harvested as well as the genotype had a significant effect on the stone weights and their numbers per kilogram (Table 3). The more intense fruiting and the bearing of smaller fruit by the tested genotypes in 2010 and 2012 resulted in lower stone weights and numbers of

Table 3. Synthesised results of repeated measures ANOVA for the peach genotypes tested (2009–2013)

Source of variation	Mean fruit weight (g)			Mean weight of one dried stone (g)			No. of stones obtained from 1 t of fruit			No. of dried stones/ 1 kg			Percentage of germinated seeds after 150 days			Percentage of stones with two seeds		
	DF	MS	P	DF	MS	P	DF	MS	P	DF	MS	P	DF	MS	P	DF	MS	P
Genotype	7	317.3	0.00	7	1.81	0.00	7	6.8E + 10	0.00	7	5,142	0.00	7	1,181	0.00	7	43.9	0.00
Error	32	16.5	0.00	32	0.01	0.00	32	6.8E + 07	0.00	32	52	0.00	32	45	0.00	32	1.5	0.00
Year	2.52^{z}	10,809.3	0.00	3	33.6	0.00	1.45^{z}	4.9E + 06	0.00	3	12,559.8	0.00	2.4^{z}	6,668	0.00	3	169.5	0.00
Year × genotype	17.6^{z}	350.2	0.00	21	1.31	0.00	10.2^{z}	2.1E + 09	0.00	21	3,799	0.00	16.8^{z}	604	0.00	21	17.2	0.00
Error	80.6^{z}	12.3	0.00	96	0.01	0.00	46.4^{z}	5.3E + 07	0.00	96	49	0.00	76.9^{z}	39	0.00	96	0.8	0.00

^{z}adjusted using the Greenhouse–Geisser correction; DF – degrees of freedom; MS – mean squares; P – probability

Table 4. Mean fruit weight, number of stones obtained from 1 t of fresh fruit, and mean weight of one dried stone of the peach genotypes tested (Dąbrowice 2009–2012)

Genotype	Mean fruit weight (g)					No. of stones in 1 t of fruit (in thousands)					Mean weight of one dried stone (g)				
	2009	2010	2011	2012	avg.	2009	2010	2011	2012	avg.	2009	2010	2011	2012	avg.
Mandżurska	66.0^{de}	40.8^{a}	83.8^{f}	38.9^{c}	57.4^{de}	15.2^{ef}	24.6^{a}	11.9^{e}	26.3^{c}	19.5^{d}	5.1^{d}	3.5^{d}	5.6^{e}	3.4^{e}	4.4^{e}
Siberian C	58.0^{bc}	46.6^{b}	94.8^{g}	37.8^{c}	59.3^{e}	17.3^{bcd}	21.5^{b}	10.6^{f}	26.6^{c}	19.0^{d}	5.2^{d}	3.3^{c}	5.6^{e}	3.1^{bc}	4.3^{d}
BN-1	55.8^{abc}	53.6^{c}	68.3^{d}	38.4^{c}	54.0^{bc}	18.0^{abc}	18.7^{c}	14.7^{d}	26.1^{c}	19.4^{d}	4.3^{b}	3.8^{e}	4.3^{b}	3.4^{e}	3.9^{bc}
BN-3	61.8^{cd}	49.8^{bc}	64.2^{bc}	35.3^{bc}	52.8^{b}	16.3^{cde}	20.1^{bc}	15.6^{bc}	28.7^{bc}	20.2^{cd}	4.9^{c}	3.3^{c}	4.2^{b}	3.3^{d}	3.9^{bc}
BN-4	70.6^{e}	60.8^{d}	62.0^{b}	32.5^{bc}	56.5^{cd}	14.2^{f}	16.5^{d}	16.2^{b}	30.9^{bc}	19.4^{d}	5.6^{e}	3.8^{e}	4.6^{c}	3.1^{bc}	4.3^{d}
BN-7	64.8^{de}	41.6^{a}	66.6^{cd}	23.7^{a}	49.2^{a}	15.5^{def}	24.1^{a}	15.0^{cd}	42.4^{a}	24.3^{a}	6.1^{f}	3.1^{b}	4.8^{d}	3.0^{ab}	4.3^{d}
BN-8	54.6^{ab}	47.8^{b}	57.9^{a}	30.4^{b}	47.7^{a}	18.4^{ab}	21.0^{b}	17.3^{a}	33.0^{b}	22.4^{b}	3.6^{a}	3.5^{d}	3.8^{a}	2.9^{a}	3.5^{a}
BN-45	50.8^{a}	47.6^{b}	80.5^{e}	33.3^{bc}	53.1^{b}	19.8^{a}	21.1^{b}	12.4^{e}	31.2^{bc}	21.1^{bc}	5.1^{d}	2.9^{a}	4.9^{d}	3.2^{c}	4.0^{c}
Average	60.3	48.6	72.3	33.8	53.8	16.8	21.0	14.2	30.7	20.7	5.0	3.4	4.7	3.2	4.1

values marked with the same letter within a column do not differ significantly according to the Duncan's *t*-test ($P \leq 0.05$); avg. – average

