Bulletin of the *Transilvania* University of Braşov
Series II: Forestry • Wood Industry • Agricultural Food Engineering • Vol. 6 (55) No. 2 - 2013

BLACK LOCUST (*Robinia pseudoacacia* L.) – AN INVASIVE NEOPHYTE IN THE CONVENTIONAL LAND RECLAMATION FLORA IN ROMANIA

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Abstract: *The aim of this review was to contrast the multiple uses of black locust (Robinia pseudacacia L.) with the risks associated with its invasive behaviour. Data regarding the chorology, ecological requirements and biological characteristics were also presented. Special attention was given to the role of black locust in land reclamation in Romania. The importance of this species is expected to increase in the future due to its high ecological amplitude and biological characteristics that make it suitable for arid lands.*

Key words: *black locust, Robinia pseudacacia, land reclamation, neophyte.*

1. Introduction

As a technique, forest land reclamation represents a system of forestry measures aimed at counteracting anthropogenic and natural degradation processes affecting forest and non-forest ecosystems [6]. Left unattended, such processes can lead to a dramatic decrease in land productivity, and, hence, reduce the range of potential land-uses for present and future generations. The main way to counteract degradation processes such as soil erosion by water or wind, soil salinization, landslides, swamp formation, etc., which impact especially agricultural lands worldwide, is land reclamation through afforestation [8].

One of the most often used tree species in forest land reclamation in Romania is black locust *(Robinia pseudoacacia* L.). It is a leguminous (*Fabaceae* Lindl.), deciduous tree species native to the south-eastern part of North America, where it occurs in a wide range of forest communities [48].

Black locust was introduced in Europe between 1623 and 1635 [47]. It is assumed that it was introduced in Romania around 1750 and one century later, it was already regarded as naturalized in some areas [16].

In Romania, this species was used for establishing both protective (especially control of wind erosion, reclamation of disturbed sites and sites improvement) and productive plantations. Large areas have been planted with black locust in the southern (Oltenia), south-eastern (Bărăgan and Dobrogea), eastern (southern Moldova) and north-western (Crişana) regions of Romania [41]. Moreover, due to its many uses, quick growth and ease of vegetative propagation, it has also become one of the most frequent tree species in rural landscapes [16].

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In the late 1960s, there were estimated 80.000-90.000 ha of black locust plantations in Romania [16]. In 1984, according to the Romanian National Forest Inventory (NFI), the area occupied by black locust was 146.499 ha [50]. In 2008, the total area covered by black locust (only in state-owned forests) was 155.687 ha [51]. Furthermore, according to the present NFI (2008-2013, report not published yet), the area occupied by black locust stands (both state-owned and privately owned forests and also trees outside the forest land) is around 250.000 ha (data available at the Forest Research and Management Institute Bucharest). The afore-mentioned national statistics and NFI data suggest that the area occupied by black locust stands has actually remained constant. The majority of restituted forest areas following the first Restitution laws (Law no. 18/1991 and Law no. 1/2000) were indeed illegally logged by private owners, but in most of the cases stand composition remained the same (100% black locust) due to coppicing. The decrease was noticeable considering the area of planted stands, which lost ground in favor of sprout-regenerated stands. Many of the restituted black locust stands are now strongly degraded due to lack of management and illegal logging/grazing. Unfortunately, very high pressure from illegal logging was exerted on black locust stands in the south and south-eastern regions, where forest resources had always been scarce and where black locust had been planted mainly for wind erosion control [41]. As a result, counties from these regions (*i.e*. Teleorman, Dolj, Călăraşi, Ialomița and Galați) continue to have large areas of degraded lands, unsuitable for agriculture [7]. Moreover, they also have the lowest percentage of forest cover, varying from 4% to 8 % [42].

Today, more than two decades after the fall of communism in Romania, the interest for using black locust in forest land reclamation and site amelioration seems to be at its highest: *i)* Law no. 289/2002 regarding the creation of a national shelterbelt network was modified in 2011 (Law no. 213/2011) and finally became operational. Black locust is expected to play a key role in many regions in establishing this network (Florin Dănescu, personal communication); *ii)* the excessive and unsustainable industrial development in the communist era has left a large number of severely disturbed sites (*e.g.* spoil banks and pollution with heavy metals) where reclamation experiments with black locust have shown promising results [3].

2. Black locust: ecological requirements and biological characteristics

2.1. Ecological requirements

Black locust is a very shade intolerant species [41]. Nevertheless, its ability to tolerate shade increases with site fertility [16]. According to Rédei and his colleagues [39], the small size of the leaflets could be an adaptation to reduce self-shading and also to rapidly adjust the leaf position according to light intensity.

