STONE FRUIT ROOTSTOK RESEARCH IN LITHUANIA

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Sour cherries and plums are the most important stone fruit crops in Lithuania. This paper presents information about rootstock researches for mentioned crops. The experiments were carried out in the central part of Lithuania, where prevail Epicalcari-Endohyppogleic clay loam soils medium rich or rich with phosphorus and potassium, containing 1.5-3% of humus, pH – 7.0-7.2.

Seedlings derived from accidental Prunus mahaleb, P. avium, P. cerasus and P. cerasifera seeds were used for tree propagation for many years. Rootstock investigations were started from the search of seedling forms with better adaptability to local soils and climate, positive effect on productivity and fruit quality. As a result of first trials seedlings of sweet cherry cv. ‘Zolotaja Losickaja’ and selection form No. 2 and two forms of P. mahaleb (No. 817 and No. 805) were recommended as rootstocks for sour cherries. Cherry trees on mentioned seedlings were of uniform growth in the orchard, bore higher yields of good quality fruits.

In later experiments clonal rootstocks PN (P. cerasus), P3, P7 (both P. padus x (P. cerasus x P. avium)) and Ž1 (P. cerasus) were tested for both sour and sweet cherries. None of tested rootstocks showed better than P. mahaleb seedlings with sour cherries, whereas sweet cherry yield per tree and yield efficiency on this rootstock was the lowest. The highest yield efficiency of sweet cherry trees was on rootstock P3, but it suckered profusely. PN was established as the most promising rootstock for sweet cherries. Trees on this rootstock were of medium yield efficiency, fruits were of good size, rootstock practically did not sucker.

Seedlings of P. tomentosa and clonal rootstocks St. Julien A, St. Julien GF655-2 and Marianna GF8-1 were tested as possible rootstocks for plums. None of the tested rootstocks was better than the standard one (P. cerasifera seedlings). Scion-rootstock incompatibility was frequent with P. tomentosa seedlings.

In recent field experiments 24 clonal rootstocks are under investigations with sweet cherry cv. ‘Lapins’. The most promising of them seem to be Gisela 4, Gi–497/8 and Gi–154/7.

The further investigations should be directed towards search of more dwarf and yield efficient rootstocks for sweet cherries and plums.
Key words: cherries, clonal rootstocks, plums, seedlings.

Introduction. Importance of rootstock for fruit tree has been changing with development of fruit growing. Good rootstock compatibility with scion cultivars and adaptation to local soil and climate conditions was satisfactory for a long time. Common rootstocks for cherries were seedlings of *Prunus avium*, *P. mahaleb* or *P. cerasus*, for plums – these of *P. cerasifera* or *P. domestica*. Trees on accidental seedling rootstocks usually grow vigorously, often are of unequal size, late come into bearing. When fruit growing become commercially important and competition among growers increased requirements for rootstocks had risen. Numerous attempts appeared to improve existing rootstocks by selection of valuable seedling forms or creating clonal ones. Perfect rootstock should provide adequate tree growth control, increase precocity and yield efficiency, should be cold and disease resistant, well adapted to certain soil conditions, easy propagated, not suckering. Good compatibility with wide range of scion cultivars and long life of grafted trees is of great importance as well (Wertheim, 1998).

Many promising rootstocks recently were released as a result of different breeding programs. Gisela, MaxMa, P-HL, Pi-Ku, Gm, Weicroot series rootstocks for sweet cherries should be mentioned (Callesen, 1998). Seedlings of selected *P. avium* and especially *P. mahaleb* forms are still important for sour cherries (Mika, 2000; Ercisli et al., 2006). Both seedling and clonal rootstocks are important for plums. Seedlings of selected of myrobalan (*P. cerasifera*) and *P. domestica* forms are usually used. Clonal rootstocks available in Europe include St. Julien and Marianna series, ‘Ackerman’, ‘Brompton’, ‘Pixy’, Myrobalan B, etc. (Okie, 1987). Promising and relatively new clonal rootstocks are ‘Ferlenain’, ‘Ferciana’, ‘Fereley’ (Wertheim, 1998).

