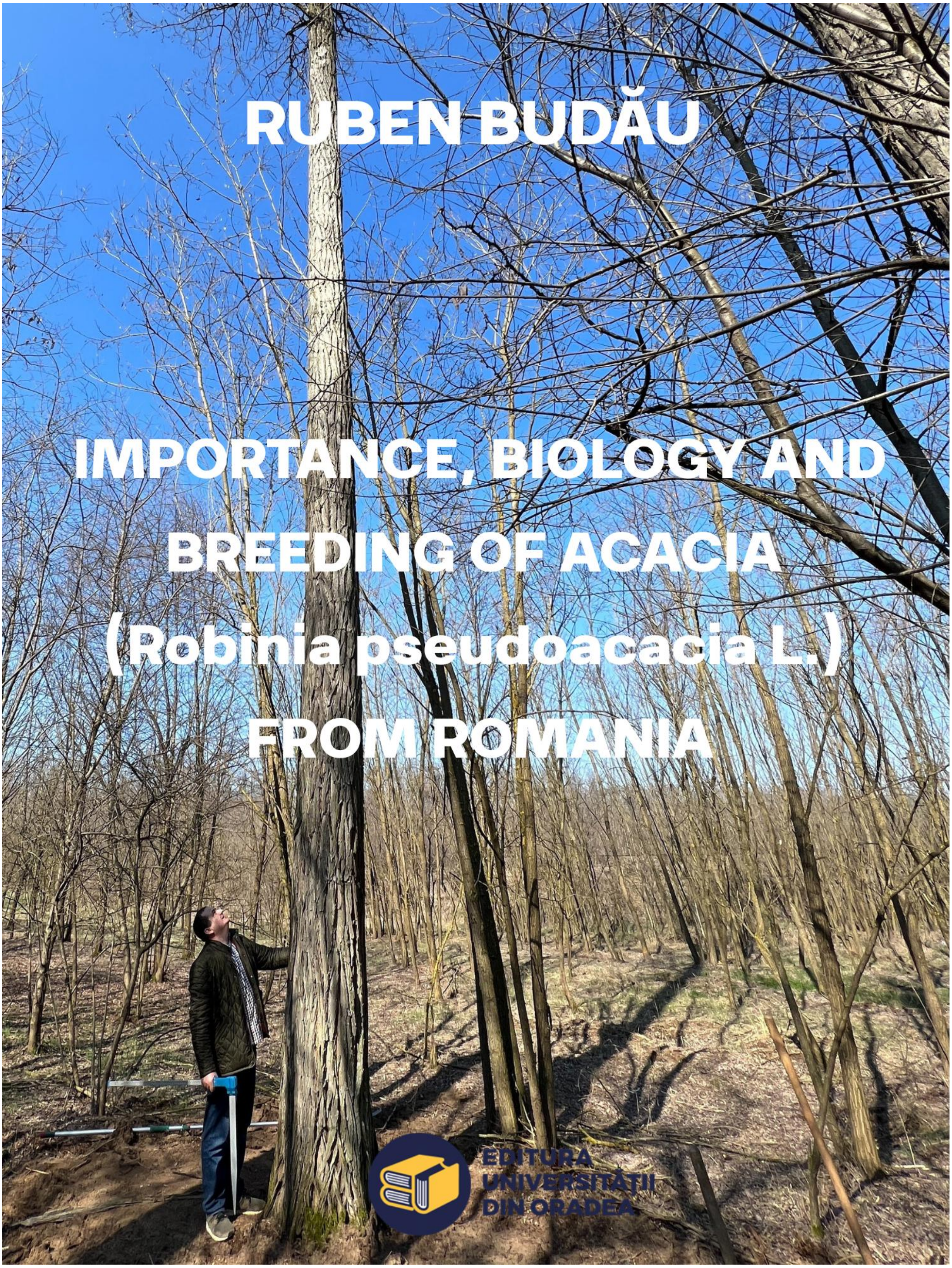
RUBEN BUDĂU

IMPORTANCE, BIOLOGY AND BREEDING OF ACACIA (Robinia pseudoacacia L.) FROM ROMANIA



EDITURA UNIVERSITĂȚII DIN ORADEA

RUBEN BUDĂU

IMPORTANCE, BIOLOGY AND BREEDING OF ACACIA

(*Robinia pseudoacacia* L.)

FROM ROMANIA

EDITURA UNIVERSITĂŢII DIN ORADEA

2025

Reviewers:

Professor Timofte Adrian Ioan – University of Oradea, Faculty of Environmental Protection, Department of Forestry and Forest Engineering

Professor Sărac Ioan, Ph.D. – King Mihai I Life Sciences University of Timişoara, Faculty of Engineering and Applied Technologies, Department III/ Genetic Engineering

ISBN 978-606-10-2404-9.

The University of Oradea Publishing House is accredited by CNCSIS, COD 149.

Citation recommendation: Budău R., 2025 Importance, Biology and Breeding of acacia (*Robinia pseudoacacia* L.) from Romania. Editura Universității din Oradea **ISBN 978-606-10-2404-9.**

Author's contact:

Department of Silviculture and Forestry Engineering, University of Oradea, 26 General Magheru Boulevard, 410048 Oradea, Romania;

e-mail: rbudau@uoradea.ro

Profil Linkedin: http://linkedin.com/in/ruben-bud%C4%83u-b81368b5

EDITURA UNIVERSITĂŢII DIN ORADEA

TABLE OF CONTENTS

1. INTRODUCTION

Scientifically known as Robinia pseudoacacia, the acacia tree, this tree has demonstrated a remarkable ability to proliferate in a diverse range of geographic locations around the globe, encompassing significant regions in both the US, Europe, and Asia. This species is valued not only for its aesthetically pleasing appearance and ornamental qualities, but also for the multitude of economic benefits and ecological functions it offers in different environments.

In the geographical context of our nation, the forestry practice of cultivating acacia has garnered a significant degree of scholarly and practical interest, particularly following the latter portion of the 19th century, during which this species has been extensively propagated across diverse regions of the country not solely as a visually appealing ornamental tree but also as a vital component in forested agricultural systems specifically situated in locales characterized by elevated summer temperatures.

Through the comprehensive examination presented in this scientific volume, the main objective was to meticulously elucidate the multiple characteristics of acacia, focusing in particular on the critical dimensions of its biological attributes, the mechanisms of improvement and reproduction and importance, as well as the significant ecological contributions to its environment.

I sincerely hope that the wealth of information meticulously curated and articulated in these pages will prove to be extremely beneficial not only to the dedicated researchers involved in the scientific exploration of this topic, but also to the practitioners who apply this knowledge in real-life contexts, as well as to ardent nature enthusiasts, thus encouraging a deep understanding and increased appreciation for this invaluable species that plays an essential role in ecosystems.

With appreciation,

Ruben Budău

2. ORIGINS AND SPREAD

2.1. Origin of acacia

The acacia *(Robinia Pseudoacacia L.)*, is native to eastern North America, in an area between 33° and 42° north latitude (Figure 1).

In its country of origin (USA), acacia has long been used as a successful species for afforestation of abandoned farms, mining dumps, especially surface mining sites, with the area occupied by this species exceeding 120,000 ha at the end of the last century. It is worth noting that in the USA, the afforestation of unproductive land is still being carried out under a program to plant about 200 ha of acacia each year.

FIGURE 1. ORIGINAL AREA OF THE ACACIA TREE

(SOURCE: USDA, NRCS, 2023)

2.2. Distribution of acacia in the World

The remarkable ecological (Figure 2) plasticity of the species is illustrated by its adaptation to a wide range of climates in terms of mean annual temperatures and rainfall levels (300-760 mm per year), as it is found in Cyprus and Israel (dry areas) as well as in northern India and Burma, in much warmer and wetter climates than in its native areas. It does very well in Japan, where rains are evenly distributed throughout the year, as well as in South Africa, where it rains only in summer.

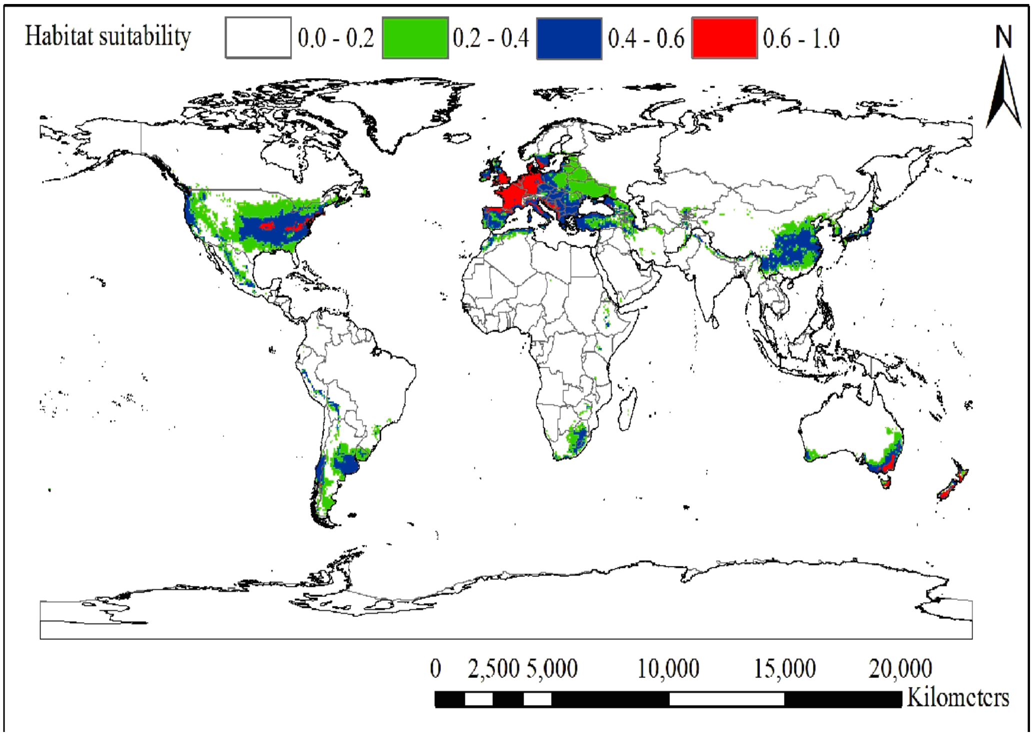


FIGURE 2. GLOBAL POTENTIAL DISTRIBUTION AREA OF BLACK LOCUST PREDICTED BY THE MAXENT MODEL AROUND THE WORLD (THE GRID CELL IS 0.5° × 0.5°); THE VALUE OF CLIMATIC SUITABILITY IS THE AVERAGE OF A TEN-FOLD CROSS-VALIDATION. THE STANDARD DEVIATION OF EACH GRID SQUARE IS 0–0.11. (SOURCE: LI G., et al., 2014)

2.3. Brief history and distribution of acacia in Europe

Around 1601, it was introduced to France by Jean Robin, director of the Paris Botanical Garden, from where its cultivation spread throughout Europe. In homage to the man who introduced the species to Europe, it was given the Latin binary name of the genus *Robinia*.

