

Results of ecological research on European chestnut (*Castanea sativa* Mill.) in the Castanetarium Horné Lefantovce

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Abstract

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The Castanetarium Horné Lefantovce was established in 1965–1970 on an area of 14.38 hectares of a former agricultural land. It is situated in a uniform ecological environment, providing suitable conditions for a thorough ecological-production research (evaluation of growth and production, phytotechnology, health condition, morphological and genetic stability) in different stand types (pure and mixed stands) and 86 seed progenies from 12 Slovak localities. Today it represents a valuable source of gene pool of the European chestnut. In this contribution we present ecological characteristics of the Castanetarium and recent scientific findings obtained when studying the subject.

Key words

European chestnut, Castanetarium Horné Lefantovce, production, thinning, seed progenies

Introduction

Reaching success in cultivation of European chestnut (*Castanea sativa* Mill.) trees in our climatic conditions requires getting perfectly familiar with biological properties and ecological demands of this species. To meet this requirement, there was established the Experimental Castanetarium in Horné Lefantovce in 1965. The main objective was to centralize the complex ecological-production research on the European chestnut under uniform site conditions (BENČAĎ and TOKÁR, 1971).

The present research on European chestnut trees in the Castanetarium Horné Lefantovce is focussed on the following issues:

1. Research on growth processes in seedlings and young plantations (BENČAĎ and TOKÁR, 1979).
2. Examining impact of tending interventions, from young stands to pole timber (pruning and cross-cutting, cleaning and thinning in various stand types (mixed and pure stands), (TOKÁR, 1987, 1998; TOKÁR and KREKULOVÁ, 2003, 2004).
3. Concentration of the whole Slovak assortment with the aim to study their biological cycles (phenology,

increment) (BENČAĎ and TOKÁR, 1978a, b, 1979; TOKÁR, 1996, 2002, 2003).

4. Establishment of a collection for testing genetic stability with a special accent on morphology of flowers and fruits.
5. Study of soil processes connected with the transformation of agricultural soil to forest one under influence of chestnut plantations (TOKÁR and KUKLA, 2006).
6. Study of resistance of European chestnut trees to biotic and abiotic harmful agents (BERNADOVIČOVÁ, 2003; TOKÁR and JUHÁSOVÁ et al., 2004).

We can see that at present time the Castanetarium Horné Lefantovce represents a concentrated rare gene pool of the European chestnut. Consequently, it requires appropriate attention and specific ways of management either in research-purposed activities or in forest management practice. For this reason, the innovation of forest management plans in 1999 assigned this territory to the special-purposed forests.

In this contribution we describe ecological characteristics of the Castanetarium and present recent scientific findings obtained studying the subject.