R. pseudoacacia is a thermophilous species, with an optimum temperature of 9-11ºC in Romania and 7-10ºC across its natural distribution range [41]. It is highly susceptible to early frosts [41], which is why black locust plantations in Romania are located at relatively low altitudes.

In its native range, climate conditions are humid, with a mean annual total precipitation of 1.000-1.800 mm [48]. In Romania, black locust stands on sandy soils in the Oltenia region cope with only 400-500 mm of annual precipitations [41].

Black locust is very sensitive to competition and in Romania it was planted mostly in pure stands for this reason [46].

It prefers soils with a coarse texture (sands and sandy loams) [16], well drained and aerated, but tolerates a wide range of edaphic conditions, including salinized soils [6] and even soils polluted with heavy metals [3]. On the other hand, high levels of calcium carbonate in the soil will lead to poor performances, especially when combined with arid conditions [41].

Black locust is resistant also to drought stress and to air pollutants [39].

2.2. Biological characteristics

R. pseudoacacia flowers at early ages (5-7 years old) and produces annually abundant seed crops. Seeds have a high viability and longevity [39].

As mentioned earlier, black locust has a rapid juvenile growth rate [28, 39, 41]. For example, on an alluvial plain in northern China, trees in a shelterbelt were nine meters tall at the age of nine [25]. On a spoil bank reclamation site in Kansas, U.S.A., black locust trees reached seven meters in height at the age of ten, surpassing all other planted species [48]. Rapid juvenile growth is very important for the establishment of shelterbelts [28] and for land reclamation in general.

R. pseudoacacia is an atmospheric nitrogen-fixing species [36]. It also has a far-reaching dimorphic root system [45], with vertical roots capable of growing downwards to a depth of about 8 meters, especially on xeric sites [5] and horizontal, shallow and wide-spreading roots going as far as 1-1.5 tree heights [49].

Furthermore, black locust has a high annual production of fast-decomposing leaves which generate a high quantity of organic matter (in the form of raw humus [36]). This species, therefore, contributes substantially to the soil formation processes [31]. It was demonstrated that when soil is mixed with leaves, soil reaction (pH) and bulk density significantly decrease, while the aggregate water stability, water holding capacity and cation-exchange capacity tend to increase [19]. At the same time, the decomposition of the leaves has a positive influence on the content and fractional composition of the soil humus [27]. It has also been documented that the establishment of a black locust shelterbelt leads to an increase in soil organic carbon and total nitrogen content, hence, improving soil quality [34].

Black locust can be propagated in both generative and vegetative ways. Even though seeds can be easily cleaned, stored and sown [39], generative propagation is often difficult due to the thickness and impermeability of the seed coat. For this reason, a pre-sowing treatment of the seeds should be applied by means of mechanical scarification, repeated hot-water treatment or treatment with sulphuric acid [20].

Seed maturation is annual, in September, when seed dissemination begins and continues until the next spring [41].

In the case of black locust, vegetative propagation is considered a more common way of reproduction than seed. Stump and root sprouts occur as a result of stem and root damage, cutting, fire, wind or disease [48].

Moreover, vegetative propagation can be done by cloning [37], by applying cuttings [21], by grafting or micropropagation. These propagation methods are often used for the multiplication of valuable varieties, as in the case of *R. pseudoacacia* var. *oltenica* [10], a variety with superior wood quality characteristics [11], or for several valuable selected clones [2].

The natural longevity of black locust is estimated to be around 90-100 years [41, 48]. In Romania, black locust stands do not usually reach old ages as the common silvicultural treatment is coppicing with 20 years rotation lengths [28]. Nevertheless, the rotation length for stands with special protective functions can be increased to

35-40 years, but only if the trees are healthy and without signs of decay [46].

Black locust is also highly resistant to many wood decaying fungus species and pests [39].

3. The role of black locust in forest land reclamation in Romania

In 1852 the first protective plantations with black locust in our country were established at Băileşti-Dolj [14], with seeds originating from Turkey [11]. After 1883, more than 38.000 ha of sandy and rocky soils in the Oltenia region were planted with black locust for wind erosion control [16].

Nowadays, black locust is one of the most used tree species for forest land reclamation in Romania [6]. This is mainly due to four reasons: *i*) it is a fast growing species with large ecological amplitude [41], *ii*) it grows on many types of degraded terrains [46], *iii*) it has a high survival rate [6], *iv*) saplings are easy and cheap to produce in tree nurseries.

According to Romanian forestry literature, black locust prefers the sandy soils in the southern parts of the country [22], [26], especially in the Oltenia region [9], where it plays an important role in the process of sand dune fixation or in the establishment of crop protection shelterbelts [30]. The afforestation of these degraded lands increases the land use potential and improves the living conditions of the local communities [4].

