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

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MORPHOLOGICAL AND BIOLOGICAL CHARACTERISTICS OF FRUITS AND SEED OF THE SERVICE TREE (*Sorbus domestica* L.)

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A B S T R A C T

From 2001 to 2003, selected populations of the service tree (*Sorbus domestica* L.) were evaluated in terms of fruit and seed characteristics and field germination rate.

Biological material was collected from ten different sites in Slovakia. From one to eighteen different genotypes grew at each site. The distance between trees varied widely. Some trees grew in isolation, while others grew in dense stands. Fruit weight ranged from 3.0 to 21.8 g. Fruit width ranged from 16.0 to 33.0 mm. Fruit length ranged from 18.0 to 38.0 mm. The average weight of 1000 seeds ranged from 12.5 to 34.9 g. Average field germination rate ranged from 7.14 to 83.3%, depending on the site. The height of annual seedlings cultivated in the field 30 to 430 mm, depending on genotype. The average height of annual seedlings ranged from 60 to 210 mm. There were positive correlations between average fruit weight and the weight of 1000 seeds (r = 0.394 and 0.713). There were positive and negative correlations between average fruit weight and field germination rate (r = 0.127 and -0.396). There were negative and insignificant correlations between the weight of 1000 seeds and the field germination rate (r = -0.150 and -0.192).

Understanding the complex interaction between the biological properties of the seeds and growth intensity will help eliminate problems during propagation and transplanting.

Key words: *Sorbus domestica* L., diversity, seed morphology, seed germination

INTRODUCTION

Most *Sorbus* species are grown as ornamental plants. Only some of species are grown for their fruits. One of the economically valuable fruit

species is the service tree (*Sorbus domestica* L., 2n = 34) which belongs to section *Cormus*.

In the Mediterranean region, the service tree has been grown for its fruits for over two thousand years (Brütsch and Rotach, 1993 after Koch, 1985). The service tree is a always a rare tree throughout its natural range. In Slovakia, the service tree has been grown in the warmer southern and western parts of the country, and only rarely in the colder eastern regions (Májovský, 1992). It is considered to be an introduced species. In the wild, the service tree propagates itself by seed, especially within its natural range (Bignami, 200). There is considerable morphological variability among self-propagated seedlings. The trees reach reproductive maturity only when they are ten to fifteen years old (Fialová, 1998).

Even today, cultivated plants continue to be propagated by seed even though methods of propagation by grafting on on different rootstocks have been developed. Among the rootstocks that have successfully been used are *Crategus* ssp., *Pyrus* ssp., *Cydonia* ssp., *Mespilus germanica*, and *Sorbus domestica* seedling rootstocks (Kausch-Blecken von Schmeling, 1992). The best rootstocks for grafting are *Sorbus domestica* seedling rootstocks. Propagation by cuttings and meristematic propagation *in vitro* are also promising.

In commercial propagation of service trees, the main disadvantages of propagation by seed are low germination rates and the lack of uniformity among the seedlings. Another disadvantage is that service trees grow slow and start to bear fruit only when they are relative old (Šimánek et al., 1977).

Seedlings propagated in the greenhouse grow faster, but are less hardy. This probably accounts for the high death rate when they are transferred outside (Miko and Gažo, 2004).

There are significant differences between trees growing where cross pollination is possible and trees which grow where cross pollination is impossible due to isolation. The germination rate varies from tree to tree, and from year to year in a single tree. Germination rate did not depend on the age of the tree (Kausch-Blecken von Schmeling, 1992).

Experiments have shown that cultivating service trees under different conditions (open soil, substrate, peat container) significantly affects the growth of one-year-old seedlings. Cultivation in open soil seems to be more a better means of generative propagation than cultivation on substrate on polyurethane sheet plastic even though losses during transplanting are higher (Krška and Fialová, 1998).