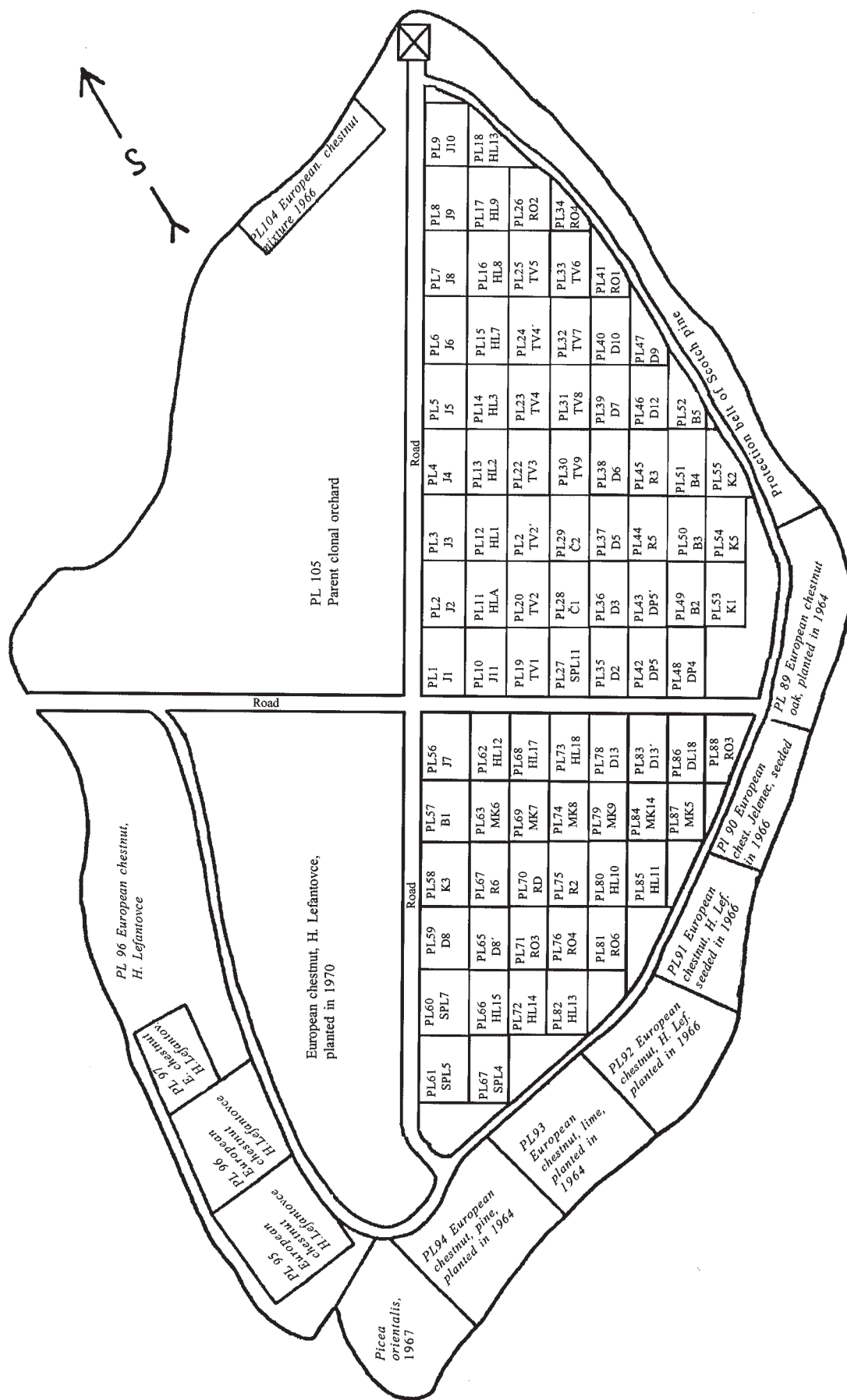


Fig. 1. Situation draft of experimental plot Horné Lefantovce
 BA – Bratislava, Č – Časť, DP – Dolné Pribelce, D – Duchonka, HL – Horné Lefantovce, J – Jelenec, K – K má,
 MK – Modrý Kameň, R – Radošiná, RO – Rovňany, SPL – Stredné Plachtince, TV – Tlstý Vrch

Material and methods

Ecological characteristics of the Castanetarium

The Castanetarium with an area of 14.38 ha and altitude 220–250 m asl is situated north of the town of Nitra, in the Tribeč Mts, the locality “Ferdinandka“. It was established in 1965–1970 on a former agricultural land by the “Arborétum Mlyňany – Institute of Dendrobiology SAS“. As for the organising structure, it belongs to the Slovak national forests, Forest Enterprise Topoľčianky, Forest District Nitrianska Streda, Area Lefantovce (Fig. 1).

As for the climate, it belongs to the warm climatic district A. At the time of establishment of the Castanetarium was the soil type at the site a brown loamy to clay-loamy soil (BENČAĽ and TOKÁR, 1971). The 30-year influence of European chestnut stands has resulted in formation of a luvisol with a typical illimerisation horizon (TOKÁR and KUKLA, 2006).

By its phyto-geography, the locality belongs to the West-Carpathian region (Carpaticum occidentale), the Pre-Carpathian flora district (Praecarpaticum).

Before the planting of European chestnut trees, the land had been used as an arable land. The succession processes running in the Castanetarium during the 35-years long growth of the woody plants have resulted in forest societies belonging to the third forest vegetation tier (oak-beech). Examination of the phytocenoses has given 86 mostly mesotrophic species characteristic for the group of forest types Fagetum pauper inferiora (TOKÁR and KUKLA, 2006).

In 1965–1970, 57,056 chestnut seedlings in various stand types (Table 1), mostly as seed progenies (86 progenies with together 24,145 trees) were planted in the Castanetarium. In 2001 at the age of 35, 13,589 chestnut trees, ie 23.82% out of the original planted material, were cultivated in the Castanetarium. This decrease was caused by stand tending (6 thinning interventions) and sanitary cutting (damaged and dry trees). More details about the methods can be found in the appended references.

