



XV WORLD FORESTRY CONGRESS

Building a Green, Healthy and Resilient Future with Forests

2–6 May 2022 | Coex, Seoul, Republic of Korea

Bitternut hickory (*Carya cordiformis* (Wangenh) K. Koch), a successful non-native tree species in the north-west of Romania

Valeriu-Norocel Nicolescu¹

¹ Faculty of Silviculture and Forest Engineering, Brasov, Romania - nvnicolescu@unitbv.ro

Abstract

The most abundant and most uniformly distributed of all the hickories (*Carya* spp.), growing throughout the eastern United States, bitternut hickory was introduced to Europe after 1689. It was used as ornamental species especially in parks and dendrological gardens as well as forest species in some European countries (e.g. Austria, Belgium, France, Germany).

In Romania, it was planted exclusively in parks and dendrological gardens, with the exception of Sacueni Forest District (north-west of the country). In this area, the first three individuals of bitternut hickory were planted in 1900, reaching nowadays breast diameters between 72.3 cm and 79.2 cm and heights over 25 m. Using seeds collected from these trees and seedlings produced in the local forest nursery, the species has expanded after 1957 and the total area of thirteen stands including bitternut hickory reaches nowadays 39.21 ha, with some interesting characteristics:

- it is found in monocultures as well as mixed stands (proportion between 10 percent and 90 percent) with different broadleaved tree species, both native (pedunculate oak *Quercus robur* L., small-leaved linden *Tilia cordata* L., sycamore *Acer pseudoplatanus* L.) and exotic (black walnut *Juglans nigra* L., northern red oak *Quercus rubra* L., pin oak *Quercus palustris* Muenchh., and black cherry *Prunus serotina* Ehrh.);
- bitternut hickory grew quickly in youth and reached mean diameters between 18 cm (25-30 years of age) and 32 cm (60 years) and mean heights between 16 m (25-30 years of age) and 25 m (60 years). These dimensions are similar to or even bigger than the associated species, both native and exotic;
- the species regenerates easily by seed and its seedlings have a higher shade tolerance than most of its associates, even though bitternut hickory is considered as intolerant of shade;
- it is a good self-pruner and epicormic branching is not a problem;
- it has never been affected by any damaging agent (diseases, pests) and is wind-firm, owing to its dense root system, with a pronounced taproot.

Keywords: bitternut hickory; north-west of Romania; biometrical performances; natural regeneration; natural pruning

Introduction, scope and main objectives

The non-native tree species are an important component of European forests, where they occupy a total area of 8.54 million ha, or 4 per cent of the total European forest area excluding the Russian Federation (Brus et al. 2019). Within Europe, 150 non-native tree species were listed as being used

in the forestry sector, out of them 145 species being grown in forests (including forest plantations). The non-native tree species originating from North-America are 71, and broadleaves prevail in this group (Brus et al. 2019). There are three *Carya* (hickory) species introduced to Europe, of which bitternut hickory is the most abundant and most uniformly distributed of all in the native range, growing throughout the eastern United States (Clay Smith 1990). In the United States, its wood is used for furniture, paneling, dowels, tool handles, ladders, as well as bars, crates, pallets, flooring. It also makes good fuel wood and is planted as an ornamental (Clay Smith 1990).

Bitternut hickory was introduced to Europe after 1689. It was used especially in parks and dendrological gardens as ornamental species (Pokorny 1990). It was also used as forest species in some European countries (e.g., Austria, Belgium, France, Germany). The best known cultures are those established in the Rhine Valley (France and Germany) since 1834, where bitternut hickory was associated with other species of *Juglandaceae* (mockernut hickory *Carya tomentosa* (Poir.) Nutt., hardy pecan *Carya illinoensis* (Wangenh.) K. Koch, black walnut *Juglans nigra* L., and butternut *Juglans cinerea* L.) as well as the *Juglans vilmoriniana* Lavallée ex. Vil. (*J. nigra* x *J. regia*) hybrid (Toussaint and Toussaint 1969, Schwab 1990).

In Romania (south-east of Europe), the year of its introduction is not known but the species was planted exclusively in parks and dendrological gardens throughout the country (Dumitriu-Tataranu (coord.) 1960, Dumitriu-Tataranu and Costea (coord.) 1988).

The only exception, where bitternut hickory was used as forest species, is Sacueni Forest District (north-west of the country, along the Romanian-Hungarian border). In this area, the first three individuals of bitternut hickory were planted in 1900, reaching nowadays breast diameters between 72.3 cm and 79.2 cm and heights over 25 m (Figure 1).



Fig. 1: One of the individuals planted in 1900. In the foreground, natural regeneration by seed of bitternut hickory

Using seeds collected from these trees and seedlings produced in the local forest nursery, the species has expanded in plantations after 1957. In this context, the scope of our paper is to outline the most important characteristics of these cultures, with focus on some relevant issues such as area of plantations including bitternut hickory, biometrical performances of the species, potential of natural regeneration by seed, potential of natural pruning and susceptibility to produce epicormic branches, resistance to damaging agents and wind-firmness.