At first, the species was valued for its fast growth and its flowers with real ornamental and honey-bearing properties, being used only as an ornamental tree near avenues and in parks (Drăcea, 2008; 1926). It was only after 1766, when the *Nouveau traité sur l'arbre nomée acacia* (a. n., cited by Drăcea, 2008; 1926) appeared in Bordeaux, that the acacia tree proved its value as a forest tree and as a tree of "all possible uses" (Haralamb, 1965 cited by Enescu, 1975). It is interesting to note that although the above-mentioned treatise appeared in France, it was the Germans who capitalized on the results presented in the book.

Immediately after its appearance, they translated the work into German and started the first acacia plantations on the sandy soils in the north of their country. The obvious success of the acacia in these plantations (fast growth, high quality timber, easy processing, sand-binding) led to its spread throughout the northern half of Germany, with many of the leading foresters of the time (Hartig, cited by Drăcea, 2008; 1926) considering it the savior of the German forest economy of the time.

Around 1710 - 1720, acacia began to migrate to Eastern Europe, first being reported in Hungary, where in 1820 the first acacia plantations were established in the Hungarian pampas.

In Europe, by far the largest grower of acacia is Hungary, with 345,000 ha covered with this species (Németh and Molnár, 2005). According to data published by DeGomez and Wagner (2011) as well as Keresztesi (2013), in the late 1980s, large areas under acacia were also found in the USSR (144. 000 ha, mainly in Ukraine and Moldova), Romania (120,000 ha), France (100,000 ha), Bulgaria (58,000 ha), Yugoslavia (50,000 ha), Czechoslovakia (28,000 ha). In Asia, large acacia growers are the Republic of Korea (1.22 million ha) and China (1.0 million ha).

2.4. History of acacia cultivation in Romania

It is believed that acacia was introduced to our country around 1770 by the Turks, hence the popular name "salcâm", by which the species is known in Romania and in several other Balkan countries such as Bulgaria, Albania and Macedonia.

The routes by which the acacia penetrated into the areas of Europe south-east of the Carpathians, i.e. the eastern part of the Balkan Peninsula, European Turkey, Macedonia, Bulgaria, old Romania, as far as Bukovina and Bessarabia, were not from the west, from France via Austria and Hungary, but the reverse, from the south-east, from Constantinople, with the Turks most probably as intermediaries, and the period when this happened was a few decades before 1777. Constantinople thus seems to have been, in the 18th century, the center from where acacia spread to South-Eastern Europe (Drăcea, 2008;1926).

The acacia, also known as the "poor man's oak", is a fast-growing forest species and was quickly "adopted" by the village population because it best meets the needs of small forest owners.

The first acacia forest in Romania was planted in Băilești, Oltenia, in 1852, when the problem of fixing the sands of Oltenia and afforesting the compact soils of the Bărăgan region was first raised in Romania. Organized attempts to afforest the sands of Oltenia with acacia date back to the 1860s, and the first stands of trees were planted in 1862 on the heavy soils of the Bărăgan.

It was only after 1853 that this species was planted in the south of Banat, at Deliblat, on the sandy soils near the Danube (Vadas, 1911; 1914). This is probably the first documentary record of the presence of acacia in a Romanian province (Transylvania).

In Muntenia and Moldavia, and in South-Eastern Europe in general, curiously enough, it seems that the acacia did not come from Hungary via Transylvania, but from the south-east, from Turkey. The approximate period of this expansion of the acacia from Turkey to South-Eastern Europe is considered to be between 1750 and 1777 (Drăcea, 2008; 1926). Beyond these uncertainties, it is certain that by 1860 acacia was a known and appreciated forest species in the provinces of the Romanian Old Kingdom, and from 1864 it experienced a very rapid spread due to the acute need for afforestation of the sandy lands of southern

Wallachia and Moldavia.

In 1883, large areas were afforested, both on the sands of south-eastern Oltenia (where over 25,000 ha were planted), as well as in north-eastern Muntenia and southern Moldavia. If we add to this the acacia afforestation carried out in north-west Transylvania at the beginning of the 20th century, as well as the afforestation in the forest area or on the heavy soils of the foothills and steppe, we have more than 120 000 ha of acacia plantations in our area at that time.

Worth mentioning is the acacia grove in the Piscu-Tunari Forests (Ciurumela point), in the Danube meadow, near the Piscu-Vechi commune (Calafat), considered to be the most beautiful in Europe (Simionescu 1961).

2.4.1. Systematic acacia cultures in Romania

In its area of origin (North America) and in many European countries, including Romania, acacia is considered an invasive species (Strode, 1977; Sîrbu, C. and A. Oprea, 2011; www.europe-aliens, robinia, 2006), which suggests that it does not have very high demands on the main vegetation factors (temperature, humidity, sunshine duration) and on the soil on which it grows. However, specialists in the field (Ivanschi et al., 1992) have made a pedoclimatic zoning of the area occupied by acacia in Romania, as follows:

- **The very favorable zone** comprising only a strip along the River Danube, starting further south of Turnu Severin and extending beyond Giurgiu;
- **Favorable area** for the cultivation of acacia, within which this species behaves well as a forest tree, producing stands of production classes II and III. This zone is represented by more or less extensive areas in all the historical regions of Romania:
  - In Muntenia, in an area starting south of Bucharest and stretching north to Târgoviște and Ploiești;
  - In Oltenia, the area favorable to acacia is represented by a strip running down the Jiului Valley from Târgu Jiu to Filiași, extending eastwards to Drăgășani;

- In Transylvania, the favorable area is the Mures Valley from Târgu Mures to Arad and the Western Plain from Chișineu Criș to north of Satu Mare;
- In Moldova, this area includes strips along the Siret from Bacău to Focsani and along the Vaslui and Prut from Iași to Galati.

FIGURE 3. ACACIA CULTIVATION ZONES IN ROMANIA

(SOURCE: ADAPTED FROM IVANSCHI ET AL., 1992)

Outside forest plantations, acacia is widely used both as a roadside tree along country roads and highways, and appears as isolated trees in the gardens and courtyards of peasant households, so that villages in the lowland region appear, from a distance, as true acacia forests (Negulescu, 1964; 1965). Particularly in the south-western regions of the nation, the acacia species has discovered an exceptionally advantageous ecological niche characterized by a climate that is predominantly warm; however, it is noteworthy to mention that this climate is significantly less humid when compared to the conditions prevalent in its native habitat, as illustrated in Figure 3.

2.4.2. The situation of acacia cultivation in Romania

In our country, the cultivation of acacia has enjoyed special attention, especially since the second half of the 19th century, being cultivated throughout the country as an ornamental tree, but also in forest crops in areas with high summer heat. It has naturalized, becoming subspontaneous from the plains to the lower mountains.

The first acacia forest plantations were established in 1852 in Băilești Dolj, and the species was subsequently planted on ever larger areas, particularly in Oltenia, on shifting sandy soils. Apart from that area, it was also used in other continental sandy areas, such as those in the north-west of the country, between Oradea and Carei, or in Moldavia, at Hanul Conachi, etc. (Doniță, 1999).

In general, acacia has been widely used for afforestation of degraded lands, on eroded coasts, on raw soils, being a good soil fixator. Its ecological plasticity has meant that it has sometimes been cultivated even in unsuitable conditions, because acacia has certain limits of ecological plasticity which are well known from the specialist literature and from the many experiments carried out in the approximately 150 years of cultivation in our country. In fact, both in our country (Drăcea, 2008; 1926) and abroad (Németh and Molnár, 2005), it is very clearly outlined that the climatic requirements of acacia are very similar to those of grapevine.

Drăcea (2008; 1926) distinguishes two separate areas in Romania, very remote and very different from each other, where acacia occurs as a forest tree, namely the sandy soils area in southern Oltenia and the unforested area (steppe) in southeastern Romania.

The first area is located on the left bank of the Danube, in southern Oltenia, roughly between Turnu-Severin and the confluence of the Danube with the river Olt, where there is a strip of land 5-15 km wide, sometimes wider, with very extensive sandy, dune-like areas. These areas used to be covered with grasses, but since the 1850s they have been either cultivated or used intensively for grazing. As a result, the sands became mobile and the land in the area took on a dune-like, wavy appearance.

The fertility of the soils, which typically exhibit elevated moisture levels, is subject to variability as a consequence of fluctuations in clay and humus concentrations. Humus has formed and accumulated over long fallow periods. When such sandy soils are subjected to the action of sand, the top layer of humus is blown away and lost to agriculture and forestry.

Other factors that have led to the impoverishment of sandy soils are agricultural crops and grazing, particularly intensive grazing. The moisture content of such soils varies greatly from place to place and is due not so much to rainfall as to groundwater input. When the waters of the danube rise, they penetrate the sandy soil laterally over kilometers of width and moisten it to varying depths.

In geographical regions characterized by low elevation, where the land is persistently inundated by water for an extended duration, it has been observed that the acacia species that have been deliberately cultivated tend to vanish or become significantly diminished in their presence. The tops of the dunes cannot benefit from this groundwater moisture, receiving only atmospheric precipitation, which in this area is less than 500 mm per year.

