Morphological parameters of container-grown, beech seedlings grown in thirteen types of pots

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Abstrakt

The paper gives shoot height, root collar diameter, root-to-shoot volume ratio, volume of fine roots, taproot length, and root abnormalities for 1-year old container-grown European beech seedlings raised in 13 types of pots.

Introduction

For over 40 years container-grown seedlings have been grown and used for reforestation in the Czech Republic (Dušek et al. 1985, Lókvenč 1962). Based on the increasing use of such seedlings in Sweden where container-grown stock accounts for 80% of total seedling production and Canada (Szable 2003) a gradual increase in the use of such stock is likely to occur also in the Czech Republic. Consequently, information is needed as what type of growing containers produces the best quality seedlings (Jurásek et al. 2006). The objective of the present work was to assess the suitability of different types of containers for raising European beech (Fagus sylvatica L.) seedlings.

Material and Methods

The current Czech technical standard CSN 48 2115 ZMĚNA Z1 (next CSN) gives the following standards (see CSN Tab. 3) for container-grown, European beech seedlings to be used for out planting (reforestation and afforestation):

<table>
<thead>
<tr>
<th>Shoot height</th>
<th>Top diameter of the container</th>
<th>Minimum depth height of the container</th>
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<tr>
<td>up to 35 cm</td>
<td>4 cm</td>
<td>10 cm</td>
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<tr>
<td>36 – 50 cm</td>
<td>5 cm</td>
<td>15 cm</td>
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</table>

The following 13 types of growing-containers were tested for the production of 1-year-old European beech seedlings was raised in the following types. They are described in Jurásek et al. (2006) and Nárovcová, Nárovec (2006): TUBUS 300 (cell...
volume 250 ml, ), HIKO V – 120 SideSlit (cell volume 120 ml), HIKO V – 310 (cell volume 310), HIKO V–265 (cell volume 265 ml), HIKO V–350 (cell volume 350 ml), HIKO V–400 (cell volume 400 ml), QUICK POT 35 T (cell volume 200 ml), QUICK POT 60 T/15 (cell volume 200 ml), QUICK POT 60 T/17 (cell volume 240 ml), QUICK POT 24 T (cell volume 330 ml), QUICK POT 15 T (cell volume 410 ml), PLANTEK 35 F (cell volume 275 ml) and ROOTRAINER FLEET A (cell volume 300 ml).

The seedlings were raised in a plastic-covered greenhouse at the Opočno Research Station using the identical cultural practices (e.g. seed stratification, the same growing media, fertilization with long-term fertilizers, irrigation, and protection of the seedlings from diseases and pests). At the end of the first year (growing season) the European beech seedlings were evaluated for their morphological characteristics.

Standard requirements according to Tab. 1 A, Tab. 2 and Attachment A of the above mentioned CSN are as follows:

- **above-ground part height**: 26 – 50 cm with a ±5 cm allowable tolerance, i.e. 21 – 55 cm
- **root collar diameter**: 5 mm, 4 mm with a 35 cm shoot height, allowable tolerance ±10 %, i.e. 3.6 mm (with a shoot length of up to 35 cm), 4.5 mm (with a shoot length over 35 cm)
- **maximum age**: 2 years
- **unacceptable form malformations**
- **minimum root-shoot ratios** (root-to-shoot volume ratio K/N): K/N 1:1 for a height of 26 – 35 cm, K/N 1 : 2 for a height of 36 – 50 cm; **no tolerance is permitted for broadleaf species with a 36 – 50 cm shoot length**
- **shoot length** minimum percentage of fine roots in the total root system volume (JK/K): JK/K 10 % for a shoot length of 26 – 35 cm, JK/K 5 % for a height of 36 – 50 cm; **no tolerance is permitted for broadleaf species with a shoot length of 36 – 50 cm**
- **taproot length** within the range of 12 cm (15 cm for the shoot length 36 cm) – 20 cm

Data sets were processed under the QC Expert program. We got average values after the verification of data homogeneity and normality. Besides average values, figure 1 and 2 show also the interval of confidence for mean value of primary set.

Average values enter into complex cluster analysis in the NCSS program. This method deals with the examination of multidimensional objects likeness (i.e. objects, whose greater number of variables had been measured) and their classification into classes, thus clusters.

The nearest neighbor clustering method was used.
Each treatment consisted of 500 seedlings; of which 100 were assessed morphologically using the above mentioned criteria (without repetition). The remaining seedlings were out planted to permanent sites in a plantation where their growth was monitored.

**Results**

The parameters measured were those set out in the CSN standard, i.e. root collar diameter, and shoot length, maximum age, root system abnormalities, and root-to-shoot ratio (K/N).

- Intolerable root system malformations were recorded at a negligible measure not exceeding the permitted tolerance of 5 % in any of the set of growing pots.
- The seedlings were grown for the period of one year and therefore meeting the requirement of maximum age stipulated by the standard.
- Average values of above-ground part height, root collar diameter and root-to-shoot volume ratio for the respective variants of the pots of containerized planting stock are presented in Fig. 1. All monitored variants met the quality requirements according to the CSN standard.