Methodology/approach

The analysis of ecological and site conditions where bitternut hickory grows was based on the last edition (2018) of forest management plans of the two working circles (I Saniob and II Sacueni), part of Sacueni Forest District (INCDS 2018a, INCDS 2018b).

This information was combined with data on biometrical performances (diameters and heights) measured within rectangular plots of 500 sq.m established in all sub-compartments where bitternut hickory makes at least 10 per cent of species composition. These data were subsequently processed during the office stage of our research, in order to produce values of mean diameters, mean heights, and standing volumes.

The issues of natural regeneration by seed, natural pruning and susceptibility to produce epicormic branches, as well as resistance to damaging agents and wind-firmness were also observed within these plots as well as at each individual stand level.

Results

The plantations including bitternut hickory were established in a region with a moderate temperate-continental climate (C.f.b.x. according to the Köppen's classification), the most important characteristics being as follows: mean annual temperature 10.3°C, mean annual precipitation 573.3 mm, mean aridity index 28.2 (transition zone between the moderately humid plain forest area and forest steppe). If the mean temperature in the north-west of Romania is within the range specific to the native range (4-18°C), the local climate is much dryer as the mean annual precipitation is lower than in the U.S. where it ranges between 640 and 1270 mm (Clay Smith 1990).

The soils of plantations including bitternut hickory, even having quite heavy texture as including an important proportion of clay (Bt horizons), are favorable to its culture. They show a medium to high fertility for broadleaved forests dominated by native oaks such as pedunculate oak *Quercus robur* L., sessile oak *Quercus petraea* (Matt.) Liebl., and Turkey oak *Quercus cerris* L.

The thirteen stands including bitternut hickory, with a total area of 39.21 ha, are located on flat lands, with an altitude of 100 m asl (80%) and 150 m asl (20%), respectively. The species itself covers 13.22 ha and the main characteristics of these stands are as follows:

a. Species composition of stands including bitternut hickory

The species is found in monocultures (5.64 ha, 14 per cent) as well as mixed stands (proportion of bitternut hickory between 10 per cent and 90 per cent; area 33.57 ha, 86 per cent) with different broadleaved tree species. These tree species are both native (predominantly pedunculate oak, but also small-leaved linden *Tilia cordata* L. and sycamore *Acer pseudoplatanus* L.) and exotic (black walnut as predominant species - Figure 2, along with northern red oak *Quercus rubra* L., pin oak *Quercus palustris* Muenchh., and black cherry *Prunus serotina* Ehrh.).

All mixtures are intimate and allows for the joint development of tree species, with similar as well as divergent requirements in terms of site and stand conditions.



Fig. 2: Mixture bitternut hickory (BH)-black walnut (BW) in sub-compartment 12A

b. Biometrical performances of the species

In the research area, bitternut hickory grew quickly in youth and reached mean diameters between 18 cm (25-30 years of age) and 32 cm (60 years) and mean heights between 16 m (25-30 years of age) and 25 m (60 years) (Table 1).

Table 1: Most important characteristics of stands with bitternut hickory

Working circle	Sub-compartment no.	Area (ha)	Tree species	Share (%)	Age (years)	Mean diameter (cm)	Mean height (m)	Standing volume (cu.m ha ⁻¹)
I Saniob	10	9.98	BW	50	45	28	25	182
			PO	20	45	24	21	55
			SL	20	45	28	25	70
			BH	10	45	28	25	42
			Total	-	45	-	-	349
	12A	2.62	BH	70	50	24	24	275
			BW	30	50	26	24	102
			Total	-	50	-	-	377
	14B	2.31	BH	100	60	26	25	420
	18C	1.71	BH	100	60	28	25	420
19B	2.67	PO	70	60	32	24	243	
		BH	30	60	32	25	126	
		Total	-	60	-	-	369	
II Sacueni	17A	0.67	BW	70	25	16	16	105
			BH	20	25	18	16	41
			SY	10	25	14	13	11
			Total	-	25	-	-	157
	52B	3.02	NRO	50	45	30	20	125
			BH	30	45	26	19	81
			POA	20	45	28	17	40
Total	-	45	-	-	246			

BH = bitternut hickory; BW = black walnut; PO = pedunculate oak; SL = small-leaved linden; SY = sycamore; NRO = northern red oak; POA = pin oak

As shown in the table, these mean dimensions of bitternut hickory trees are similar to or even bigger than the associated species, both native and exotic. They are also comparable to the mean heights and diameters reached on a good site in the native range (Ohio Valley) (15 cm diameter and 12.2 m height at 30 years, 29 cm diameter and 21.0 m height at 60 years) (Clay Smith 1990).

c. Potential of natural regeneration by seed

In the north-west of Romania, bitternut hickory regenerates easily by seed (Figures 3a and 3b).