In different countries different rootstocks are used. The main stone fruit crops in Lithuania are sour cherries and plums. Seedlings of *P. mahaleb*, *P. avium*, or *P. cerasus* for cherries and these of *P. cerasifera* for plums were important rootstocks for a long time, but changing situation in modern fruit growing promoted search of better ones. Lithuania had close contact with Russia where some perspective clonal rootstocks for cherries were bread. *P. padus* and *P. cerasus* were used in this breeding program (Kolesnikova et al., 1985). Rootstocks P3, P7 and PN were tested in the Ukraine (Шарко et al., 2000). P3 and P7 are characterized as vigorous, PN – as dwarf one (Барааш, 1995). Very poor information is available about mentioned rootstocks.

In this paper the main stone fruit rootstock investigations carried out in Lithuania are overviewed. Rootstocks bread in former Soviet Union and in some countries of Western Europe were included into our research program.

Materials and methods. Experiments were carried out at the Lithuanian Institute of Horticulture (LIH) in the central part of Lithuania in the latitude of 55° North and longitude 23° East. Average annual temperature of the terrene is 6.4°C, total amount of the precipitation – 630 mm (in April–September – 380 mm). Prevailing soils – Epicalcari-Endohypogleic clay loams medium rich or rich with phosphorus and potassium, containing 1.5–3% of humus, pH – 7.0–7.2.
Rootstock field trials were established in three-four replications with 4 trees in each experimental plot. Tree planting distances were 5 x 2.5–3 m. Orchard floor management combined herbicide strips in the rows and frequent mown sward between the rows. In the first experiments tree canopies were trained close to the natural, in recent ones – as spindles.

Tree growth vigour in the first year of growth was assessed by total shoot length or tree height, latter – by trunk diameter. Yield was recorded for the whole experimental plot and recalculated to the yield per tree or per hectare. Annual yield efficiency was calculated as a ratio of tree yield with trunk cross-section area (TCSA). Final yield efficiency is a sum of annual efficiencies. Average fruit weight was determined on a representative sample of 100 fruits per each experimental plot. Rootstock suckering was evaluated in scores (0–5 scale, where 0 – no suckers; 5 – abundant suckering) or number of suckers per tree was calculated. Tree mortality was expressed as a percent of dead trees at the end of experiment.

For data statistical evaluation LSD_{0.05} or Duncan test was used.

Results. Cherry rootstocks. Seedlings derived from accidental *P. mahaleb*, *P. avium* or *P. cerasus* seeds were used as rootstocks for sour and sweet cherries. After the experiments carried out by A. Šumskis in 1984–1998 seedlings of sweet cherry cv. ‘Zolotaja Losickaja’, selection form No. 2 and two forms of *P. mahaleb* (No. 817 and No. 805) were recommended as rootstocks for sour cherries (Šumskis, 2001). Cherry trees on seedlings of mentioned forms ensured more uniform tree growth and higher yields of good quality fruits. Tree survival on these rootstocks was better. They withstand well cold winter of 1986–1987 and other unfavorable conditions during the years of the experiment.

Parallel search of clonal rootstocks was started in the nursery. There were selected some winter hardy, disease resistant and easy propagating by green cuttings clonal rootstocks: PN (*P. cerasus*), P3, P7 (both *P. padus* x (*P. cerasus* x *P. avium*) all bread at the Nonchernozim Institute of Horticulture in Russia (Евстратов, 1986) and Ž1 (*P. cerasus*) selected at the LIH (Šumskis, 1997). Their testing in the orchard was started in 1999. Mentioned rootstocks were tested with both sour and sweet cherries. *P. mahaleb* seedlings served as a control.

The most vigorous sour cherry trees in the young age were on rootstock P7 (Table 1). With the rest of rootstocks tree growth was similar. Yield per tree, yield efficiency and average fruit weight was not significantly affected by the rootstock (Lanauskas, 2005 a). The most suckering rootstocks were P3 and P7. The highest tree mortality was on rootstocks P7 and PN. None of tested rootstocks showed better than standard one – *P. mahaleb* seedlings.