MATERIAL AND METHODS

Service tree fruits and seeds were collected from various sites throughout Slovakia, including: Modra, Moravské Lieskové, Jabloňovce, Brhlovce, Pukanec, Hosťová, Hrnčiarovce, Jelenec, Príbelce, Sebechleby, and Zemplín. The trees studied were found growing in non-forest communities. The

distance between trees varied widely. Some trees grew in isolation, while others grew in dense stands. Fruits were collected in the first half of September in 2001 and 2002. Two weeks later, they were evaluated in terms fruit weight, fruit length, fruit width, number of seeds per fruit, seed length, seed width, seed thickness, and the average weight of 1000 seeds. Seeds which were brown were considered to be normal and were washed in tap water, dried, and cold stratified for ten to fourteen weeks at 2 to 4°C. During stratification, the seeds were regularly treated with Previcur. After stratification, germination and seedling growth were evaluated in the greenhouse. The seedlings were planted in a sawdust-perlite mixture 10 cm apart in rows. The seedlings were shaded, watered, fertilized, and treated to prevent pest infestation and diseases.

In 2002, the one-year-old seedlings planted in 2001 were moved out into an open plot. The soil was a brown soil with a pH of 6.4, humus content of 2.5%, nitrogen content of 2520 mg/kg, phosphorus content of 287 mg/kg, and potassium content of 265 mg/kg. The plot was situated 130 meters above sea level. Average annual rainfall was 561 mm. Average temperature during the vegetative phase was 16.3°C.

In 2003, the one-year-old seedlings planted in 2002 were planted in a substrate consisting of 60% composted coniferous sawdust, 30% peat and 10% perlite. The plants were fertilized by means of foliar applications of a 0.2% solution or Harmavit.

RESULTS

In 2001, seventeen genotypes were evaluated at five sites. Average fruit weight ranged from 7.4 to 14.8 g. Individual fruit weight ranged from 4.9 to 21.8 g. The relative variability of fruit weight ranged from 4.3 to 22.3 g. Average fruit width ranged from 21.4 to 27.2 mm. The relative variability of fruit width ranged from 17 to 39 mm. Average fruit length ranged from 23.1 to 32.3 mm. The relative variability of fruit length ranged from 20 to 37 mm.

In 2002, thirty-nine genotypes were evaluated at eight sites. Average fruit weight ranged from 4.6 to 15.8 g. Individual fruit weight ranged from 3.0 to 21.0 g. Fruit width ranged from 18.9 to 30.5 mm. The relative variability of fruit width ranged from 16 to 33 mm. Average fruit length ranged from 21.2 to 32.8 mm. The relative variability of fruit length ranged from 18 to 38 mm.

Results for the average weight of one thousand seeds (WTS) are presented in Tables 1 and 2. Average (WTS) ranged from 23.3 g at Jabloňovce in 2002, to 32.7 g at Modra in 2002. Individual WTS ranged from 12.5 g at Jabloňovce in 2001, to 34.9 g at Jelenec in 2002. The relative variability of WTS ranged from 1.4 to 37.7 g.

In 2001, a total of 1042 seeds from eight sites were tested for germination. Average germination rate ranged from 7.1% at Hosťová to 27.3% at Jabloňovce. Individual germination rate ranged from 0.0% at Modra and Jabloňovce, to 54.6% at Jabloňovce (Tab. 3).

Table 1. Weight of thousand seeds (WTS) of *Sorbus domestica* L. in 2001

Locality	Number of trees	WTS [g]	Range of values
Modra	3	27.3	20.0-33.3
Moravské Lieskové	8	23.8	19.0-27.8
Jabloňovce	18	23.4	12.5-31.2
Brhlovce	2	28.4	23.5-33.3
Pukanec	2	25.0	24.0-26.1
Hosťová	1	23.8	*
Devičany	1	28.6	*
Hrnčiarovce	1	29.0	*