Results

In the course of building of the Castanetarium and the chestnut trees development miscellaneous facts on the European chestnut were collected. This holds for the first consistent knowledge about the planting and establishment of European chestnut stands (BENČAĽ and TOKÁR, 1972), influence of seed mass on the height growth (BENČAĽ and TOKÁR, 1979), influence of pruning on height increment and habitus of young plantations of European chestnut (BENČAĽ and TOKÁR, 1978a), phenology (BENČAĽ and TOKÁR, 1978b), structure and production of various stand types of young European

chestnut trees (TOKÁR, 1987, 1996, 1998, 2003) and the chestnut trees grafting (TOKÁR and KOVALOVSKÝ, 1971).

In addition to establishment of European chestnut plantations, we are also focussing on providing high-quality seedlings. We use healthy seed material, assorted according to the weight. The research has shown that seed with larger mass would provide also higher-quality seedlings. The influence of the seed weight on the height increment is evident up to the 5-th year (BENČAĽ and TOKÁR, 1979). The quality of seedlings of plants in tree nurseries can also be influenced by using industrial, primarily nitrogen, fertilisers (TOKÁR, 1980) and by grafting. We recommend side-grafting and notch grafting. Important is the selection of a right graft and stock tree. The graft must be vital and it must be transplanted on a corresponding, synchronously flushing stock tree at the appropriate time. Better results can be obtained with side-grafting and grafting on one-year old wood than with notch grafting or side-grafting on two-year old wood (TOKÁR and KOVALOVSKÝ, 1971).

Chestnut plantations are getting shrub-like in case when frequently browsed by hare, red deer and roe deer. It is necessary to promote their development with pruning. The research results have shown that the European chestnut has a very good tolerance not only to coppice pruning but also to pruning of the main stem (BENČAĽ and TOKÁR, 1978a).

The research on phenology, beginning of phenophases and resistance to late frosts gave variable results, depending on the selection tree (genetic disposal) and climate in the respective year (BENČAĽ and TOKÁR, 1978b).

Since the establishment of the thinning experiment (1976), the chestnut stands in the Castanetarium were subjected to a 25-year tending and they have reached to the present days the growth stage of pole timber (TOKÁR and KREKULOVÁ, 2003). According to the survey accomplished in 2001, the mixed stands tended by crown thinning reached better results than untended stands and pure stands (Table 2), Fig. 2. The growing stock in tended stands at the age of 38 years ranges from 335.66 m³ ha⁻¹ (pure stand of European chestnut) to 410.89 m³ ha⁻¹ (mixed stand of chestnut trees with small-leaved linden).

Based on the overall evaluation of 86 seed progenies (SP) performed in 2001 at the stand age of 35 years (TOKÁR, 2003) when we calculated mean values of the standard deviation for all evaluated quantitative (dbh, height, growing stock, total volume production) and qualitative variables (quality of stem and crown), the seed progenies were classified in 6 categories (Fig. 3). In the category “very good”, there were assigned 17.44% of progenies: Jelenec 2, Horné Lefantovce A, Tlstý Vrch 1, 2, 2', 3, 4, 9, Duchonka 2, 3, 5, 6, 10, 12, Bratislava 4.