The second distinct area for growing acacia is the unforested steppe in south-eastern Romania (counties of Ialomița and Brăila in Muntenia; central Dobrogea), which can be considered as an extension of the Russian steppe to the south. Here, with the exception of villages, acacia was planted on large, isolated areas.

The sands and sandy soils of our country occupy approximately 400 000 ha. Of these, over 100 000 ha are forested (mostly with acacia). As a result of wind deflation (blowing away), the sand has been scattered and the desert area has greatly expanded, covering some 200 000 ha in the three counties of Oltenia (Olt, Dolj and Mehedinți). Very recent data published by Giurgiu (2005), Șofletea and Curtu (2000), Nețoiu (2012), Ciuvăț et al. (2013) consider that the area occupied by acacia in Romania currently amounts to 250,000 ha.

Archival documents and specialized works (Drăcea, 2008: 1926) attest that the first mention of the use of acacia in afforestation works in the areas described above dates back to 1852. At that time, on Prince Știrbey's estates in the Băilești area, a series of experimental works aimed at fixing the sands by afforestation with seedlings of several forest species such as mulberry, maple, downy oak, acacia, black and Scots pine, elm and others.

After two years it was observed that the acacia performed best on sandy soils. Depending on the interests and receptiveness of other landowners, such afforestation work was carried out sporadically at Deveselu and Jiana.

Since then, the acacia has become one of the most common trees in Romania's sandy areas. Here it not only forms extensive forests, but is also widespread in the countryside, where almost every peasant has planted one or two acacia trees at the edge of their garden.

3. THE IMPORTANCE OF ACACIA

Acacia (*Robinia spp*.), (Figure 4) as the main forest crop genus, is of particular importance in our country, due to its multiple uses and the obvious economic and ecological advantages of its cultivation.

FIGURE 4. ACACIA CULTIVATION GROWN IN BÂRZEȘTI, ARAD COUNTY, ROMANIA (SOURCE: RUBEN BUDĂU, 2014)

Although some sources in the specialized literature, especially those of the early 20th century (Ashe, 1922; 1923; Rydberg, 1924; Small, 1933), accredit the genus *Robinia* as having 20 species, according to recent taxonomic analysis (Isely and Peabody, 1984; Mabberly, 1997), the genus *Robinia* comprises only four species of acacia (*R. pseudoacacia, R. hispida, R. viscosa and R. neomexicana*), all native to North America and Mexico, represented by trees and shrubs of woodland and ornamental interest, highly valued for their wood or for the abundance of their flowers, white or pink, pleasantly scented, honey-bearing. In our country, only three of the four species listed above are found in forest crops or planted for ornamental purposes: *R. pseudoacacia, R. hispida and R. viscosa*. Isolated (Banat, Caras-Severin), in private gardens and botanical gardens, representative specimens of R. neomexicana can be found, appreciated ornamentally for their pale-pink flowers.

Of all the woody species introduced in our country, *R. pseudoacacia* L., the common acacia, has established itself both as a forest tree and as a tree of almost all possible uses, and is today very widespread and appreciated, especially in rural areas (Enescu, 1975).

At present, the attention and interest given to the species is based not only on its ability to fix unstable soils (prone to wind or rain erosion), but also on the many silvicultural and economic advantages of growing acacia, including:

- ⇨ relatively simple and inexpensive culturing technique;
- ⇨ rapid growth;
- ⇨ significant wood production;
- ⇨ short production cycle;
- ⇨ large biomass production for making unconventional fuel;
- ⇨ the therapeutic value of certain products made from acacia flowers and honey;
- ⇨ exceptional honey-bearing value, as the most honey-bearing tree in Romania.

In its native country, the acacia forms mixed stands with *Carya ovata, Castanea dentata, Quercus alba, Q montana, Liriodendron tulipifera, Juglans nigra, Gleditsia thriacanthos, Prunus serotina, Fraxinus americana*. It occurs in meadows, but not in floodplains, and climbs to about 1500 m altitude.

It demonstrates a remarkable degree of adaptability to various soil conditions, exhibiting the capability to thrive across a diverse array of soil types, albeit with the notable exception of those soils that are characterized by excessive dryness and compaction, which significantly hinder growth and development.

Thanks to this remarkable ecological plasticity, as well as extremely favorable cultural characteristics (speed of growth, wood quality, lack of pests, almost unlimited range of uses etc.), acacia is now the third most widely planted species in the world, with only eucalyptus and hybrid poplar surpassing it in this respect (Keresztesi, 1988).

3.1. The importance of acacia as a forest species

Mass stands of acacia plantations change the indoor climate little, because through their relatively transparent canopy, light and heat reach the ground in quantities close to those in the open environment outside the plantation.

Physiologically, however, the willow's environment is quite unique, exerting a strong force of ecological screening and biological competition, due primarily to its vigorous, richly branched roots in the humus horizon, which are intensively water and nutrient consuming. For this reason, very few woody species can be maintained in association with acacia, which means that, due to their marked bioclimatic receptivity, acacias are often exposed to soil drying and weed propagation (Stănescu, 1979; Costea et al., 1969).

Among the numerous arborescent species that have been systematically introduced and cultivated within the geographical boundaries of our nation, the acacia tree has indisputably and firmly established itself not only as a significant specimen within the field of forestry but also as an organism of remarkable versatility, which has consequently resulted in its extensive distribution across various regions and its esteemed value, particularly in rural agrarian locales where its various applications are highly regarded. The primary attributes that have contributed to its efficacy as a tree include its accelerated growth from the onset of its development, its simplicity of cultivation, and the utility of its timber for an array of domestic applications. In certain contexts, its resilience or more accurately, its adaptability has facilitated its extensive utilization, especially beyond its indigenous habitat. The fertility of the soils, which typically exhibit elevated moisture levels, is subject to variability owing to fluctuations in clay and humus composition.

According to accepted criteria for what some authors call "fast-growing species", many acacia populations cultivated in Romania, of unknown origin, fall into the category of "fast-growing provenances", with maximum average growth rates of 15-17 m^3/year/ha and reaching the age of absolute exploitability at 30 years.

It is also rarely attacked by diseases and pests (Trăuțescu et al., 1969), although it sometimes suffers from late spring frosts and often, particularly older specimens in simple groves, are affected by stem rot.

3.2. The importance of acacia as a wood-supplying species

In our country, among the acacia species used for the establishment of plantations for logging purposes, the most commonly used is *R. pseudoacacia* L., var. rectissima. The high yields of woodmass it produces at a young age and the numerous uses to which wood can be put are social and economic benefits which increase the value of this species. This species currently covers a very large area in our country compared to the other species of the genus *Robinia* "adopted" (Ciuvăț et al., 2013), and it seems that the current trend is to expand its area of cultivation, even in areas with lower productive potential. The same authors consider that at present, especially in Oltenia, significant areas are occupied in forest crops by a Romanian variety of acacia, *R. pseudoacacia* L., var. oltenica, obtained by Bîrlănescu, Costea and Stoiculescu (1966), by selection, from var. rectissima.

The average productivity of the best acacia stands in plantations reaches 15-17m^3/yr/ha at the age of 20 years, while the productivity of stands from shoots of the same age is 13.4m^3/yr/ha (Figure 5). Acacia wood, with well-developed, greenish-brown heartwood, is durable, dense, with extremely varied domestic and industrial uses, starting with firewood, poles for vine plantations, posts for fences or for reinforcing mine shafts, railway sleepers, timber (Drăcea, 1926; 2008) and ending with veneers, rustic furniture, parquet flooring or even solid wood furniture (Armășescu et al., 1969 ; Bîrlănescu, et al.,1966; Timofte and Budău, 2008; Budău and Timofte, 2012).

In Hungary, this species has played a role of great importance in the forest management, covering approximately 23% of the forested area and providing about 19% of the annual timber output of the country (Rédei K, et al.2011).

FIGURE 5. ACACIA STANDS IN VARIOUS STAGES OF PRODUCTION

As firewood, acacia is of exceptional value, from at least three points of view, namely:

- ⇨ reaches maturity for exploitation as firewood at a relatively young age (8-10 years), an age at which other species used for this purpose (beech, oak, hornbeam, etc.) are not exploitable (http://rubenbudau.ro, 2011).
- ⇨ in acacia, typically, only the main stem is suitable for high-end industrial uses (veneer, parquet, solid wood furniture, etc.), while the branches (category I to III) are most often used as firewood, due to their irregular shape and frequent knots (Mihai and Oana Ionescu, 2011 - 2012).
- ⇨ The calorific value of acacia wood with 30% moisture content is high, comparable to that of spruce and beech (about 3600-3700 kcal/kg), while in oak, hornbeam and poplar, with the same moisture content, it is between 3200-3400 kcal/kg (Milescu, 2006).

⇨ completely dried acacia wood (0 % moisture content) has a calorific value of 4327 kcal/kg, being exceeded, among deciduous trees, only by oak (4390 kcal/kg) and beech (4494 kcal/kg) (Giurgiu, 2005).

FIGURE 6. PILLARS AND FENCE MADE FROM ACACIA WOOD READY FOR COMMERCIALIZATION (SOURCE: RUBEN BUDĂU, 2023)

As construction timber, acacia has a wide range of uses as products that preserve the wood structure (planks, joists, strips, battens, beams), considered as raw products, or as semi-finished (glued timber, panels, plywood) (Figure 6) and finished products (sills, paving, veneers) (Furdui et al, 2009).

As products that no longer preserve the structure of wood, acacia is used in the manufacture of agglomerated PFL, PAL (woodchip particleboard) and OSB (*Oriented Strand Board*), which are highly appreciated in the production of formwork for concrete structures, but also in the construction of entire holiday homes, residential houses, military or site huts, etc. (Cotta et al, 1990; Manusciac, 1997; Furdui, 2011).

Acacia wood, as well as oak or mulberry, is successfully used in the manufacture of staves for barrels in which various alcoholic beverages are stored for aging, which are enriched with a yellow-greenish color and a specific flavoring.

3.3. The importance of acacia as a nitrogen-fixing species

Like all legumes (papilionaceae), acacia also has the capacity to fix atmospheric nitrogen in nodules (Figure 7) formed by Azotobacter bacteria on the roots of plants of this family. As the number of forest species able to fix atmospheric nitrogen is very small, it is not surprising that many authors consider acacia as a decisive component in the favorable modification of forest ecosystems (Boring and Swank, 1984).