Table 5. Number of dried stones per kg, percentage of germinated seeds, and percentage of stones with two seeds for different genotypes tested (Dąbrowice 2009–2013)

Genotype	No. of stones per 1 kg					Percentage of germinated seeds after 150 days of stratification					Percentage of stones with two seeds				
	2009	2010	2011	2012	avg.	2010	2011	2012	2013	avg.	2010	2011	2012	2013	avg.
Mandżurska	197^{cd}	290^{d}	177^{e}	293^{cd}	239^{f}	50.8^{c}	90.0^{cd}	53.6^{d}	95.6^{ab}	72.5^{d}	5.2^{ab}	5.8^{c}	0.8^{d}	4.6^{a}	4.1^{b}
Siberian C	191^{d}	308^{c}	179^{e}	320^{b}	249^{e}	31.8^{d}	95.6^{ab}	63.2^{c}	96.6^{ab}	71.8^{d}	4.2^{bc}	7.0^{c}	0.4^{d}	1.6^{d}	3.3^{c}
BN-1	232^{b}	261^{e}	232^{b}	291^{d}	254^{d}	55.6^{c}	91.8^{cbd}	86.6^{a}	93.0^{bc}	81.8^{bc}	3.8^{c}	3.6^{d}	3.4^{b}	0.4^{e}	2.8^{c}
BN-3	206^{c}	301^{c}	236^{b}	301^{c}	261^{bc}	88.8^{a}	96.0^{a}	81.6^{ab}	98.4^{ab}	91.2^{a}	6.2^{a}	11.4^{a}	2.2^{c}	2.4^{bc}	5.5^{a}
BN-4	179^{e}	266^{e}	217^{c}	323^{b}	246^{e}	77.4^{b}	93.6^{abc}	89.8^{a}	100.0^{a}	90.2^{a}	5.2^{ab}	9.0^{b}	3.6^{ab}	0.8^{e}	4.7^{b}
BN-7	164^{f}	327^{b}	208^{d}	333^{e}	258^{cd}	75.8^{b}	88.8^{d}	87.2^{a}	88.0^{c}	85.0^{b}	3.3^{c}	3.2^{d}	2.0^{c}	2.8^{b}	2.8^{c}
BN-8	281^{a}	285^{d}	262^{a}	340^{a}	292^{a}	87.6^{a}	94.8^{ab}	82.2^{ab}	94.4^{abc}	89.8^{a}	1.2^{d}	1.0^{e}	0.6^{d}	1.8^{cd}	1.3^{d}
BN-45	195^{d}	343^{a}	203^{d}	319^{b}	265^{b}	67.8^{b}	95.8^{a}	76.4^{b}	80.8^{d}	80.2^{c}	6.3^{a}	9.8^{b}	4.2^{a}	2.2^{bcd}	5.6^{a}
Average	206	298	214	315	258	67.0	93.3	77.6	93.4	82.8	4.4	6.4	2.2	2.1	3.8

values marked with the same letter within a column do not differ significantly according to the Duncan's *t*-test ($P \leq 0.05$); avg. – average

stones per kilogram compared with those observed in 2009 and 2011 (Tables 4 and 5). The dried stones of the genotype BN-8 possessed the lightest average weights over the four-year evaluation period. Small stones are advantageous because they allow for reductions in harvesting costs, storage, stratification and sowing. On average over the course of the study, the highest number of stones per kilogram was obtained from the genotype BN-8.

In nurseries, the usefulness of seed genotypes is also determined by the germination capacities of the seeds harvested from their trees. A higher germination capacity indicates that a higher number of seedlings (rootstocks) will be obtained in relation to the number of seeds sown. In this evaluation, the germination capacity was significantly influenced by both the genotype of the seeds and the year in which they were harvested (Table 3). The greatest germination capacities for all genotypes were observed in 2013 and 2011, and the lowest were detected in 2010 and 2012 (Table 5). The weather conditions likely affected these germination capacities. In the months of July and August of 2010 and 2012, higher temperatures were recorded compared with those in 2009 and 2011, which contributed to the fruit development and seed maturation. Variations in germination capacities depending on the growing season were also reported in the sweet cherry (Suszka 1976), apple (Lewandowski, Żurawicz 2009), and apricot (Szymajda et al. 2013b). The results of our four-year study have shown that the seeds of the tested genotypes have significantly higher germination capacities compared with those of the control cvs Mandżurska and Siberian C. Among the tested genotypes, the seeds with the highest germination capacities were produced by the trees of BN-3, BN-4 and BN-8. In addition, genotypes BN-3 and BN-45 produced the most stones containing two seeds, which may positively affect the numbers of rootstocks obtained in relation to the numbers of seeds sown (Table 5).