Table 1. Number of trees in Castanetarium Horné Lefantovce

| Permanent research plot (PRP) | Number of site in the year of establishment | Tree species | Origin of tree species | Type of forestation | Trees planted in 1965–1970 | | Note | |
|-------------------------------|---|-------------------------------|------------------------------------|---------------------|----------------------------|-----------------------------|-------|---|
| | | | | | (n ha ⁻¹) | Number of trees in 2001 (%) | | |
| I, II | 92 | <i>Castanea sativa</i> Mill. | Horné Lefantovce | planting | 1,471 | 433 | 29.43 | Six thinning interventions at PRP II from 1976 |
| III, IV | 90 | <i>Castanea sativa</i> Mill. | Protected area Jelenec | sowing | 7,691 | 2,807 | 36.50 | Observation of sprouting capacity from 1982 |
| V, VI | 89 | <i>Castanea sativa</i> Mill. | Horné Lefantovce | planting | 1,365 | 742 | 54.36 | Without observation on account of oak decline from 1986 |
| | | <i>Quercus petraea</i> Liebl. | | | 1,389 | 31 | 2.23 | |
| VII, VIII | 93 | <i>Castanea sativa</i> Mill. | Horné Lefantovce | planting | 2,151 | 248 | 11.53 | Six thinning interventions at PRP VIII from 1976 |
| | | <i>Tilia cordata</i> Mill. | | | 1,207 | 324 | 26.84 | |
| IX, X | 94 | <i>Castanea sativa</i> Mill. | Horné Lefantovce | | 1,100 | 319 | 29.00 | Six thinning interventions at PRP X from 1976 |
| | | <i>Pinus sylvestris</i> L. | | | 650 | 116 | 17.85 | |
| Seed progenies | 1–88 | <i>Castanea sativa</i> Mill. | Slovakia (12 localities) | planting | 24,145 | 3,798 | 15.73 | 86 seed progenies; five thinning interventions |
| Clonal orchard | 105 | <i>Castanea sativa</i> Mill. | Slovakia (12 localities) | planting | 2,791 | 712 | 25.50 | In 1972 re-grafted with grafts of 124 plus trees taken from 12 localities in Slovakia |
| The other plots | 91, 95–99 106 | <i>Castanea sativa</i> Mill. | Horné Lefantovce, mixture of Slov. | sowing, planting | 16,342 | 4,530 | 27.72 | – |
| Total | – | <i>Castanea sativa</i> Mill. | Slovakia | | 57,056 | 13,589 | 23.82 | – |

Table 2. Number of trees and growing stock volume in various stand types of European chestnut (*Castanea sativa* Mill.) on the PRP series in the Castanetarium Horné Lefantovce in years 1976–2001

| Permanent research plot (PRP) | Woody plant | Number of trees | | | | Growing stock | | | | Mean periodical increment (MPI) m ³ ha ⁻¹ y ⁻¹ | Increment percent (p) | Index (p) to the control PRP % |
|-------------------------------|------------------------------|--|--------|---|-------|---|--|---|--|--|--------------------------|-----------------------------------|
| | | y. 1976 | | y. 2001 | | y. 1976 | | y. 2001 | | | | |
| | | After intervention n ha ⁻¹ | % | Before intervention n ha ⁻¹ | % | After intervention m ³ ha ⁻¹ | Before intervention m ³ ha ⁻¹ | After intervention m ³ ha ⁻¹ | Before intervention m ³ ha ⁻¹ | | | |
| I. (control) | <i>Castanea sativa</i> Mill. | 10,379 | 100.00 | 2,138 | 20.60 | 41.80 | 356.10 | 12.57 | 30.07 | 100.00 | | |
| II. | <i>Castanea sativa</i> Mill. | 8,029 | 80.58 | 1,501 | 15.06 | 41.54 | 335.66 | 11.76 | 28.31 | 94.15 | | |
| VII. (control) | <i>Castanea sativa</i> Mill. | 5,490 | 48.08 | 1,018 | 8.92 | 33.15 | 194.80 | 6.47 | 19.52 | 100.00 | | |
| | <i>Tilia cordata</i> Mill. | 5,928 | 51.92 | 1,991 | 17.43 | 19.88 | 221.49 | 8.06 | 40.54 | 100.00 | | |
| | Total | 11,418 | 100.00 | 3,009 | 26.35 | 53.03 | 416.29 | 14.53 | 27.40 | 100.00 | | |
| VIII. | <i>Castanea sativa</i> Mill. | 3,648 | 43.82 | 861 | 10.34 | 40.35 | 260.85 | 8.82 | 21.86 | 111.99 | | |
| | <i>Tilia cordata</i> Mill. | 2,978 | 35.78 | 457 | 5.49 | 11.68 | 150.04 | 5.53 | 47.34 | 116.77 | | |
| | Total | 6,626 | 79.60 | 1,318 | 15.83 | 52.03 | 410.89 | 14.35 | 27.58 | 100.66 | | |
| IX. (control) | <i>Castanea sativa</i> Mill. | 5,466 | 74.12 | 1,596 | 21.64 | 19.35 | 213.82 | 7.78 | 40.21 | 100.00 | | |
| | <i>Pinus sylvestris</i> L. | 1,908 | 25.88 | 565 | 7.66 | 25.97 | 219.69 | 7.75 | 29.84 | 100.00 | | |
| | Total | 7,374 | 100.00 | 2,161 | 29.30 | 45.32 | 433.51 | 15.53 | 34.27 | 100.00 | | |
| X. | <i>Castanea sativa</i> Mill. | 3,977 | 54.38 | 928 | 12.68 | 15.28 | 199.55 | 7.37 | 48.23 | 119.94 | | |
| | <i>Pinus sylvestris</i> L. | 1,698 | 23.22 | 317 | 4.33 | 23.14 | 171.02 | 5.91 | 25.54 | 85.59 | | |
| | Total | 5,675 | 77.60 | 1,245 | 17.02 | 38.42 | 370.57 | 13.29 | 34.59 | 100.93 | | |