The least growth of sweet cherries was on rootstocks Ž1 and P7 (Table 2). Tree mortality on these rootstocks was the highest (Lanauskas, 2005 b). The most vigorous trees were on rootstock PN, but their trunk diameter was close to the one of trees on P3 and *P. mahaleb* seedlings. The highest yield and yield efficiency was of trees on rootstock P3, but this rootstock suckered profusely. The lowest yield and yield efficiency was recorded for trees on *P. mahaleb* seedlings.
Table 1. Rootstock effect on the performance in the orchard of six-year-old sour cherry trees of cv. ‘Vytėnų žvaigždė’ (Lanauskas, 2005 a)

<table>
<thead>
<tr>
<th>Rootstock Poskiepis</th>
<th>Trunk diameter Kamieno skersmuo, cm</th>
<th>Suckering (0–5 scores) Atžalų kiekis (0–5 balai)</th>
<th>Cumulative yield (kg tree⁻¹) Suminis derlius, kg vaism.⁻¹</th>
<th>Yield efficiency (kg cm⁻² of TCSA) Produktyvumas, kg cm⁻² KSP*</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. mahaleb</em></td>
<td>8.2 a**</td>
<td>0.3 a</td>
<td>12.4 a</td>
<td>0.32 a</td>
</tr>
<tr>
<td>PN</td>
<td>8.1 a</td>
<td>0.4 a</td>
<td>12.7 a</td>
<td>0.34 a</td>
</tr>
<tr>
<td>P3</td>
<td>8.2 a</td>
<td>3.3 b</td>
<td>11.6 a</td>
<td>0.32 a</td>
</tr>
<tr>
<td>P7</td>
<td>8.7 b</td>
<td>2.8 b</td>
<td>10.2 a</td>
<td>0.23 a</td>
</tr>
<tr>
<td>Ž1</td>
<td>8.2 a</td>
<td>0.8 a</td>
<td>11.1 a</td>
<td>0.28 a</td>
</tr>
</tbody>
</table>

* Trunk cross section area / Kamieno skerspūvio plotas
** In this and further tables means within the columns marked with the same letter do not differ statistically at the probability level p = 0.05 / Šioje ir kitose lentelėse tarp skiltys te pačia raide pažymėtų skaičių esminių skirtumų nėra (tikimybės lygis p = 0.05).

Table 2. Rootstock effect on the performance in the orchard of six-year-old sweet cherry trees of cv. ‘Vytėnų rožinė’ (Lanauskas, 2005 b)

<table>
<thead>
<tr>
<th>Rootstock Poskiepis</th>
<th>Trunk diameter Kamieno skersmuo, cm</th>
<th>Suckering (0–5 scores) Atžalų kiekis (0–5 balai)</th>
<th>Cumulative yield (kg tree⁻¹) Suminis derlius, kg vaism.⁻¹</th>
<th>Yield efficiency (kg cm⁻² of TCSA) Produktyvumas, kg cm⁻² KSP*</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. mahaleb</em></td>
<td>11.4 ab</td>
<td>0.1 a</td>
<td>3.5 a</td>
<td>0.040 a</td>
</tr>
<tr>
<td>PN</td>
<td>12.0 b</td>
<td>0.3 a</td>
<td>5.7 ab</td>
<td>0.064 a</td>
</tr>
<tr>
<td>P3</td>
<td>11.6 ab</td>
<td>3.1 c</td>
<td>12.0 c</td>
<td>0.134 a</td>
</tr>
<tr>
<td>P7</td>
<td>10.6 a</td>
<td>1.9 b</td>
<td>5.0 a</td>
<td>0.064 a</td>
</tr>
<tr>
<td>Ž1</td>
<td>10.3 a</td>
<td>0.3 a</td>
<td>9.0 bc</td>
<td>0.130 b</td>
</tr>
</tbody>
</table>