Table 2. Weight of thousand seeds (WTS) of *Sorbus domestica* L. in 2002

Locality	Number of trees	WTS [g]	Range of values
Modra	2	32.7	26.6-33.7
Zemplín	5	31.2	29.0-34.3
Jabloňovce	6	23.3	20.8-28.3
Moravské Lieskové	6	27.9	25.9-31.0
Jelenec	7	26.3	22.7-34.9
Príbelce	3	27.1	21.9-33.2

Table 3. Germination rate of *Sorbus domestica* L. after stratification, seeds collected in 2001 and 2002

Locality	Average germination rate [%] 2002	Range of germination rate [%] 2002	Average germination rate [%] 2001	Range of germination rate [%] 2001
Modra	8.7	-	19.0	0-19.0
Moravské Lieskové	18.5	1.6-100.0	23.5	6.7-43.9
Jabloňovce	61.7	24.0-71.6	27.3	0-54.6
Brhlovce	*	*	17.2	16.7-17.6
Pukanec	*	*	18.7	17.4-20.0
Hosťová	*	*	7.1	*
Devičany	*	*	19.0	*
Hrnčiarovce	*	*	25.8	*
Jelenec	40.1	7.1-37.3	*	*
Porúbka	83.3	70.0-100.0	*	*
Koňuš	62.5	-	*	*

In 2002, a total of 1033 seeds from six sites were tested for germination. Average germination rate ranged from 8.7% at Modra to 83.3% at Porúbka. Individual germination rate ranged from 1.6% at Moravské Lieskové to 100% at Moravské Lieskové and Porúbka (Tab. 3).

In 2002, growth intensity was evaluated for 217 plants from seven sites. Average seedling height ranged from 128 mm at Pukanec to 210 mm at

Hosťová. Individual seedling height ranged from 35 mm at Jabloňovce to 430 mm at Jabloňovce) (Tab. 4).

T a b l e 4 . Growth intensity of one-year-old *Sorbus domestica* L. seedlings in 2002

Locality	Number of seedlings	Average height [mm]	Range of height [mm]
Modra	20	173	80-335
Moravské Lieskové	58	206	60-420
Jabloňovce	111	175	35-430
Brhlovce	8	201	65-350
Pukanec	9	128	75-155
Hosťová	3	210	105-325
Hrnčiarovce	8	140	85-250

In 2003, growth intensity was evaluated for 222 plants from eight sites. Average seedling height ranged from 60 mm at Koňuš to 83 mm at Jelenec. Individual seedling height ranged from 30 mm at Moravské Lieskové to 123 mm at Jabloňovce (Tab. 5).

T a b l e 5 . Growth intensity of one-year-old *Sorbus domestica* L. seedlings in 2003

Locality	Number of seedlings	Average height [mm]	Range of height [mm]
Modra	42	73	50-85
Moravské Lieskové	25	66	30-94
Jabloňovce	13	75	35-123
Choňkovce	35	71	44-90
Pribelce	12	78	39-85
Koňuš	15	60	45-75
Jelenec	72	83	46-95
Porubka	8	77	55-90

Correlations between fruit weight, WTS and germination rate are presented in Table 6.

T a b l e 6 . Correlations between fruit weight, weight of one thousand seeds (WTS) and germination rate in 2002 and 2003

Correlated characters	Weight of thousand seeds (WTS)	Germination rate
Fruit weight 2002	0.71^{++}	-0.40^{+}
Fruit weight 2003	0.39^{+}	0.13
WTS 2002	*	-0.19
WTS 2003	*	-0.15

2002 – $P_{0.05} – 0.350$. $P_{0.01} – 0.450$
2003 – $P_{0.05} – 0.325$. $P_{0.01} – 0.418$

DISCUSSION AND CONCLUSIONS

In the literature, the service tree is reported to propagate primarily by seed, especially within its native range. If insufficient ripening of seeds affects their biological characteristics, then fruit weight may be a good indicator or germination rate on the inter-genotype and intra-genotype levels.