Fig. 2. Pure 23-years old European chestnut stand established on the site Horné Lefantovce (photographed by the author)

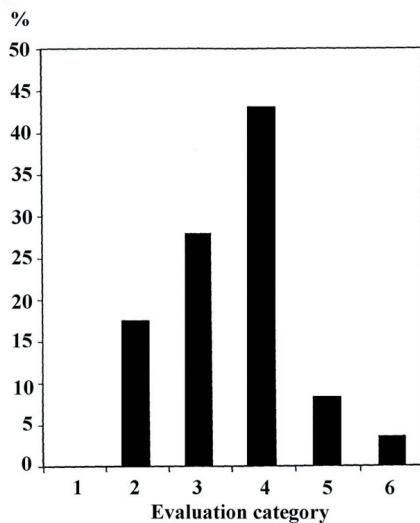


Fig. 3. The percentage of the 35-years old seed progenies of European chestnut in qualitative categories on the experimental chestnut plantation in Horné Lefantovce (1 – excellent, 2 – very good, 3 – good, 4 – bad, 5 – very bad, 6 – inconvenient)

In stand establishment, there should be avoided selection trees with progenies belonging to the categories bad, very bad and unsatisfying.

The Castanetarium Horné Lefantovce provides also a scarce gene pool for assessment of health status of this woody plant species. The evaluation of damage caused to chestnut trees by the fungi of genera *Phyto-*

phthora and *Cryphonectria* showed considerable differences in the presence of damaged trees among 86 seed progenies and also between the stand types (BERNADOVIČOVÁ, 2003; TOKÁR and BOLVANSKÝ, 2002; TOKÁR and JUHÁSOVÁ et al., 2004).

Conclusions

The Castanetarium Horné Lefantovce represents, even 35-years after its establishment, a highly rare collection of the European chestnut (*Castanea sativa* Mill.) gene pool in Slovakia. It provides possibilities for a comprehensive research on taxonomy, biology, ecology, production and protection of chestnut trees growing in the same ecological conditions. Especially important is concentration of valuable genetic material (seed progenies and grafted trees) from 124 selection trees from the most important 12 localities in Slovakia, planted in the Castanetarium mostly in multiple replications. The presented results have found implementation in fruit growing and silvicultural practice.

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Výsledky ekologického výskumu gaššana jedlého (*Castanea sativa* Mill.) v Kastanetáriu Horné Lefantovce

Súhrn

Kastanetárium Horné Lefantovce predstavuje aj po 40 rokoch od jeho založenia veľmi cenný zdroj genofondu gaššana jedlého (*Castanea sativa* Mill.) na Slovensku. Umožňuje rozvíjať komplexný taxonomický, biologický, ekologický, produkčný a ochranársky výskum v jednotných ekologických podmienkach. Obzvlášť významná je skutočnosť sústredenia cenného genetického materiálu (semenných potomstiev a štepencov) zo 124 výberových stromov z 12 najvýznamnejších lokalít Slovenska, ako aj zhodnocovanie vplyvu fytotechniky na produkciu rôznych porastových typov gaššana jedlého. Dosiahnuté výsledky, ktoré sme prezentovali, sa využívajú v ovocinárskej a lesníckej praxi (dopestovanie sadeníc, výsadba, tvarovací rez, porastové typy a ich fytotechnika). Pri štepení sa dobré výsledky dosiahli pri štepení do boku a na koziu nôžku. Pri fytotechnike porastov najlepšie výsledky v produkcii dosahujú vychovávané zmiešané porasty gaššana jedlého s lipou malolistou (pri veku 38 rokov zásoba 410,89 m³ ha⁻¹). V r. 2001 najlepšie výsledky v raste, produkcii a kvalite dosahuje 17,44 % semenných potomstiev (Jelenec 2, Horné Lefantovce A, Tlstý Vrch 1, 2, 2', 3, 4, 9, Duchonka 2, 3, 5, 6, 10, 12, Bratislava 4).

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