4. Black locust: a multi-purpose tree species

Due to its wide ecological amplitude, fast growth, and many uses, black locust has been used intensively in Romania in the last 150 years for the establishment of productive and protective forest plantations. The wide range of timber and non-timber uses supports it as a genuine multipurpose tree species [49].

Firstly, due to its ecological requirements and biological characteristics, being famous for its ability to grow under a wide spectrum of soil conditions and to colonize bare terrains [40], it is suitable for land reclamation in forest steppe areas.

Secondly, black locust is very appreciated for its capacity to produce durable, heavy and high density heartwood [24, 28], suitable for many uses (e.g. timber and poles [13], barrel staves, railway sleepers or parquetry [41]). Moreover, it is one of the most important tree species for biomass production and carbon fixation across Europe [15, 29, 35]. In Hungary, for example, black locust is the most used tree species for establishing fuel plantations [38].

Thirdly, black locust shelterbelts, beside their protective and land reclamation uses, can provide habitat to several small mammals [23]. Moreover, its leaves and stems can be used as fodder [44].

Last but not least, this tree species can have other uses, such as raw material in the food industry, in biotherapy, apiculture [17] and landscape architecture [33].

As an ornamental tree species, the forms *decaisneana* and *semperflorens* or variety *umbraculifera* [41] can be used in parks, on roadsides or even in gardens.

5. Black locust: risks

According to Daehler [12], rapid vegetative propagation and nitrogen fixation represent indicators of plant invasiveness. As a result, black locust is regarded as one of the most aggressive invasive neophytes in Central Europe [18]. It is also reported as invasive in other European countries such as Cyprus, France, Greece, the Netherlands, Switzerland and the United Kingdom [49].

From a nature conservation perspective, one of the central problems regarding black locust colonisation is the species' capacity to rapidly increase the soil nutrient concentration and to alter soil chemical properties [18, 47]. These modified conditions facilitate invasion by other non-native species [43], particularly nitrophilous plants [47].

According to Berthold and his colleagues [1], after only two generations of black locust had been cultivated on the same site, soil chemical properties were severely altered.

Moreover, black locust seems to be especially invasive on nutrient-poor, dry and warm sites, which are particularly worthy of protection [18, 47].

Another risk is posed by the long term use of coppicing for stand regeneration in plantations, as it leads to a decrease in genetic variability (*i.e.* the gene pool), and consequently, to a decrease in stand vitality [41]. Consequently, a steady decrease in stand productivity is expected [16] and it seems that fewer and less vital sprouts are produced [46].

Last but not least, the fact that black locust is only planted in pure stands [11, 46] represents a limiting factor to stand and site biodiversity. On the other hand, when this species is planted on sterile mining dumps or other heavily degraded sites, it improves the local biodiversity (*e.g*. by offering shelter and nesting places for bird species which are considered top indicators of food chain in those areas).

6. Conclusions

The high adaptability of this species rather than its invasive behaviour was the reason why it was extended in culture, leading to its naturalisation.

According to this brief literature review, black locust should be regarded more as a very useful multi-purpose tree species with a high potential for forest land reclamation, rather than a dangerous invasive neophyte. Nevertheless, the presence of this species should be carefully monitored around nature reserves and fragile landscapes in nutrient-poor and dry locations, as it has a great harmful potential.

The importance of black locust in Romania is also reflected by the relatively high number of stands designated as forest genetic resources distributed throughout the country [32]. In the future, in order to obtain the best protective-productive results, planting material originating from forest genetic resources must be used.

The Romanian experience acquired in land reclamation with *R. pseudacacia* is very important from the perspective of global warming. It is expected that the importance of this species will increase in the future due to its high ecological amplitude and biological characteristics that make it suitable for arid lands.

References

1. Berthold D., Vor T., Beese F., 2009. Effects of cultivating black locust (*Robinia pseudoacacia* L.) on soil chemical properties in Hungary. In: Forstarchiv 80(6): 307-313.
2. Bîrlănescu E., Diaconu M., et al., 1977. Cercetări privind ameliorarea salcâmului (*Robinia pseudoacacia* L.) (Researches regarding the breeding of black locust (*Robinia pseudoacacia* L.)). In: Analele ICAS 34(1): 41-54.
3. Blaj R., Mărginean M., Stanciu M., 2009. Aspects regarding to ecological reconstruction at Copşa Mică, Sibiu County. In: Research Journal of Agricultural Sciences 41(2): 23-28.
4. Blujdea V., Abrudan I.V, Pahonțu C., 2003. Afforestation of degraded and low productive lands by flexible instruments under Kyoto Protocol. In: Analele ICAS 46(1): 399.