The forestry importance of acacia is considerably increased by its capacity to enrich the soil with nitrogen, which is why it is considered a good associate or forerunner of other broadleaved trees (Rice, 2004), since the nitrogen fixation benefits not only the acacia but also the trees of the other species with which it grows in association or of the species that follow after clearing an acacia stand. According to data published by Montagnini et al. (1986) and DeGomez and Wagner (2011), the amount of nitrogen fixed by acacia in a mixed plantation of *Robinia*, *Castanea* and *Quercus* four years after planting was 30 kg/ha, but reached 108-274 kg/ha in a pure acacia plantation of 5-18 year old trees on mining dumps. It is evident from these data that acacia has an atmospheric nitrogen-fixing capacity comparable to that of grain legumes (peas, fava beans, beans, soybeans, etc.) and fodder legumes (clover, alfalfa, sainfoin, etc.) (Bridgen, 1992).

FIGURE 7. NODULES FORMED BY AZOTOBACTER BACTERIA ON ACACIA ROOTS (SOURCE: RUBEN BUDĂU, 2014)

However, the ability of acacia to fix atmospheric nitrogen must also be considered from another point of view. It is clear that, because of this property, the requirements of pure acacia crops for nitrogen fertilization are reduced. Empirical investigations have demonstrated that, within these types of plantations, the introduction of nitrogen-based fertilizers resulted in a deceleration of growth in acacia species (Bridgen, 1992), whereas the utilization of phosphorus fertilizers produced beneficial outcomes regarding the advancement of the acacia stand (DeGomez and Wagner, 2011).

Finally, it should not be overlooked that protein compounds are present in the leaves and bark of young acacia trees in much higher amounts than in other deciduous trees, which explains why this species plays an important role in the foraging of both forest animals and some domestic animals (sheep, goats) (Putman et al, 1991).

3.4. The importance of acacia as a medicinal plant

Of the forest species, acacia is probably the most valued in herbal medicine. The constituents of the acacia tree that are predominantly utilized for medicinal applications are primarily its blossoms, while its bark and foliage are utilized to a significantly lesser extent (Bernáth, 2001; Dragomirescu, 2014).

The blossoms are meticulously collected during the flowering period, specifically in the months of May and June, through the manual act of plucking from the axis of the inflorescence. They are transported in paper-lined wicker baskets. Drying can be carried out naturally in well-ventilated, shaded areas or artificially at temperatures between 35 and 40. One kilogram of dried product results from 6-8 kg of fresh flowers (Constantinescu and Agopian, 1967).

The desiccated floral specimens exhibit a coloration that ranges from a cream-white to a pinkish-white hue. After removal of the flower stalks, the dried flowers are kept as they are or milled, and the product obtained (the powder) is packaged and stored in appropriate rooms (Beldeanu, 2004), preferably in hermetically sealed packages so as not to alter its chemical composition rich in active principles such as flavonoids (acacetin derivatives), volatile oils, phenyl-propanic compounds, tannins, carbohydrates, free amino acids (Albulescu et al., 1978; Tămășdan et al., 1981).

The therapeutic action of the above-mentioned chemical compounds is mainly antiseptic of the respiratory tract, gastric antacid and antiulcerative, emollient, slightly sedative and cholagogue (stimulates the evacuation of bile in the duodenum), (Dragomirescu, 2014).

Internally administered, the product is used to treat gastritis, gastric and duodenal ulcers, pyrosis (heartburn in the stomach area). It is recommended for its soothing action in bronchial asthma, coughs, mild colds and headaches. Together with linden and common motherwort, it can be used successfully to combat insomnia. Externally, the product is only used in folk medicine to treat wounds and burns (Simionescu, 1961).

The administration of powdered acacia blossom in the treatment of the aforementioned ailments is as follows: four times a day, at least 30 minutes before a meal, one teaspoonful of powder is taken, held sublingually for 15 minutes, and then swallowed with a little water. If one prefers to take it as a macerate, it is prepared from two teaspoonfuls of acacia flower powder put in one liter of plain water. The mixture is left overnight at room temperature, and in the morning, it is strained and drunk, in small sips, in 4-6 daily doses (Dragomirescu, 2014).

In addition to the beneficial effects listed above, the powder and macerate from acacia flowers also have the ability to soothe, calm and invigorate the body in various neurotic states, acting on the nervous system.

Pharmaceutical products made from acacia flowers are used in many psychosomatic disorders that occur as a direct consequence of mental tensions: frequent conflictual states, with tendencies to aggressiveness and exaggerated criticism; fits of anger and mental irritability; muscle cramps of a nervous nature; nervous, physical and intellectual exhaustion, degenerating into insomnia, states of anxiety and prolonged psychological depression; uncontrolled reactions to stressful situations, headaches and migraine headaches against a background of stress; memory, balance and vision disorders, in some cases leading to herpetic eruptions of the shingles on the skin (Simionescu, 1961).

In this sub-chapter, we will not discuss the curative properties of acacia honey for two main reasons:

- acacia honey is not a product of the acacia tree, but rather of bees.
- the curative properties of honey are quasi-general for most types of honey (mixed, sunflower, rapeseed, linden, acacia etc.), and are not specific to acacia honey.

3.5. The importance of acacia as a honey bearing species

Among forest species, the acacia is the most important honey-bearing species next to the linden (Horeanu, 1996). Its flowers, rich in nectar and characteristically flavored manna, are particularly attractive to bees (Figure 8).

Acacia honey has over 40% more fructose than other types of honey, with sucrose and lactose in proportions of about 10% and about 30% glucose. It also contains vitamins B1, B2, B6, B6, B12 and many other substances that contribute to the body's proper functioning. Acacia honey hardens slowly, over the course of a year or more, due to its high fructose content. It stimulates appetite and aids digestion, improves heart and liver function and increases the percentage of hemoglobin in the blood.

FIGURE 8. ACACIA STAND DURING FLOWERING IN BÂRZEȘTI, MAY 2015

Genuine acacia honey has a specific, but not exaggerated, acacia blossom smell. An exaggerated acacia blossom odor is a clear indication that the honey has been adulterated by mixing it with acacia blossom infusion.

As per the findings disseminated by Keresztesi (2013), optimal yields of acacia honey are achieved in plantations or stands that are between 10 and 20 years of age, with a decline noted in stands that are either younger or older than this specified age range.

Due to the differences in altitude and microclimate in which acacia is found in our country, its flowering is staggered in time and lasts up to 20 days, occurring first in lowland stands, then in those in the low hills and finally in those in the high hills. Under these conditions, two or even three harvesting periods can be carried out on acacia in one beekeeping season. It is reported, for example, that after a first harvest in the forests in the southern part of Oltenia, a second harvest can be carried out in the forests in the north of Mehedinți, Olt and Vâlcea counties, with a third harvest in Argeș county; similar situations are also recorded in Prahova, Ilfov and other counties (Cîrnu, 1980).

In the southern and eastern parts of the country, which form the basis of acacia honey production, between 300 and 1600 kg of honey can be obtained per hectare; in favorable harvesting weather and with abundant flowering, 10-12 kg of honey can be obtained daily from a hive (Hristea, 1976). For these reasons, in 2010-2011, ICAS realized a geographic database including all the acacia stands in eight counties in the south and south-west of the country, considered as the most important area for apiaries in Romania (Vlad et al., 2012).

In terms of production realized by a strong family of bees, in the best years, it can reach 60 kg; the value of this indicator, as well as the achievable honey production per hectare, make the economic importance of acacia to be considered very high (Cîrnu, 1980). According to the same author, the amount of nectar produced by an acacia flower in normal years in terms of climate is 1-4 mg, with a sugar concentration ranging from 40 to 70%.

In some years, acacia also provides a significant production of honeydew honey; Cîrnu (1980) mentions in this respect that between 1959 and 1960, in Banat plantations, honeydew dripped like a rain of syrup. A very intensive harvest was carried out at that time, resulting in a daily honey production of 10-12 kg/bee family. Such a result is really very good, especially if we take into account that in June-July, when most of the honey bearing species are no longer in bloom, the daily honey yield in a control hive did not exceed 1 kg/family of bees (Beldeanu, 2004).

3.6. The importance of acacia as a food and forage species

From the food point of view, the acacia is of particular interest for the nectar, pollen and manna it provides to bees, being considered the main honey bearing tree species in our country, for its unrivaled harvest, in terms of nectar rate and potential, especially in the lowland region (Corlățeanu, 1984). The main product obtained indirectly by bees - acacia honey - has almost unlimited food uses, from fresh consumption to the most sophisticated pastries and confectionery.

Directly in the human diet, acacia has a relatively restricted use, with only the flowers being used for this purpose and only in certain areas of the country. It should be noted that the flowers, in which robinine (a toxic compound present mainly in the bark) is present in very low proportions, do not present any danger, so they can be used for food purposes and the infusion prepared from them can be used in prolonged cures (Beldeanu, 2004).

Until recently, the most common uses of acacia flowers in food were the preparation of acacia sherbet and pancakes filled with acacia flowers.

On the other hand, acacia finds quite varied uses in animal fodder, starting with the fact that for many herbivorous forest animals (deer, rabbits, etc.) this species is the main source of food, especially in dry years when the production of forest grass is very low or even totally compromised. Even in the feeding of some domestic livestock species (sheep, goats, buffalo, horses), young shoots and leaves of acacia are considered very good fodder because of their high protein content (10-19%), comparable to that of red clover (18-23%) (Vadas, 1911; 1914).

In the Republic of Korea, according to data published by Dong (cited by Keresztesi, 2013), dried and pulverized acacia leaves are mixed with rice bran up to 30% and fed with good results in the daily forage ration of pigs. For this purpose, a tetraploid acacia clone with leaves three times larger and 1.4 times higher protein content than the diploid form of acacia is used (Hwang et al., cited by Keresztesi, 2013).