The seeds of the evaluated peach genotypes began to germinate after at least 90–100 days of stratification, depending on the year and genotype. The largest number of them germinated between the 110th and 130th day of stratification. Very few seeds germinated after that period. The germination of peach seeds after a similar period of stratification was also observed by Jakubowski (2000, 2004) and Czynczyk (2012). For nursery production, it is very useful to know the optimum duration of stratification for peach seeds because it aids in determination of the start date of the treatment in relation to the planned sowing date.

CONCLUSION

These results clearly show that selection may be used to obtain seed genotypes of *P. persica* that can regularly produce large quantities of seeds with high germination capacities The regular bearing of fruit by the genotypes BN-1, BN-4 and BN-8, despite severe winter and spring frosts, suggests that they are very well suited for the establishment of seed orchards in central European countries. The genotypes included in this evaluation produced small fruit with small stones. All of the selections produced seeds with higher germination capacity compared with those of the control cvs Mandżurska and Siberian C. With respect to all the characteristics evaluated, the genotype BN-8 is the best as a seed source trees. Studies are underway to assess the compatibilities of the obtained rootstocks with the peach cultivars grafted onto them and to assess the effects of the rootstocks on the growth and fruiting of the trees of these cultivars.

References

Czynczk A., 2012. Szkółkarstwo sadownicze. [Propagation of Fruit Crops.] Warszawa, Powszechne Wydawnictwo Rolnicze i Leśne.

FAOSTAT, 2013. FAO Statistical Databases. Available at http://faostat.fao.org

Jakubowski T., 1986. Evaluation of frost injuries to peaches after a test winter of 1984–1985. Fruit Science Reports, *13*: 117–122.

Jakubowski T., 1991. Stratyfikacja nasion brzoskwini. [Stratification of Peach Seeds.] I Międzynarodowe Seminarium Szkółkarskie. Lublin, Poland.

Jakubowski T., 1993. Akumulacja chłodu przez pąki kwiatowe brzoskwini. [Chilling accumulation by peach flower buds.] Prace ISK Seria A, *31*: 79–85.

Jakubowski T., 2000. Uprawa brzoskwini i nektaryny. [Cultivation of Peach and Nectarine.] Warszawa, Hortpress Sp. Zo.o.

Jakubowski T., 2004. Comparison of two stratification methods of three peach rootstock clones. Acta Horticulturae (ISHS), 258: 637–639.

Layne R.E.C., 1987. Peach rootstock, In: Rom R.C., Carlson R.F. (eds.), Rootstocks for Fruit Crops. New York, Wiley: 185–216.

Lewandowski M., Żurawicz, E., 2009. The influence of genotype on germination of apples seeds. Acta Horticulturae (ISHS), 814: 429–432.

Nikolić D., Raconiac V., Milatović D., Fotirić M., 2010. Multivariate analysis of Vineyard peach [*Prunus persica* (L.) Batsch] gerplasm collection. Euphytica, *171*: 227–234.

Reighard G. L., Loreti F., D., 2008. Rootstocks development. In: Layne D.R., Bassi D. (eds.), The Peach: Botany, Production and Uses. Wallingford, CAB International: 193–220.

Richardson E.A., 1974. A model for estimating the completion of rest for Redhaven and Elberta peach trees. HortScience, *9*: 331–332.

Room R.C., 1983. The peach rootstock situation: An international perspective. Fruit Varieties Journal, *37*: 3–14.

Rubio-Cabetas M.J., 2012. Present and future trends in peach rootstock breeding worldwide. Acta Horticulturae (ISHS), 962: 81–90.

Suszka B., 1976. Variability of the germination capacity of Mazzard cherry (*Prunus avium* L.) seeds collected from 10 trees in 5 different seasons. Arboretum Kórnickie, *21*: 273–278.

Szewczuk A., Gudarowska E., Deren E., 2007. The estimation of frost damage of some peach and sweet cherry cultivars after winter 2005/2006. Journal of Fruit and Ornamental Plant Research, *15*: 55–63.

Szewczuk A., Jawoszek B., Gudarowska E., 2010. Forma korony a uszkodzenia mrozowe pędów i pąków kwiatowych drzew brzoskwini. [Crown shape and frost damage to shoots and flower buds of peach trees.] Zeszyty Naukowe Instytutu Sadownictwa i Kwiaciarstwa im. Szczepana Pieniążka, *18*: 39–49.

Szymajda M., Pruski K., Żurawicz E., Sitarek M., 2013a. Freezing injuries to flower buds and their influence on yield of apricot (*Prunus armeniaca* L.) and peach (*Prunus persica* L.). Canadian Journal of Plant Science, *93*: 191–198.

Szymajda M., Pruski K., Żurawicz E., Sitarek M., 2013b. Suitability of selected seed genotypes of *Prunus armeniaca* L. for harvesting seeds for the production of generative rootstock for apricot cultivars. Journal of Agriculture Science, *5*: 222–232.

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