Fig. 1: Shoot height, root collar diameter, and root-to-shoot volume ratio of container-grown European-beech seedlings (average values)
Fig. 2. shows the average values for taproot length, and fine root volume as a percentage of total root system volume. These traits meet the requirements for standard quality for all 13 growing pot treatments. In regard to shoot length form, the deviations of individual variants did not exceed the boundary of 5%.

Using cluster analysis (Fig. 3) the container (pot) types were placed into seven clusters based on the seedling morphological criteria as follows:

Cluster 1: container type HIKO V – 120 SideSlit
Cluster 2: container type QUICK POT 35 T
Cluster 3: container types QUICK POT 60 T/15, PLANTEK 35 F and HIKO V – 350
Cluster 4: container types QUICK POT 24 T, HIKO V – 400 and QUICK POT 15 T
Cluster 5: container types QUICK POT 60 T/17, TUBUS 300 and ROOTRAINER FLEET A
Cluster 6: container type HIKO V – 265
Cluster 7: container type HIKO V – 310.
Discussions and Conclusions

Standard criteria for planting stock (according to CSN) is set at having no more than 5% of non-standard individuals. Our results show root collar diameter, shoot height, maximum age, unacceptable root system deformities, and root-to-shoot volume ratio were achieved in all 13 growing pot treatments used to grow European beech seedlings. The planting stock raised in all 13 pot (container) types reached acceptable standards. Other standards of the planting stock were achieved as well with the minimum values exceeded several times for fine roots in relation to total root volume. Development of a compact root system with a many have been reported previously for containerized seedlings grown on an underlying, e.g. in Vaca (2001), South, Shelton, Enemark (2001) who also observed that callus creation was occurred due to air pruning. An added benefit was that this resulted in new root growth after the seedlings were out planted in a plantation. The positive effect of air pruning on the amount of roots is apparent even after out planting onto permanent sites.

According to the cluster analysis the planting stock parameters in the individual treatments (growing containers or pots) are affected by the cell volume and height. Similar morphological parameters of seedlings were found in growing pots of
approximately the same cell volume and height. Shoot height achieved in pots with the smallest cell volume (120 ml) was 25 cm while the height achieved in containers whose volume ranged between 200 – 300 ml was 3 – 40 cm (with an exception of type HIKO V 265 in which the height exceeded the acceptable limit), and shoot height in containers with more than 330 ml volume was above 40 cm (with a cell height over 15 cm).

Shoot height during the growing season suggests a distinct improvement for containers with a volume of over 330 ml. Container-grown European beech can reach its growth potential and if an enough growing space is available European beech seedlings can grow up to a height of 45 cm within just one growing season.

The results of others (LOKVENC, 2001, JURÁSEK, 2004, KUPKA, 2004, NÁROVCOVÁ, 2004, NÁROVEC, 2006) demonstrate the quality of containerized planting stock provided that all conditions of intensive cultivation have been meet, e.g. tried container for the planting stock, a functional air cushion, and adherence to the 1-year period for growing the containerized seedlings in pots. Possible development of containerized planting stock abnormalities was drastically reduced (MAUER, PALÁTOVÁ, 2004) by substantial changes in growing technology, namely by essential changes in the construction of containers. Our results shows that adherence to conditions of intensive cultivation assures that the seedlings will not have root deformities. Eliminating root deformities in container-grown planting stock can be achieved by consistent use of biologically tested types of containers which in turn will results in a considerably higher use of containerized seedlings and transplants for forest regeneration (ZEZULA 2004).

Acknowledgement

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Literature


**Souhrn**


Objem a výška buněk pěstebních obalů se odráží ve znacích produkce. V obalech o nejmenším objemu buňky (120 ml) byla dosažena výška nadzemní části na úrovni 25 cm, průměrná výška 35 – 40 cm odpovídala použití pěstebních obalů o objemu 200 – 300 ml (s výjimkou obalu HIKO V 265, ve kterém výška přesahuje uvedenou hranici) a výška nadzemní části nad 40 cm v obalech objemu nad 330 ml (při výšce obalu nad 15 cm). Na dostatek prostoru (buňky o objemu nad 330 ml, výšky buněk nad 15 cm) buk reaguje mohutným růstem nadzemních částí i kořenových systémů. Buk lesní pěstovaný intenzivní technologií dokáže využít svého růstového potenciálu a při použití pěstebních obalů vyššího objemu narůstá na výšku 45 cm v průběhu jedné vegetační sezóny.

**Abstrakt**

Příspěvek uvádí morfologické parametry (výška nadzemní části, průměr kořenového krčku, poměr objemu kořenového systému k objemu nadzemní části, podíl jemných kořenů v objemu celého kořenového systému, délka kůlového kořene, deformace kořenů) jednoletých krytokořenných semenáčků buku lesního pěstovaného ve 13-tí typech pěstebních obalů.

**Kontaktní adresa**

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