5. Bunger M.T., Thomson H.J., 1938. Root development as a factor in the success or failure of windbreak trees in the southern high plains. In: Journal of Forestry 36: 790-803.
6. Ciortuz I., Păcurar V-D., 2004. Forest land reclamation (in Romanian). Braşov. Lux Libris Publishing House.
7. Constandache C., Nistor S., Ivan V., 2006. Afforestation of the degraded lands unsuitable for agriculture in the southeast of the country (in Romanian). In: Analele ICAS 49: 187-204.
8. Constandache C., Păcurar V. et al., 2010. The functional efficiency of forestry plantations for protection and amelioration works on degraded lands (in Romanian). In: Revista Pădurilor 1: 26-31.
9. Constantinescu E.V., Catrina I., et al., 1970. Research using radioactive isotopes for assessing the mineral nutrition of black locust (in Romanian). In: Analele ICAS 2: 27-56.
10. Corneanu M., Corneanu G.C., et al., 2010. Micropropagation of *Robinia pseudoacacia* var. *oltenica* selected stress resistant clones on media with deuterium depleted water. In: Journal of Horticulture, Forestry and Biotechnology 14(1): 141-144.
11. Costea A., Lăzărescu C., Bîrlănescu E., 1970. Contributions regarding the selection of black locust and stand manipulation with this species (in Romanian). Analele ICAS 2: 163-168.
12. Daehler C.C., 1998. The taxonomic distribution of invasive angiosperm plants: ecological insights and comparison to agricultural weeds. In: Biological Conservation 84: 167-180.
13. Dini-Papanastasi O., 2004. Contribution to the selection of productive progenies of *Robinia pseudoacacia* var. *Monophylla* Carr. from young plantations in Northern Greece. In: Forest Genetics 2: 113-123.
14. Drăcea M., 2008. Contributions to the study of black locust in Romania with a focus on its silviculture on sandy soils in Oltenia (in Romanian). Editura Silvică Publishing House, Bucureşti.
15. Grünewald H., Böhm C. et al., 2009. *Robinia pseudoacacia* L.: A Lesser Known Tree Species for Biomass Production. In: Bioenergy Research 2: 123-133.
16. Haralamb At. M., 1967. The silviculture of forest tree species (in Romanian). Editura Agro-Silvică Publishing House, Bucureşti.
17. Ion N., Ion V. et al., 2010. Informatics System for Planning the Pastoral Beekeeping in Romania. Proceedings of the 1st International Animal Health Science Conference –The Beekeeping Conference "New Advancements and Challenges in the Beekeeping World". Addleton Academic Publishers, New York, SUA.
18. Ivajnšič D., Cousins S.A.O., Kaligarič, M., 2012. Colonization by *Robinia pseudoacacia* of various soil and habitat types outside woodlands in a traditional Central-European agricultural landscape. In: Polish Journal of Ecology 60: 301-309.
19. Khan B., Ablimit A. et al., 2010. *Robinia pseudoacacia* leaves improve soil physical and chemical properties. In: Journal of Arid Land 2: 266-271.
20. Lăzărescu C., Okskay S., 1951. Contributions to the study of seed quality and seed manipulation in the case of black locust (in Romanian). In: Analele ICAS 12(1): p. 72-98.
21. Lăzărescu C., Papadopol C.S., Papadopol V., 1963. Propagation of black locust through cuttings (in Romanian). In: Analele ICAS 23(2): 5-14.
22. Lăzărescu C., 1968. Contributions regarding favourable forest areas for the establishment of black locust (in Romanian). In: Analele ICAS 26: 5-8.