Since 1999 the following rootstocks are under investigation with sweet cherry cv. ‘Lapins’: Edabriz, PHL-A, Damil, Gisela 4, Gi-497/8, Gisela 5, Gi-209/1, Gi-148/8, Gi-195/20, Gi-154/7, Gi-523/02, Weirroot 53, Weirroot 158, Colt, MaxMa 14, MaxMa 97, MaxMa 60, Hexaploid Colt, Gi-318/17, Gi-195/1, Gi-107/1, Gi-148/13, Gi-148/1, Weirroot 10. According to our investigations the most promising of them are Gisela 4, Gi-497/8 and Gi-154/7.

Interstocks for sweet cherries. In order to decrease tree growth the following interstocks were investigated: ‘Vladimirskaye’, ‘Poliovka’, ‘Žagarvysnė’ (all P. cerasus), ‘Severianka’ (P. avium), Colt (P. avium x P. pseudocerasus) and P. fruticosa (Šumskis, 1998). The most of interstocks decreased tree TCSA and canopy projection area. The highest decrease of TCSA was with P. fruticosa interstock. Trees with interstocks required less pruning. Interstocks decreased fruit yield per tree.
Plum rootstocks. *P. cerasifera* seedlings still are the main rootstocks for plum cultivars grown in Lithuania. Searching for more yield efficient and dwarf rootstocks seedlings of *P. tomentosa* were evaluated with 11 plum cultivars (Kviklys, 1999). Control trees were on *P. cerasifera* seedlings. Seedlings of *P. tomentosa* decreased tree height, canopy diameter and TCSA of all tested cultivars. Average yield on *P. tomentosa* seedlings was about twice less than on *P. cerasifera* ones (Table 3). Yield efficiency was similar on both rootstocks. Scion-rootstock incompatibility and silver leaf infections were more frequent with *P. tomentosa* seedlings. It was established that *P. tomentosa* seedlings could be used only with cvs. ‘Rausvė’ and ‘Niagara’ if planted more densely (1666 trees per hectare).

Table 3. Rootstock effect on the performance in the orchard of nine-year-old plum trees (average data of 11 cultivars) (Kviklys, 1999)

<table>
<thead>
<tr>
<th>Rootstock Poskiepis</th>
<th>TCSA KSP, cm²</th>
<th>Cumulative yield (kg tree⁻¹) Suminis derlius, kg vaism.⁻¹</th>
<th>Yield efficiency (kg cm⁻² of TCSA) Produktyvumas, kg cm⁻² KSP</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. cerasifera</em></td>
<td>132 b</td>
<td>68.5 b</td>
<td>0.5 a</td>
</tr>
<tr>
<td><em>P. tomentosa</em></td>
<td>54 a</td>
<td>32.4 a</td>
<td>0.6 a</td>
</tr>
</tbody>
</table>

Since 1999 clonal rootstocks St. Julien A, St. Julien GF655-2 and Marianna GF8-1 are under investigation with plum cvs. ‘Stanley’ and ‘Kauno vengrinė’. After 7 years the least tree growth was on rootstock GF655-2 (Table 4). Trees on rootstock GF8-1 were of the same growth vigour as on standard rootstock – *P. cerasifera* seedlings. The highest cumulative yield and yield efficiency was on *P. cerasifera* seedlings. The most suckering rootstock was GF655-2.

Table 4. Rootstock effect on the performance in the orchard of seven-year-old plum trees (average data of cvs. ‘Stanley’ and ‘Kauno vengrinė’) (Lanauskas, 2006)