3.7. The importance of acacia as an ornamental plant

From an aesthetic perspective that emphasizes ornamental value, it is imperative to recognize that the acacia genus holds significant importance across all four distinct species that are both documented and actively cultivated within the geographical boundaries of Romania (*R. pseudoacacia, R. Hispida, R. Viscosa and R. neomexicana*). It should also be mentioned that the ornamental function of the four species is realized less through massive forests (plantations) and much more frequently and convincingly as isolated trees, clumps (groups), green walls, alignments (Bridgen, 1992; Carbonnière, et al., 2007; Clinovschi, 2004; 2005). It is not recommended for use in hedgerows, as the resulting root shoots invade adjoining land (Bîrlănescu et al., 1977; Catrina 2005).

The brief description of the four ornamental species of the genus *Robinia*, with emphasis on their decorative characteristics, is based on an extremely rich bibliography from which the most significant works have been selected (Clinovschi, 2004; 2005; Constantinescu, 1976; Costea et al., 1969; Doniță, 1999; Dumitrașcu, 2008; Fitschen, 1994; Horneanu, 1996; Iliescu, 2005; Jacamon, 1966; Mănescu, 2010; Németh and Molnár, 2005; Rameau et al., 1993; Stănescu, 1979; Șofletea and Curtu, 2000; Vadas,1914).

R. pseudoacacia L., commonly referred to in botanical and ecological literature as white acacia, is characterized by arboreal specimens that exhibit a remarkable stature, attaining heights that range from an impressive 25 to 30 meters, while simultaneously demonstrating trunk diameters that are capable of reaching, and in certain instances, surpassing the considerable measurement of 100 centimeters. The trunk is straight, firmly erect and the crown is sparse and irregular. The shoots are olive to reddish-brown, edged, with thorns on either side of the buds. The imparipinnate compound leaves, with 7-19 leaflets, may be glabrous or pubescent and appear before flowering. The floral structures exhibit white pigmentation, demonstrate bilateral symmetry, and are organized in pendulous racemes measuring 10-25 cm in length, characterized by a pleasing aromatic quality.

Floral development transpires subsequent to foliation during the months of May and June, occasionally followed by a secondary bloom in August and September. The resultant fruits are characterized as dehiscent, dark-hued pods, and which exhibit limited ornamental value.

R. hispida L. (pink acacia) is a medium-sized tree, up to 3-4 m tall, with a broad, globular crown. The shoots are reddish-brown, bristly and thornless, retaining their color throughout the growing season. The leaves are imparipinnately compound, with fewer (7-13) leaflets than white acacia, but larger. The flowers are pinkish or pale-purplish, fragrant, clustered in pendulous, downy racemes. The phenological onset of flowering is typically early, occurring in the second year of vegetative growth, demonstrating considerable abundance, and predominantly transpires in the month of June; occasionally, a secondary flowering event is observed during the months of August to September. The fruits are dehiscent pods, covered with reddish-brown hairs, and are highly decorative.

R. viscosa Vent., (red acacia) is an exotic tree of size III, with a sparse, globular crown. The shoots are glandular-viscous and thornless, and the leaves are imparipinnately compound, large (13-25 leaflets) and with a glandular, dark petiole. The flowers are red with shades of purple, unscented, clustered 6-16 at a time, in pendulous racemes. Floral emergence transpires during the period extending from late May to early June. The fruits are dehiscent, glandular, downy pods. This species is frequently utilized as an ornamental arboreal specimen in the Danube Delta, Dobrogea, and within the sylvan regions of Moldova.

R. neomexicana Gray (Mexican acacia) is an exotic shrub, 2 m tall, native to the southeastern USA and northwestern Mexico. In our country it is grown sporadically in parks and gardens and as a lining tree mainly for decorative purposes, because of its floral coloring. Its shoots have numerous, frost-hardy thorns and its leaves have about 15 elliptic-lanceolate, long, silky-pubescent leaflets on the underside. It blooms between June-August, with light-pink flowers arranged in pendulous, multiflowered racemes.

3.8. The ecological importance of acacia

The ecological importance of forests has long been recognized in all countries that have benefited and wish to continue to benefit from their role as ecological regulators. A substantial proportion of the oxygen essential for sustaining life on the planet is generated by forest ecosystems; the thermal, precipitation, and atmospheric circulation patterns are significantly affected by forested areas, and the degree of soil erosion in regions characterized by elevated precipitation levels is intrinsically linked to the presence or absence of arboreal flora and associated underbrush. The significance of this issue has been rendered even more evident in contemporary times, as the ramifications of global warming are becoming progressively discernible on a global scale.

The massive deforestation of the last three centuries is considered by most specialists (Drăcea, 1944; Giurgiu, 2005; Bălteanu, 2005), the main cause of disastrous ecological changes in our country, which have led to massive landslides, catastrophic floods, erosion of the fertile soil horizon and degradation of slopes by sinkholes and gullies, serious reduction in crop yields in ever larger areas affected by drought, blocking of roads and localities by snow and floods, increased frequency and intensity of storms, etc.

The negative economic consequences of these environmental changes are immense and sometimes difficult to assess, especially from a historical perspective.

According to some data published by Doniță and Radu (2013), before the Peace of Adrianopol (1928), when the Romanian Principalities obtained economic autonomy, the then Romanian territory included more than 19 million hectares of forests, but the subsequent decreases in the forest cover have meant that today the country's forested area is less than six million hectares and it is still subject to great destructive pressures. The consequences, apart from the excessive climatic phenomena mentioned above, are manifested in a pronounced trend of steppe becoming semi-desert, of forested steppe becoming steppe and of woodlands becoming forested steppe.

Enescu and Dănescu (2013) states that the Romanian experience accumulated in land reclamation with *R. pseudoacacia* is highly significant from the perspective of global warming. It is estimated that the importance of this species will increase in the future due to its high ecological amplitude and biological characteristics, which make it well-suited for arid lands.

In the view of the authors cited in the previous paragraph, three distinct categories of measures are needed to halt this totally unfavorable trend:

a. Afforestation of large areas of land (about three million hectares), chosen mainly on ecological criteria, leading to improved environmental conditions in the country's most important hydrographic basins. Of this area, two million hectares are already available for afforestation, representing, in fact, large areas of forest from which woody vegetation has disappeared due to chaotic, mostly illegal, deforestation, especially in the last 150 years. Indeed, in relation to the aforementioned geographical and ecological regions, the most appropriate and scientifically accurate designation for the suggested environmental initiative aimed at restoring the forest ecosystems would unquestionably be termed 'reforestation'. To these two million hectares should be added another one million ha of severely degraded agricultural land, which is practically unsuitable for agriculture and has a serious entropic potential as it is permanently subject to erosion, floods and landslides (Giurgiu, 2013).

From a legislative point of view, this first measure was given the green light as early as March 2008, when Law 46/2008 (Forestry Code) envisaged the afforestation of no less than two million hectares by 2035. According to the data presented by Giurgiu (2013), in each of the six years since the enactment of Law 46/2008, 70-80 times less than the planned amount has been afforested, which means that at this rate, the provisions of that law will be realized in about 2000 years.

b. The creation of a national network of forest buffers to protect against wind erosion is the second category of measures designed to improve the climate in areas affected by drought in summer and blizzards in winter. Although the measure is expected to apply throughout the country, it is considered that the most exposed are the areas located in the south-east of the country, where about 100,000 ha (Doniță and Radu, 2013) of protective curtains would be needed (Doniță and Radu, 2013), which would not only protect crops in the large agricultural holdings of the area, but also protect communication networks and the localities in question, especially against devastating winter blizzards.

c. The restoration of juniper thickets on the sub-alpine level and on the salinized sandy meadows would be the third category of measures aimed at increasing the area of land covered with protective woody vegetation. The massive clearing of juniper thickets or even their burning, in order to extend pasture areas, has triggered an extremely accelerated erosional process on the steep slopes of the subalpine zone and has led to the deregulation of the hydrological regime in the basins of all the major rivers flowing from the Carpathians (Cernelea, 1982).

The restoration of the juniper thickets in the sub-alpine zone should start with the heavily eroded areas and be combined with systematic forest improvement works (Ciortuz, 1981). Certainly, once the erosion has stopped, there will be clear signs of improvement in the water regime of this area. At the same time, there is also a need for measures to restore the sparse tree stands in the lower part of the subalpine zone, which provide additional soil stability in the area and prevent avalanches.

The restoration of shrublands in the salinized sandy meadows in the south-east of the country is intended to prevent wind erosion and protect agricultural land, communication routes and remote rural settlements. Obviously, in these cases, forest species resistant to high concentrations of sodium and potassium salts in the soil, such as red and white sea-buckthorns, will have to be used.

It is interesting to note that Doniță and Radu (2013) recommend numerous forest species (English oak, downy oak, Turkey oak, Balkan ash, pubescent ash, etc.) for the realization of the three categories of measures aimed at increasing the country's forested area, but do not mention acacia. This omission is surprising because in our country as well as in its homeland (USA) or Hungary (Drăcea, 2008; 1926; Haralamb, 1965; DeGomez et al., 2011; Keresztesi, 1983), acacia has established itself from the beginning of its cultivation in those countries as the most efficient forest species in fixing sandy soils and in quickly realizing protective curtains for agricultural crops, roads and settlements.

3.9. The role of acacia in anti-erosion forest plantations on agricultural land and for the protection of road and railroad tracks

Since its beginnings in Romania (1852), the acacia has proved to be a providential species for afforestation of shifting sands, fixing hillsides and slopes and in plantations on degraded lands, and later as a main species in forest buffers in steppe and forest-steppe regions, for the protection of agricultural lands and in buffer strips along roads and railroads (Ciuvăț, 2013). It is also considered to be a highly valuable tree, used almost exclusively for ameliorative forest plantations on sands and light, non-limestone soils in the warm southern parts of the country (Doniță and Radu, 2013; Amos News, 2003).

Based on comparative research of several forest species, Neșu (2000) concludes that acacia can be considered the most suitable species for the realization of anti-erosion protective forest buffers, especially where wind erosion is the most active degrading factor. It is estimated that, in our country, sands and sandy soils occupy approximately 400,000 ha (Dobre, 2009), of which almost 200,000 ha are located in only three counties in the south-east of the country (Olt, Dolj and Mehedinți) and only 100,000 ha have been afforested (mainly with acacia) since 1852 until today.