Májovský (1992), in botanical characterization of species, reports that fruit weight in the service tree ranges from 20 to 30 g. In our study, average fruit weight ranged from 7.4 to 21 g, at the lower end of the range reported by Májovský. The lowest individual fruit weight in our study was 3.0 g. The high variability of fruit weight and fruit shape is reflected by the relative variability of fruit width, which ranged from 16 to 39 mm. This agrees with Májovský, who found that average fruit width ranged from 21.4 to 27.7 mm, and that fruit length ranged from 15.0 to 30.0 mm.

The relative variability of WTS is dependent on genotype and is often used as as an indicator of quality. There is no reliable information on the relative variability of WTS in the literature. In our study, individual WTS ranged from 12.5 to 34.9 g. Piotti and Di Noi (2001) reported that WTS averaged 31.2 g, but did not provide any information on germination.

The disadvantages of propagation trees by seed include poor germination rates, transplant shock, lack of uniformity, slow growth, and late age of bearing. To prevent these problems, the seeds need to be treated properly and suitable genotypes need to be selected. Growth intensity can be enhanced by grafting on rootstocks in the greenhouse, but this reduces hardiness and contributes to higher losses when the plants are transferred outdoors.

Krška and Fialová (1998) reported that average field germination rate ranged from 35.3% to 65% with seeds collected in Jalta. Greenhouse germination rate ranged from 70 to 90%. Kausch-Blecken von Schmeling (1992) reported that field germination rate of stratified seeds ranged from 60 to 100%. Germination rates varied widely on isolated trees that were not capable of being cross-pollinated. Germination rate not only varied from tree to tree, but also from year to year in the same tree. Germination rate was not affected by the age of the tree. In our study, germination rate also varied widely, from 0 to 100%, though we did not find that germination rates were higher with cross pollinated trees. In our studies, we have experimented with different stratification conditions, such as stratification under natural conditions and in the refrigerator box. We determined that the stratification period recommended in the literature, ten to fourteen weeks, is not enough, because some seeds germinate in the second year after sowing. Our results did not show that germination rate depends on cross pollination. We actually found that isolated trees had higher germination rates than trees growing in clusters. We also did not find any correlation between germination rate and either fruit weight or WTS. There was a positive correlation between fruit weight and WTS.

Pagan and Paganová (2002) found that average seedling height ranged from 56.1 to 85.3 mm in their study of year-old seedlings from different sites under

field conditions. There was considerable variability in seedling height. Krška and Fialová (1998) measured seedling height in plants grown in the greenhouse. Their results are comparable to the heights of seedlings cultivated under natural conditions, but lower than the heights of seedlings cultivated in substrate.

Cultivation plants in the field is less demanding, but has many disadvantages. In the second year after planting, the plants are often infected by fungus. The plants do not transplant well and suffer transplant shock. The soil needs to be mellow and good water distribution so that the plants do not form roots longer than 600 mm long roots. Cultivation in containers and substrates on plastic sheets reduced mechanical injury to roots during transplanting, but also reduced growth intensity.

Understanding the complex interaction between the biological properties of the seeds and growth intensity will help eliminate problems during propagation and transplanting.

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REFERENCES

Bignami C. 2000. Service tree (*Sorbus domestica* L.). Description and use of service tree Viterbo. ITALY INFORMATORE-AGRARIO 56: 55-58.

Brütsch U., Rotach P. 1993. Der Speierling (*Sorbus domestica* L.) in der Schweiz: Verbreitung, Ökologie, Standsortsanspruche, Konkurrenzkraft und Waldbauliche Eignung. Schweiz. Z. Forstwes 144, 1993, pp. 967-991.

Fialová M. 1998. Oskeruše – dřevina pro zemědělsky nevyužívané půdy: Diplomová práca. Lednice na Moravě: Mendelova zemědělská a lesnická universita v Brně, 1998, 58 p.