<table>
<thead>
<tr>
<th>Rootstock Poskiepis</th>
<th>Trunk diameter Kamieno skersmuo, cm</th>
<th>Suckering (0-5 scores Atžalų kiekis (0-5 balai)</th>
<th>Cumulative yield (kg tree⁻¹) Suminis derlius, kg vaism.⁻¹</th>
<th>Yield efficiency (kg cm⁻² of TCSA Produktyvumas, kg cm⁻² KSP)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>P. cerasifera</em></td>
<td>9.8 c</td>
<td>1.2 b</td>
<td>14.4 b</td>
<td>0.32 b</td>
</tr>
<tr>
<td>St. Julien A</td>
<td>9.2 b</td>
<td>0.5 a</td>
<td>9.2 a</td>
<td>0.23 a</td>
</tr>
<tr>
<td>GF655-2</td>
<td>8.8 a</td>
<td>2.4 c</td>
<td>10.2 a</td>
<td>0.28 ab</td>
</tr>
<tr>
<td>GF8-1</td>
<td>9.9 c</td>
<td>0.4 a</td>
<td>12.4 ab</td>
<td>0.27 ab</td>
</tr>
</tbody>
</table>

Discussion. Investigations carried out at the Lithuanian Institute of Horticulture showed that *P. mahaleb* seedlings were enough good rootstocks for sour cherries if grown on neutral and not too wet soils. Sour cherry trees on *P. mahaleb* seedlings were yield efficient and not too vigorous. *P. mahaleb* seedlings or clonal rootstocks are important for sour cherry propagation in Poland (Mika, 2000), Hungary (Hrotkó,
Magyar, 2004), Turkey (Ercisli et al., 2006) and some other countries too (Perry, 1987).

More complicated situation is with sweet cherry rootstocks. P. mahaleb, P. avium or P. cerasus seedlings tested in Lithuania did not provide adequate tree growth control, yield efficiency on those rootstocks was not satisfactory. Our attempts to decrease tree size with interstocks gave certain results. Tree growth was reduced by most used interstocks but positive effect on the yield was not achieved. The most dwarfing was interstock of P. fruticosa. This is in coincidence with the results obtained in the other countries (Rozpara et al., 1998; Hrotkó et al., 1998). As interstock positive effect was slight and tree production with interstocks is more expensive researches in this direction were stopped.

Search for dwarfing sweet cherry rootstocks was started by testing Russian clones PN, P3, P7 and local Ž1. There were not found dwarfing among them. Existing information about dwarfing effect of PN (Барашкин, 1995) was not confirmed by our experiments. Trees on this rootstock in the young age were of the same growth vigour like on P. mahaleb seedlings. Sometimes tree growth reduces when it comes into full bearing (Ystaas, Frøynes, 1991). Further results of this rootstock effect will be available in some years. Tree yield efficiency on PN was slightly higher than on P. mahaleb. By our observations made in 2006 (data not presented in this paper) this tendency became more evident. PN probably is the most interesting rootstock for sweet cherries in this experiment. The most yield efficient rootstock was P3, but it suckered profusely complicating orchard floor management. It is reported that suckering is strongly related to the rootstocks belonging to the species P. cerasus (Toribio et al., 1998). Franken-Bembenek and Gruppe (1985) reported that the most severe suckering is observed in progenies with P. cerasus and P. fruticosa. In our experiment PN and Ž1 rootstocks from P. cerasus almost did not sucker. The most suckering rootstocks were P3 and P7 originated using P. padus.

Sweet cherry rootstocks from Western Europe and USA being under tests at the LIH now provide better growth control. More exhaustive investigations of the best of them are necessary with the most important cultivars in future. Until now Gisela 4, Gi-497/8 and Gi-154/7 performed well, whereas the most popular in many countries Gisela 5 showed worse. Gisela 4 and Gisela 5 as promising sweet cherry rootstocks were mentioned in neighbouring Latvia (Ruisa, Rubauskis, 2004). Cmelyk et al. (2004) recognized Gisela 4 as dwarfing, precocious and productive rootstock as well.

In our experiments the most dwarfing rootstocks for plums were seedlings of P. tomentosa but they were discarded for frequent incompatibility with scion cultivars and negative effect on yield. P. tomentosa got similar evaluation in the experiments carried out by Oosten (1997).