From a legislative point of view, the first systematic approach to the problem of planting forests to protect agricultural land belongs to the Cuza Government and dates from May 6, 1860. In practice, however, such protective forest plantations were only carried out sporadically, over small areas, at the initiative of directly interested landowners, although two works by Professor D.D. Russescu (The insecurity of agricultural harvests in Romania, 1904, and The question of artificial afforestation in Romania, 1906) had succeeded in sounding a serious alarm on the subject.

The most beneficial period for the realization of this system of protection did not begin until 1937 when, at the insistence of Prof. Marin Drăcea, the Ministry of Agriculture and Domains commissioned the Institute of Forestry Research and Experimentation (ICEF) to develop the Technique for the creation of forest protection strips to protect fields. As a result, in 1938, Prof. Marin Drăcea set up the Dobrogea Experimental Forestry Station in the Comorova forest, with the main objective of developing the technique for the creation and maintenance of protective strips.

Over time, this station became a powerful center for research and design of forest plantations not only for Dobrogea, but also for other counties in the south of the country, so that by 1957 the areas planted in this system exceeded 10,000 ha, and by the end of the 1970s they reached 100,000 ha (Amos News, 2003).

Unfortunately, after 1989, illegal logging and uncontrolled deforestation, favored by the restitution of many forested areas to their pre-1948 owners or their descendants, as well as by the lack of adequate control of the way in which the Forest Code (Law 46/2008) was being complied with in the restituted forests, have caused these areas of anti-erosional forest plantations to decrease significantly. The last ten years have, however, witnessed a firm reorientation of our country's government policy that led to the elaboration of a National Project for Afforestation of Degraded Agricultural Lands in Romania (2006) and, with external financial support, the afforestation with acacia of about 2700 ha in the south and east of the country was achieved (Ciuvăț et al., 2013).

The acacia also proved to be equally important in the practical implementation of the provisions of the Program for the Establishment of Forest Hedgerows to Protect Means of Communication against Snow (HG 994/2004***). This program provides for the establishment of such plantations, especially of acacia, in Moldova, Dobrogea, Muntenia and Oltenia, areas of the country where roads and some settlements, located in the direction of strong northeasterly winds, are severely affected by heavy snowfalls, blizzards and winter storms.

A total of 1 082 km of road protection will be planted, covering 3 458 ha. Of these, 2,738 ha will be protective strips along 870 km of national roads and

720 ha will be protective strips for 212 km of railways. Some 30 million forest saplings will be purchased for these plantations, of which 15 million will be oak and acacia (Amos News, 2006).

Considering the current climate context, the *Robinia pseudoacacia* L. species may become more significant due to its strong adaptation to poor and eroded soils, fluctuating temperatures, and positive economic impacts (Budău R., et al. 2023).

In addition to the protective effect that these plantations will have on the roads, it is also important to bear in mind the contribution of water to the soil that these hedgerows can provide to the land adjacent to the roads by means of snowmelt. The significance of this matter is becoming increasingly pronounced and critical, especially in light of the fact that the ramifications and consequences associated with the phenomenon of global warming are being experienced with greater intensity and frequency within the geographical and environmental boundaries of our nation.

4. ACACIA BIOLOGY

The fact that the acacia can be found, today, everywhere on the globe where it has encountered a minimum of favorable conditions is due to its biological particularities that give it a particularly high ecological plasticity. Since *R. pseudoacacia* L. is the most common species, both in our country and in other countries with significant areas of acacia, this sub-chapter briefly presents the eco-biological characteristics of this species.

4.1. Morphological characterization

The main bibliographical sources used in the elaboration of this subchapter are represented by the works of the following authors: Clinovschi, 2005; Doniță, 1999; Iliescu, 1994, 2005.

The acacia (*Robinia pseudoacacia* L.) is an exotic, size I tree (25-30 m tall and 80-100 cm stem diameter) with a longevity that can exceed 100 years.

The root, as illustrated in Figure 9, undergoes a developmental process characterized by the formation of a taproot during the initial three to four years of its existence, particularly prevalent in sandy soil environments, during which it can attain a remarkable depth ranging from 2.0 to 2.5 meters beneath the surface. After this period, the lateral roots develop more strongly than the taproots, reaching up to 20 m from the trunk.

FIGURE 9. THE ROOT (SOURCE: RUBEN BUDĂU, 2014)

The stem (Figure 10) is straight, with an initially smooth bark, reddish-brown to grayish-olive in color, with an irregular, sparse crown that does not shade the soil sufficiently to avoid crowding by perennial grasses or even dicotyledonous plants (e.g. *Urtica dioica, L*).

Tree to 25 m, with deeply furrowed brown bark, glabros or slightly pubescent (Reheder, 1962).

The stem biomass of *Robinia pseudoacacia* constitutes the majority of its total biomass, ranging from 58.25% to 60.62%, density significantly affects both stem biomass and total biomass, with increasing densities promoting the accumulation of plant biomass in the sample plot (Hu, Y., et al., 2024).

FIGURE 10. ACACIA STEM (SOURCE: RUBEN BUDĂU, 2018)

The shoots (Figure 11) are greenish-gray in color, edged, with thorns on either side of the buds (the stipes turn into thorns).

Buds are alternate, small in size, hidden in a protrusion in the middle of the scar.

The leaves (Figure 12) appear late (May), are 15-30 cm long and are comprised of 7-23 leaflets arranged imparipinnately. The leaves are medium-sized (3-5 cm), mucronate, whole, glabrous or pubescent.

FIGURE 11. SHOOT WITH THORNS (SOURCE: RUBEN BUDĂU, 2018)

FIGURE 12. SHOOT WITH THORNS, LEAVES AND BEGINNING OF INFLORESCENCE (SOURCE: RUBEN BUDĂU, 2022)

FIGURE 13. ACACIA FLOWERS (SOURCE: RUBEN BUDĂU, 2022)

FIGURE 14. ACACIA SEED PODS (SOURCE: RUBEN BUDĂU, 2022)

The floral structures (Figure 13) exhibit a predominantly white coloration, occasionally with a subtle yellowish tint, are characterized as bisexual, display bilateral symmetry, conform to type 5 morphology, and are aggregated in drooping racemes with lengths varying from 10 to 25 centimeters. The tree blooms late, after producing leaves, and the flowers give off a strong, pleasant fragrance. ***The fruits*** are dehiscent pods (Figure 14), dark brown in color, containing 10-18 blackish seeds (Figure 15) with a very hard seed coat. Due to this characteristic of the seed coat, the acacia does not regenerate naturally from seed, and germination requires artificial forcing.

FIGURE 15. ACACIA SEED (SOURCE: RUBEN BUDĂU, 2025)

4.2. Ecological prerequisites

In its native area, acacia thrives in a warm climate (annual average of 7-10º C) with sufficient rainfall (700-900 mm per year). Following the dissemination of its cultivation to various regions globally, this species underwent significant adaptations to climatic conditions that are markedly disparate from those of its indigenous habitat. Presently, it is observable across a spectrum of environments, ranging from the Mediterranean climate characterized by minimal precipitation (approximately 300 mm annually in Israel) to the tropical conditions of Burma, where it encounters humidity and thermal levels considerably exceeding those of its original locale (potentially up to 5000 mm annually). It has developed in Japan, with abundant rainfall throughout the year, but also in South Africa where it rains only in summer (Stănescu et al., 1997).

It is an important multipurpose spe cies with major economic, ecological and social roles for producing wood, fodder, honey, a source of bio-oil, for bio mass production and carbon sequestration, soil stabilization/ erosion control, re-vegetation of landfills, mining areas and wastelands, in biotherapy, and in landscaping. (Nicolescu et al., 2020)

In our country, acacia thrives and produces a large amount of plant biomass in warm regions, with mild and long autumns, sheltered from early frosts that cause the young, unlignified saplings to die off. At mean annual temperatures below 7-8º C it vegetates poorly, suffers from freezing, and cold winds and frost cause branches to break, shoots to detach from the stump, and the disintegration of the forked stems (Stănescu et al., 1997).

The temperament of acacia is pronounced by light, which causes the pure stands to become sparse at an early stage, leading to soil becoming weedy and gradually drying out. The optimal soil types are characterized by sandy, coarse-textured, loamy compositions that exhibit excellent aeration and permeability while being devoid of carbonaceous materials. It grows satisfactorily on soils with low trophicity, even saline soils, such as those of the Danube Delta (Costin, 1979), but grows very poorly on argillaceous, compact and chalky soils (Clinovschi, 2005).

Because of its rich and extensive root system, acacia consumes large quantities of minerals from the soil, which means that with repeated cropping of acacia the soil becomes extremely depleted in macro and micro elements. On the other hand, in a medium-lasting crop (15-20 years), acacia can significantly enrich the soil in nitrogen due to the Azotobacter nodosomes with which it lives in symbiosis (DeGomez et al., 2011).

Acacia's soil moisture requirements are quite high. As a rule, it prefers humid, well-aerated soils with a constant supply of moisture at depth. In the dunes of southern Oltenia, it grows well on surface-dry soils, thanks to its root system, which is capable of utilizing the groundwater at great depths. It is not suitable for very dry soils, nor for soils with excess moisture, cold soils, or soils exposed to floods, on which it dries out quickly (Stănescu et al., 1997).

4.2.1. Ecological and Growth Characteristics

Black locust is highly adaptable, thriving in both nutrient-poor and nutrient-rich soils, and is drought-tolerant, growing in areas with annual precipitation as low as 500–550 mm (Nicolescu et al., 2020).

It is a fast-growing species, with growth peaking before the age of 20, and primarily regenerates vegetatively through root suckers (Nicolescu et al., 2020). The species is shade intolerant and often replaced by more shade-tolerant species in its native range, but this succession is less predictable in Europe (Kato-noguchi & Kato, 2024).

4.2.2. Management Practices

Management typically involves a simple coppice system, promoting root suckers over stool sprouts, and includes thinning and pruning to focus on crop trees (Nicolescu et al., 2020).

In regions like Ukraine, black locust is used in protective forest stands and for erosion control, with management strategies aimed at preventing its spread into natural ecosystems (Chornobrov & Solomakha, 2023).