Kausch-Blecken von Schmeling W. 1992. Der Speierling (*Sorbus domestica* L.), Arterhaltung durch Nachzuch, Goltze-Druck GmbH & Co., Göttingen, 219 p.

Krška B., Fialová M. 1998 První zkušenosti z rozmnožováni oskoruše. In: Zb. Ref. "Problematika zachováni a ochrany starých či krajových odrud ovocných dřevín". Záhr. Fakulta Mendlova zemědesko-lesnícka universita Brno, Lednice na Moravě, pp. 77-80.

Májovský J. 1992. Jarabina. In: Bertová, L. et. al.: Flora Slovenska IV/3, Angiospermophytina, Dicotyledonopsida, Rosales. Bratislava: Veda, 1992, ISBN 80 – 224 – 0077 – 7, pp. 401-409.

Miko M., Gažo J. 2004. Genofond ovocných a okrajových druhov. In: J. Brindza (ed.), Záchrana ohrozeného genofondu starých a krajových odrôd z rastlinných druhov na Slovensku, Nitra: SPU v Nitre, 2004, pp. 65-71.

Pagan J., Paganová V. 2000. Poznatky o jarabine oskorušovej *Sorbus domestica* L. v krajine, In: Hrubík P. (ed.) Použitie rastlín v záhradnej a krajinnej tvorbe, Slovenská poľnohospodárska univerzita v Nitre, Nitra. pp. 7-13.

Piotti B., Di Noi A. 2001. Seed propagation of Mediterranean trees and shrubs, Roma I.G.E.R., ISBN 88-448-0081-0, p. 120.

Šimánek J. et al. 1977. Menej známe ovocniny. 1. vyd. Bratislava: Príroda, 1977, pp. 57-61.

OCENA WYBRANY MORFOLOGICZNYCH I BIOLOGICZNYCH CECH OWOCÓW I NASION JARZĄBU POSPOLITEGO (*Sorbus domestica* L.)

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S T R E S Z C Z E N I E

W latach 2001-2003 badano wpływ zmienności wybranych cech na poziom owoców i nasion oraz weryfikację zróżnicowania genotypów w warunkach polowych niektórych populacji gatunku jarząba pospolitego (*Sorbus domestica* L).

Materiał biologiczny zebrano z dziesięciu różnych geograficznie miejscowości w Słowacji. W jednym miejscu oceniano od 1 do 18 genotypów. Poszczególne drzewa charakteryzowano przez różną odległość pomiędzy nimi. W badaniach parametrów nasion określono średnią masę 1000 nasion w przedziale od 12,5 do 34,91 g. Zmienność masy owoców wynosiła od 3,0 do 21,8 g, zmienność szerokości owocu od 16,0 do 33,00 mm, a zmienność długości owocu od 18,0 do 38,0 mm. Zdolność kiełkowania nasion w warunkach polowych, w zależności od miejscowości, wynosiła od 7,14 do 83,33%. Przyrosty roczne siewek uprawianych w warunkach polowych, w zależności od genotypu, wynosiły od 30 do 430 mm. Średnia wysokość jednorocznych siewek wynosiła od 60 do 210 mm. Stwierdzono pozytywną korelację (r = 0,394 i 0,713) między średnią masą owoców i masą 1000 nasion. Między średnią masą owoców i kiełkowaniem nasion w polu stwierdzono pozytywną i negatywna korelację (r = 0,127 i -0,396). Natomiast korelacja pomiędzy masą 1000 nasion i kiełkowaniem nasion w polu okazała się negatywna i nieistotna (r = -0,150 i -0,192).

Wyniki wskazują na różny poziom zewnętrznej i wewnętrznej zmienności genotypowej cech morfologicznych i biologicznych z zastosowaniem w selekcji i rozmnażaniu klonów.

Słowa kluczowe: jarząb pospolity, *Sorbus domestica* L., zmienność, morfologia nasion, kiełkowanie nasion