23. Lęcki R., 2004. Small mammals in two midfield shelterbelts of different age. In: Polish Journal of Ecology 52(4): 455-459.
24. Ledgard N.J., 1993. *Robinia pseudoacacia* for ground-durable posts? In: N.Z. Forestry: 7-9.
25. Li C., Guan W. et al., 2003. Assessment of landscape ecology of agricultural protection forest system at Beizang Town, Daxing County, Beijing. In: Journal of Forestry Research 14(2): 135-140.
26. Mateescu Fl., 2008. Soil reclamation, fertilization and herbicidation (in Romanian). M.A.S.T. Publishing House, Bucureşti.
27. Mazurek R., Piotrowska A., 2010. Influence of black locust (*Robinia pseudoacacia* L.) shelterbelts on the content and fractional composition of humus in arable soil developed from loess. In: Ecological Chemistry and Engineering 17(12): 1585-1590.
28. Muşat I., 2012. Principles for the establishment of transport network windbreaks and their practical implementation (in Romanian). In: Revista de Silvicultură şi Cinegetică 17: 30-33.
29. Nuță S.I., Niculescu M., 2009. The characterization of the ecological efficiency of the forest curtains through the quantification of the biomass carbon accumulation for the forest species which are specific to the Sadova-Corabia Improvement System. In: Analele Universității din Craiova, seria Agricultură-Montanologie-Cadastru 39: 302-305.
30. Nuță S.I., Niculescu M., 2011. The influence of forest belts on tobacco crops in hydro ameliorative Sadova-Corabia system. In: Analele Universității din Craiova, seria Agricultură-Montanologie-Cadastru XLI(2): 210-214.
31. Panagopoulos T., Hatzistathis A., 1995. Early growth of *Pinus nigra* and *Robinia pseudoacacia* stands: contributions to soil genesis and landscape improvement on lignite spoils in Ptolemaida. In: Landscape and Urban Planning 32: 19-29.
32. Pârnuță Gh., Stuparu E. et al., 2011. National Catalogue of Forest Genetic Resources (in Romanian). Editura Silvică Publishing House, Bucureşti.
33. Pârvu C., 2006: Plant Universe (in Romanian). ASAB Publishing House, Bucureşti.
34. Piotrowska A., Mazurek R., 2009. Assessment of black locust (*Robinia pseudoacacia* L.) shelterbelt influence on enzymatic activity and some chemical parameters of Eutric Cambisol. In: Polish Journal of Soil Science XLII/1: 31-41.
35. Quinkenstein A., Freese D. et al., 2012. Agroforestry for Mine-Land Reclamation in Germany: Capitalizing on Carbon Sequestration and Bioenergy Production. In: Advances in Agroforestry 9: 313-339.
36. Rahmonov O., 2009. The chemical composition of plant litter of black locust (*Robinia pseudoacacia* L.) and its ecological role in sandy ecosystems. In: Acta Ecologica Sinica 29: 237-243.
37. Rédei K., Osváth-Bujtás Z., Balla I., 2002. Clonal approaches to growing black locust (*Robinia pseudoacacia*) in Hungary: a review. In: Forestry 75(5): 547-552.
38. Rédei K., Csiha I., Keserű Z., 2011. Black locust (*Robinia pseudoacacia* L.) Short-Rotation Crops under Marginal Site Conditions. In: Acta Silvatica et Lignaria Hungarica 7: 125-132.
39. Rédei K., Csiha I., et al., 2012. The Silviculture of Black Locust (*Robinia pseudoacacia* L.) in Hungary: a Review. South-East European Forestry 2:101-107.

40. Sabo A.E., 2000. *Robinia pseudoacacia* Invasions and Control in North America and Europe. In: Restoration and Reclamation Review 6(3): 1-9.
41. Şofletea N., Curtu L., 2007. Dendrology (in Romanian). Transilvania University Publishing House, Braşov.
42. Vasilescu M.M., 2003. Forest shelterbelts-a topic of great interest (in Romanian). In: Revista de Silvicultură şi Cinegetică 17: 30-31.
43. Von Holle B., Joseph K.A. et al., 2006. Facilitations between the Introduced Nitrogen-fixing Tree, *Robinia pseudo-acacia*, and Nonnative Plant Species in the Glacial Outwash Upland Ecosystem of Cape Cod, MA. In: Biodiversity and Conservation 15:2197-2215.
44. Zhang G.J., Li Y., et al., 2012. The chemical composition and ruminal degradation of the protein and fibre of tetraploid *Robinia pseudoacacia* harvested at different growth stages. In: Journal of Animal and Feed Sciences 21: 177-187.
45. Zhou Z.C., Shangguan Z.P, 2005. Soil anti-scouribility enhanced by plant roots. In: Journal of Integrative Plant Biology 47: 676-682.
46. *** Tehnical norms for forest stand manipulation (in Romanian). 2000. Ministerul Apelor, Pădurilor şi Protecţiei Mediului.
47. *** Case Studies on Alien Species in Germany. Available at: http://www.umweltdaten.de/publikationen/fpdf-l/1942.pdf.
48. *** *Robinia pseudoacacia*. In: Fire Effects Information System. Available at: http://www.fs.fed.us/database/feis.
49. *** Forestry Compendium. Available at: http://www.cabi.org/FC/.
50. *** Synthesis of Romanian National Forest Inventory, 1984. Forest Research and Management Institute, Ministry of Forestry.
51. *** Statistical report, code SILV-1, 2007. The yearbook of National Institute of Statistics (in Romanian).