(a)



(b)

Fig.3: Seedlings (a) and saplings (b) of bitternut hickory under a dense canopy cover

Its seedlings are sometimes the only ones established under the shelter of closed stands (crown cover 80 to 90 per cent), showing a higher shade tolerance than most of its associates, even though bitternut hickory is considered as intolerant of shade (Clay Smith 1990). This characteristic - higher shade tolerance than the associates - is also shown by the species on bottom lands in the native range (Clay Smith 1990).

d. Potential of natural pruning and susceptibility to produce epicormic branches

Bitternut hickory is generally a good self-pruner (Figure 4a) since early ages and epicormic branching is not a problem, even though a few branches do occur (Figure 4b) due to either sudden exposure to light through thinning or when stand density is too high and the crown size is not big enough to cover the light requirements of mature trees; consequently the crown expands downwards by epicormics.

e. Resistance to damaging agents and wind-firmness

In the north-west of Romania, since its introduction over 120 years ago, bitternut hickory has never been affected by any damaging agent (diseases or pests).

When some minor windfalls occurred in the region, the species has never been affected as it is wind-firm, owing to its dense root system, with a pronounced taproot (Clay Smith 1990).



(a)



(b)

Fig. 4: Perfect (a) and imperfect (b - shows few epicormics) natural pruning of bitternut hickory trees

Discussion

Bitternut hickory was introduced in the north-west of Romania over 120 years ago. Since then, but especially after 1957, when its forest use has grown, the species has become an interesting component of local forest flora, either in pure or mixed stands, with both native or exotic tree species.

Even not planted on a large scale, owing to the past and current forest legislation in Romania, prohibiting the large-scale use of non-native tree species, regardless their ecological or commercial/industrial values, in different site conditions (MAPPM 2000), bitternut hickory has shown some interesting features:

- it grows quickly in youth so can reach important sizes (diameters, heights) and productions (cu.m ha^{-1}) at quite young ages;
- it is easily regenerated naturally by seed even under the shelter of closed stands. Its shade tolerance is obviously higher than most of its associate species, either native or non-native;
- natural pruning of bitternut hickory trees is perfect (no remaining branches in the lower part of the trunk) and starts at early ages. Sometimes epicormic branches occur below the `normal` crown, owing to the sudden opening of canopy or high stand density and competition, leading to too small crowns. However, epicormic branching is not a problem for bitternut hickory trees;
- neither diseases nor pests affected bitternut hickory trees since the introduction in the north-west of the country. This is also true in terms of wind damages, as the species is able to resist to strong winds owing to its dense root system, including a pronounced taproot.

Conclusions

Bitternut hickory, a species with a quite long history - over 120 years - in the north-west of Romania, has confirmed the expectations of its culture in terms of growth and yield, natural regeneration, natural pruning, resistance to diseases and pests or wind.

The success of its past and present cultivation in the region is a guarantee for its further use in forestlands even on a small-scale, as imposed by the current Romanian regulations on species compositions for new plantations.

Acknowledgements

I thank our colleagues and friends from Sacueni Forest District for their invaluable help and assistance throughout the fieldwork phase of our study. This work was not funded by any source but carried out voluntarily.

The views expressed in this information product are those of the author and do not necessarily reflect the views or policies of FAO.

References

- Brus R, Pötzelberger E, Lapin K, Brundu G, Orazio C, Straigyte L, Hasenauer H. 2019. Extent, distribution and origin of non-native forest tree species in Europe. *Scandinavian Journal of Forest Research*, 34(7): 533-544.
- Clay-Smith H. 1990. Bitternut hickory (Wangenh.) K. Koch. In: R.M. Burns and B.H. Honkala (eds), *Silvics of North America. Vol. 2. Hardwoods*. United States Department of Agriculture, Forest Service, Agriculture Handbook no. 654, Washington, D.C., pp. 190-197.
- Dumitriu-Tataranu I. (coord.) 1960. *Arbori si arbusti forestieri si ornamentali cultivati in R.P.R.* Editura Agro-Silvica, Bucuresti, 810 pp.
- Dumitriu-Tataranu I, Costea A. (coord.) 1988. *Compatibilitatea ecologica si silvoproductiva a unor specii lemnoase exotice in R.S. Romania*. Centrul de Material Didactic si Propaganda Agricola, Bucuresti, 114 pp.
- INCDS. 2018a. *Amenajamentul Ocolului silvic Sacueni, Directia silvica Bihor, U.P. I Saniob*. Institutul National de Cercetare-Dezvoltare in Silvicultura "Marin Dracea", Bucuresti, 383 pp.
- INCDS. 2018b. *Amenajamentul Ocolului silvic Sacueni, Directia silvica Bihor, U.P. II Sacueni*. Institutul National de Cercetare-Dezvoltare in Silvicultura "Marin Dracea", Bucuresti, 509 pp.
- MAPP. 2000. *Norme tehnice privind compozitii, scheme si tehnologii de regenerare a padurilor si de impadurire a terenurilor degradate 1*. Ministerul Apelor, Padurilor si Protectiei Mediului, Bucuresti, 253 pp.
- Pokorny J. 1990. *Arbres*. Editions Gründ, Paris, 142 pp.
- Schwab S. 1990. *Juglans und Carya im Elsaß*. *Allgemeine Forst Zeitschrift* 48: 1227-1230.
- Toussaint E, Toussaint J. 1969. *Juglans et Caryas en Alsace*. *Revue Forestière Française* 6: 537-546.