

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 pseudoacacia 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 pseudoacacia, 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, Ialomiţa and Galaţi) 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 9-11°C in Romania and 7-10°C 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. pseudoacacia* 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.

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