4.2.3. Invasive Potential and Ecological Impact

Black locust is considered invasive in several European countries, altering soil chemistry through nitrogen fixation, which can lead to soil acidification and nutrient depletion (***"Soil chemical and biological changes through the N2 fixation of black locust (*Robinia pseudoacacia* L.)-A contribution to the research of tree neophytes", 2022).

Its presence can reduce native species diversity and alter the composition of plant and animal communities (Kato-Noguchi & Kato, 2024) (Slabejová et al., 2023). The species' invasiveness is exacerbated by its allelopathic properties and resistance to natural enemies (Kato-Noguchi & Kato, 2024).

Black locust is regarded worldwide as a multipurpose tree, mainly due to its great adaptability to face different kinds of environmental stresses Kellezi, M.K.; Kortoci, Y. (2022), Budău R., et al. 2023.

Despite the considerable economic advantages that can be derived from the utilization of black locust, it is imperative to recognize that the ecological ramifications stemming from its invasive characteristics demand meticulous management and vigilant monitoring in order to effectively mitigate its detrimental impacts on the diverse ecosystems that comprise European forests. The intricate task of balancing the practical utility of this species with essential conservation initiatives presents an ongoing and critical challenge that must be addressed within the framework of comprehensive forest management strategies designed to promote ecological integrity.

4.3. Cariology. Inter-and intraspecific variability

The diploid number of chromosomes is different in the four species of the genus *Robinia* which explains the fundamental differences between them. Thus, *R. pseudoacacia* has 2n=22 chromosomes (Kumari and Bir, 1990; Ivanova and Vladimirov, 2007), but in older and even newer works, this species is considered to have 2n=20 chromosomes (Darlington and Wylie, 1955; Goldblat and Johnson, 1998).

At present, based on the data presented by Kumari and Bir, 1990, the diploid number of 2n=22 chromosomes is accepted as a reliable diploid number for *R. pseudoacacia* L., the above-mentioned authors considering that most species of the Fabaceae family have the basic chromosome number x=6, the specification and different diploid chromosome numbers being realized due to evolution by aneuploidy and polyploidy (e.g. R. hispida. with 2n=30 chromosomes, Zeven and Zhukovski, 1975).

The interspecific variability of the genus *Robinia* is very high, and the best evidence for this is the fact that works in the field, especially those of the early 20th century, considered the genus to comprise no fewer than 20 species (Ashe, 1922; Small, 1933).

With the passage of time, evidence has emerged refuting the validity of some of these species, but even in recent works (Lavin et.al, 2003; wikipedia.org/robinia, 2013) 11 species of the genus *Robinia* are still mentioned (*R. boyntoni, R. ellioti, R. hartwigii, R. hispida, R. keleseyi, R. luxurians, R. nana, R. neomexicana, R. pseudoacacia, R. viscosa, and R. zirkelii*).

Recent taxonomic analyses, based on well-defined and easily identifiable criteria (type of growth, flower color, shape and size of pods, etc.), have led to the conclusion that there are only four species of the genus *Robinia*, namely (Table 1):

Species of the genus *Robinia*

Table 1

Species	***Flowers***	***Source***
R. pseudoacacia L		*Budău R,* *2025*
R. viscosa L,		*Budău R,* *2025*

R. hispida L,		*https://en.wikipedia.org/wiki/Robinia_hispida#/media/File:Robinia-hispida2.jpg*
R. neomexicana.		*https://en.wikipedia.org/wiki/Robinia_neomexicana#/media/File:Robinia_neomexicana1.jpg*

Referring exclusively to *R. pseudoacacia* L., which is, in fact, the species of interest in this paper, it is worth noting the great variability of morphological characters of silvicultural, ornamental or ecological importance. Due to the fact that, in the intricate tapestry of natural ecosystems, this particular species predominantly engages in a mode of propagation that is almost entirely vegetative in nature, specifically through the generation of root shoots, the resultant populations that emerge from this reproductive strategy may exhibit a notable degree of relative genetic and morphological uniformity, which is a characteristic that can be observed across individual specimens within those populations;

however, it is also quite plausible that there exist significant and pronounced differences when one examines the various populations in different ecological contexts or geographical locations, leading to a fascinating array of diversity despite the overall uniformity within each population. This is normal if we accept that, in fact, a natural acacia forest is made up of as many clones as there are mature individuals that have participated in propagation by root-sprouts. This very high inter-populational variability has been the main reason for the nomination of a large number of species within the genus *Robinia* and, by implication, a large number of varieties within *R. pseudoacacia* L.

The specialized literature, especially that of the second half of the last century, abounds in names of varieties of the species *R. pseudoacacia* L. Limiting ourselves to the literature of our country, it is significant that in older works (Stănescu et al., 1997) this species is listed with four varieties (rectissima, umbraculifera, inermis and microphylla) and five forms (bensoniana, pyramidalis, monophilla, decaisneana, sempeflorens) while in more recent works (Clinovschi, 2004; 2005) both the aforementioned varieties and forms are listed as varieties. Moreover, Bîrlănescu et al. (1966) propose the registration of a new variety of acacia, characterized by monopodial growth, thornless shoots and flowers without petals or with very small petals, which they call *R. pseudoacacia* var. oltenica (Bîrl., Cost. et Stoic., 1966). Perhaps in this respect, the opinion expressed by DeGomez and Wagner (2011) sheds some relevant light on the causes that have favored the emergence of such a large number of new varieties of *R. pseudoacacia* L.

The very high variability of this species meant that, from early times, breeders selected certain populations with a homogeneous appearance and characteristics of forestry, ornamental or anti-erosion protection interest, which they registered as cultivars, and which were subsequently cultivated as such.

The first acacia cultivar was officially registered in France in 1804 (Jacobson, 1996), and a considerable number of cultivars were subsequently registered, mainly in the USA, but also in France, Hungary, Poland, Germany, Bulgaria, etc.

DeGomez and Wagner (2011), in their scholarly discourse, provide a comprehensive enumeration of twenty-two distinct acacia cultivars that have been meticulously developed in the aforementioned nations, which notably includes the various white acacia varieties that have been previously discussed in the context of their agricultural significance and ecological applications.

At present, the only universally accepted variety of *Robinia pseudoacacia* L. is var. rectissima Raber, characterized by Raber (1936). The name rectissima seems to have been inspired by the fact that trees of this variety, renowned for their straight and strong wood, have long been used for making masts for ships (DeGomez and Wagner, 2011).

5. ACACIA PROPAGATION

The various species belonging to the genus Acacia possess an inherent ability to maintain and advance their propagation mechanisms through a series of natural processes, which not only include generative methods that rely on the intricate utilization of seeds to ensure genetic diversity and survival, but also incorporate vegetative approaches that strategically exploit the remarkable capacity for growth exhibited by root shoots, thereby facilitating the continuation of the species in diverse ecological contexts. In conjunction with these two prevalent natural modes of propagation, there are also three commonly employed artificial techniques that researchers and horticulturists frequently utilize to enhance the propagation of acacia, which include the method of propagation by cuttings, the technique of propagation through grafting, and the advanced practice of micro propagation, which is fundamentally based on the principles of tissue culture.

As in other forest species (Budeanu et al., 2013), propagation by seed in acacia is preferred when it is necessary to produce a large number of acacia seedlings whose obvious phenotypic variability is not an impediment (e.g. for the afforestation of eroded or totally unsuitable land (e.g. mining dumps, reforestation of deforested or naturally devastated sites, creation of anti-erosion or protection hedgerows for roads and settlements, or afforestation of land).

Both vegetative propagation (via rootstocks, cuttings, grafting) and micropropagation, which is to a large extent also vegetative propagation, are used when the aim is to multiply superior genotypes for breeding purposes, to produce parent plantations for industrial propagation, to obtain planting material of particular ornamental value, etc. Vegetative propagation, mainly by root cuttings, is often preferred in forestry practice in our country because it is very convenient and cheaper than propagation from seeds (Ciuvăț et al., 2013).

5.1. Propagation via seeds

Seed propagation of acacia does not occur naturally or is extremely low (0.3% of seeds germinate) due to the large thickness of the seed coat and its poor permeability (Chapman, 1936; Tănăsescu, 1967; 1970). When this type of propagation is used by man for forestry purposes, special treatments are necessary to improve the germination capacity of the seeds. The most commonly used such treatments are: soaking the seeds in concentrated sulphuric acid for 20 - 120 minutes, soaking in water at a temperature close to boiling point (90 - 95ºC) for 10 - 80 minutes and mechanical scarification (Bujtas, 1992).

Stimulation of germination through physical methods: (scarification) might be an alternative approach to the chemical substances used nowadays, with ecological advantages as well as the possibility to be used on a larger scale with high efficiency (Roman, A.M., et al., 2022).

Mechanical scarification is biologically efficient and allows large quantities of seed to be treated, which can then be mechanically sown immediately. It requires, however, special machines that are quite expensive both in price and maintenance (Chapman, 1936, Holonec, 2007).

Sulphuric acid and hot water treatments are relatively easy to apply and their efficiency is quite high (germinability is 80-250 times higher than natural), but they have some major drawbacks, namely (Meginnis, 1937; Arrillaga and Merkle, 1993; Hartmann et al., 1997; Lin et al., 1996):

- The quantity of seeds which can be treated in any individual batch is quite small.
- After treatment with sulfuric acid, the seeds must be rinsed two or three times in clean water, and after treatment with hot water, they need to be treated with plenty of cold water in order to bring down the temperature and end the treatment.
- After both types of wet treatments, the seeds need to be dried so that they may be sown mechanically.
- In both methods, it is necessary to pre-test the treatment times for each seed lot, due to the high variability in the structure of the seminal integument and its permeability.

(Rédei et al., 2008) Seed harvesting is carried out by stripping the soil layer from underneath the plus (elite) trees, previously marked as seed producers, to a depth of 15-20 cm and sifting it after crumbling. The seed yield obtained by this process is quite variable, most often ranging between 400-900 kg/ha of stripped soil (Keresztesi, 1988).