The rest of tested plum rootstocks had a slight influence on tree growth. From the first year plum trees on rootstock St. Julien A grew somewhat less vigorously and at the end of the experiment their trunk diameter was by 6% less in comparison with the one on P. cerasifera seedlings. The young plum trees on rootstock GF655/2 grew more vigorously but in the bearing age growth slightly decreased and finally their trunk diameter was by 10% thinner in comparison with the one on P. cerasifera-
Fruit trees on rootstock GF8/1 were of the same growth vigour as control ones. Our observations in most cases are in consistence with the results obtained in other countries (Hrotkó et al., 1998; Sosna, 2002).

The highest yield and yield efficiency of plum trees in our experiments was on *P. cerasifera* seedlings. In most foreign experiments clonal rootstocks improve plum tree productivity (Grzyb et al., 1998a; Hrotkó et al., 2002), but there are cases when trees on *P. cerasifera* seedlings were the most prolific (Grzyb et al., 1998b). Growth and yield of different scion-rootstock combinations depends on soil and climate conditions and the results may vary (Sitarek et al., 2004).

The most suckering rootstock was GF655/2. Similar information on it is presented by the other researches (Kosina et al., 2000; Sosna, 2002). St. Julien A and GF8/1 practically did not sucker. Trees on *P. cerasifera* seedlings produced few suckers, mostly from rootstock stem part, when trees planted to shallow.

According to the data of our experiment none of the tested plum rootstocks was better than standard *P. cerasifera*. In recent years scientists from neighbouring Poland revealed advantages of ‘Wangenheim Prune’ seedling rootstocks. Scion cultivars on this rootstock often are of superior characteristics in comparison with *P. cerasifera* seedlings or clonal rootstocks (Grzyb et al., 1998a; Rozpara, Grzyb, 1998; Sitarek et al., 2004). In the nearest future ‘Wangenheim Prune’ seedlings should be introduced into rootstock tests in Lithuania.

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KAULAVAISIŲ POSKIEPIŲ TYRIMAI LIETUVOJE

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Santrauka


Daugelį metų vyšnios ir trešnės buvo skriejamos į atsitiktinius trešnės (Prunus avium), kvapiosios (P. mahaleb) arba paprastosios (P. cerasus) vyšnios sėjiniukus, o slyvos – į skėtastakės slyvos (P. cerasifera) sėjiniukus. Pirmaisiais tyrimais buvo stengiamasi atrinkti vaismedžių, kurių sėjiniukai gerai prisiaikę prie mūsų agroklimato sąlygų, teigiamai veikia įskiepių derėjimą ir vaisių kokybę, formas. Vyšnioms skiepyti tinkamais buvo pripažinti trešnių veislės ‘Zolotaja Losickaja’ ir selekcinio Nr. 2 bei dviejų kvapiosios vyšnios formų – Nr. 817 ir Nr. 805 – sėjiniukai. Vaismedžiai su šiais poskiepiais sode augo vienodi, gausiai derėjo, vaisiai buvo geros kokybės.

Vėlesniais tyrimais įvertintas kloninių poskiepių PN (P. cerasus), P3, P7 (abu P. padus x (P. cerasus x P. avium)) ir Ž1 (P. cerasus) tinkamumas vyšnioms ir trešnėms. Nė vienas iš minėtų poskiepių vyšnioms nebuvo geresnis už standartinius – kvapiosios vyšnios sėjiniukus, o trešnės, skiepytos į kvapiosios vyšnios sėjiniukus, derėjo prasciausiai. Produktyviausias trešnės buvo su P3 poskiepiu, tačiau jis augino daug šakų atžalų. Perspektyviausias iš tirtų poskiepių trešnėms gali būti PN. Vaismedžiai su šiuo poskiepiu yra Žiok tėk produktyvesni negu skiepyti į kvapiosios vyšnios sėjiniukus, poskiepis neformuoja atžalų, vaisiai yra tinkamo dydžio.


Ateityje turtėtų būti tiriami nauji slyvų ir trešnių žemaugiai poskiepiai su perspektyviausiomis šių augalų veislėmis.

Reikšminiai žodžiai: kloniniai poskiepiai, sėjiniukai, slyvos, trešnės, vyšnios.