As acacia seeds can retain their viability in soil for a long time even 10-30 years, (Keresztesi, 1988), it is normal that seeds harvested from under plus trees are of different ages and therefore show a large variability in seed coat permeability and germination capacity. This is the main reason why pre-testing of treatment times is necessary when applying wet scarification.

Sowing is carried out mechanically, using machines for sowing straw cereals, at a distance of 40-70 cm between rows and at a depth of 3-5 cm, with a sowing rate ensuring 40-50 germinable seeds per linear meter of sowing, thus ensuring a density of about 250 000 seedlings/ha.

The technology for producing seedlings from seed is well developed and fairly similar in all countries that produce such planting material in large quantities. Seed disinfection is carried out to prevent the installation of various diseases or the attack of pests during the germination period until emergence (Bartha, 2024).

5.2. Vegetative propagation

The process of vegetative propagation for the species of acacia can be effectively accomplished through a variety of methods, including but not limited to the utilization of rootstocks, the practice of root cuttings, the technique of grafting, and the advanced procedure of tissue culture, which is often referred to as micro propagation in scientific literature. Among these diverse methodologies, it is important to note that the most prevalent and widely adopted techniques for the propagation of acacia species are, without question, those that involve the use of root cuttings as well as the innovative approach of micro propagation, which has gained significant traction in contemporary practices. Propagation by root cuttings (Figure 16) has two variants (Bujtas, 1992): long (8-10 cm) and short (3-5 cm) cuttings. In both cases, the cuttings are fragmented from roots harvested from mother plantations specially established for this purpose on sandy soils where root harvesting is easier.

FIGURE 16. RESULTS OBTAINED WITH ROOT CUTTINGS OF DIFFERENT DIAMETERS (SOURCE: RUBEN BUDĂU, MAY 2023)

Long cuttings are planted by hand, in open furrows 40-50 cm apart, with the top about 1 cm below ground level. The short cuttings are planted in spring, mechanically, with a chive planting machine, at the same row spacing as the long cuttings and at a depth of 4-5 cm, ensuring a density of 25-30 cuttings/linear meter.

In our country, the best results (Lăzărescu, 1968) were obtained with 15-25 cm long root cuttings, planted immediately after harvesting and pruning at distances of 60 cm between rows and 20 cm between cuttings per row.

Propagation by green cuttings (DeGomez and Wagner, 2011) is less commonly practiced because it is more complicated and costly. Green cuttings are harvested in the spring when the cuttings are 20-25 cm long. Immediately after harvest, they are placed in water to avoid wilting.

The cuttings are planted in sterilized perlite after pre-treatment with IBA or Radistim. After planting, a relative air humidity of 100 % should be ensured by artificial misting or frequent watering of floors, parapets, etc. Treatments against diseases and fertilizers are applied weekly. Micro propagation by meristem culture has been successfully applied to acacia since 1983 (Chalupa), using apical and nodal meristems as explants. Subsequently, dormant shoots (Davis and Keathley, 1987), cotyledons and leaves of seedlings obtained from in vitro germinated seeds (Arrillaga and Markle, 1993), axillary shoots of *R neomexicana* new seedlings (Lin and Wagner, 1996), were used as explants with good results.

In our country, the beginnings of micro propagation in acacia were initiated by Enescu (1989; 1991) and later Băbeanu et al., 2006, Corneanu Mihaela et al. (2001; 2008, 2010) made valuable improvements to this method of propagating acacia. Unfortunately, very pertinent economic research (Gruber and Hanover, 1992) shows that this method is 3-6 times more expensive than propagation by root cuttings in acacia.

Grafting, usually with detached buds, is practised in acacia only in rare cases for propagation of particularly valuable ornamental cultivars. Seedlings of *R. pseudoacacia* are usually used as rootstocks and ornamental cultivars of *R. hispida*, *R. viscosa* and *R. neomexicana* as grafts (DeGomez and Wagner, 2011).

6. ACACIA AMELIORATION

The first systematic work on acacia amelioration was initiated in Hungary in 1930 and later spread to several Balkan countries (Romania, Yugoslavia, Bulgaria, Greece), as well as to the USA, Canada and the former USSR (Barrett et al., 1990).

In Romania, the scientific improvement of forest trees, including acacia, almost certainly began with the establishment, in 1933, of the Institute of Forestry Research and Experimentation (ICEF), the name under which ICAS (Institute of Forestry Research and Management) operated in its early years. Since the inception of the aforementioned institution, which delineates the commencement of its scholarly and investigative pursuits, a cumulative total of five discrete research divisions have been established and evolved over time, one of which is the specialized Department of Forest Tree Improvement that is dedicated to the progression and refinement of arboreal species.

6.1. Objectives of acacia amelioration

As with other crop species, productivity is the main objective of acacia amelioration programs. Its character is very complex and depends on a fairly large number of productivity factors, the most important of which are: tree height, diameter, tendency to develop splits in the trunk, growth rate, resistance to winter frosts, disease and pest resistance.

Unfortunately, in our country very little research has been carried out into the genetic determinism of these traits, on which, to a large extent, the productivity of acacia depends. Special mention should be made to the PhD thesis by Ciuvăț (2013) who, based on the analysis of a large number of 1 - 4 year old acacia stands in south-western Oltenia, developed allometric equations for estimating the total biomass and its components according to the biometric characteristics of the measured specimens. Beyond the value of these data for the needs of the respective PhD thesis, they could constitute a good database for calculating the heritability of the respective traits, characteristic of the respective populations or as a result of individual measurements.

The most extensive research on the heritability of productivity traits in acacia was carried out at Michigan State University, East Lansing, USA, where in 1982 and 1983 seeds were collected from 434 acacia trees covering an extremely large area of eastern USA and Canada. After scarification of the seeds with sulfuric acid, they were sown in the nursery resulting in 434 half SIB family seedlings, which were planted in 1985 in randomized block comparative cultures at four locations in Michigan.

Observations and measurements taken at the end of the first four growing years on all individuals in each family allowed the calculation of heritabilities, in the broad (H) and narrow (h2) sense, for six important productivity elements in biomass production. The findings were disseminated by Mebrahtu and Hanover (1989) in conjunction with Barrett et al. (1990) and are encapsulated within Table 2.

It can be seen that for tree height, thorn length, budding date and leafing date, the broad heritability (H) values are quite high (above 0.50), suggesting that phenotypic selection for these traits within families can be effective, resulting in appreciable genetic gains.

However, as the narrow heritability (h2) values for all traits are extremely low, the efficiency of such selection would be seriously affected by genotype × environment interactions. This means that few of the productivity elements in acacia have a predominantly additive polygenic genetic determinism and that most of them are rather determined by epistasis gene effects.

Heritability of some productivity traits in acacia

Table 2

Calculated based on:		Height	Frost resistence	Trunk splitting	Thorn length	Budding	Leafing
Individual trees	H	0,56	0,13	0,31	0,89	0,83	1,11
	h^2	0,019	0,013	0,016	0,023	0,038	0,04
Families	H	0,55	0,22	0,40	0,69	0,57	1,11
	h^2	0,07	0,063	0,075	0,06	0,086	0,076

Source: Mebrahtu and Hanover (1989); Barrett et al. (1990)

In formulating conclusions such as the above, it is also worth considering the results obtained by Surles et al. (1990) who, on the basis of enzymatic analyses applied to half SIB acacia progeny, conclude that the degree of relatedness of individuals of such a family is extremely variable (ro = 0.20 - 0.43), which casts serious doubt on the presumption that individuals obtained from the seeds of a tree whose flowers have been freely pollinated are all half SIB.

The low (1-3)/high (11-23) number of leaflets in the leaf appears to be determined by a single major gene, and this finding may indirectly serve to improve for productivity. If the parental forms had as a genetic marker the high/low number of leaflets in the leaf, hybrid individuals can be easily identified and then processed by selecting hybrids with the highest level of trans-heterosis.

6.2. Timber quality

The timber quality in acacia is a particularly important improvement objective because the way acacia wood is utilized depends directly on its structure and characteristics.

Drăcea (1928; 2008), analyzing the structure and characteristics of the wood of 104 acacia trees, concludes that 26% of the wood volume is represented by bark. Decei and Armășescu (1959) and Bereziuc et al. (1976) reached similar results following comparative studies on several forest species. Their conclusion is that, upon meticulous examination and comprehensive analysis of the various factors pertaining to the proportion of bark relative to the entire volume of wooden material, as well as the thickness characteristics of said bark, it is evident that acacia unequivocally surpasses all indigenous forest species found within the geographical confines of Romania.

The density of green acacia wood was determined by Drăcea (1928; 2008) immediately after felling, with values ranging from 724 to 930 kg/m^3, and Vintilă and Galbenu (1944) found a density of 780 kg/m^3 for acacia wood with a humidity of 20%. The results obtained in this respect by Hernea et al. (2009, 2010) are interesting, as the wood density determinations were carried out by these authors on *R. pseudoacacia* var. oltenica. The values pertaining to the density of wood, as determined and reported by the aforementioned authors, were as follows:

- for anhydrous timber, the range of density values was noted to be between 0.634 and 0.785 grams per cubic centimeter, indicative of the mass per unit volume of the material in its dehydrated state, which is essential for understanding its structural properties.
- for conventional density, the reported values spanned from 0.532 to 0.648 grams per cubic centimeter, reflecting the typical density measurements that are usually taken under standard conditions with moisture content that is generally present in the wood.
- and for dry timber, the density values ranged from 0.680 to 0.791 grams per cubic centimeter, which are crucial for determining the wood's performance characteristics and its suitability for various applications in construction and manufacturing.

The resistance of acacia wood to humidity and decay caused by xylophagous fungi (Trametes versicolor, Coniophora puteana, Serpula lacrymans, Daedalea quercina) gives it a very high durability, comparable to that of oak and sessile oak (Vintilă, 1944). The shear resistance of acacia wood differs according to the area from which it originates. The greatest differences are observed between the southern and northern populations of Romania, with northern acacia wood being more resistant to tangential shearing than southern acacia wood, while southern acacia wood is more resistant to shear forces applied on longitudinal and transversal sections (Porojan, 2011). The same author finds that the shear strength of our acacia (both northern and southern) is higher than that mentioned in the world literature for oak and beech.

As far as the quality of acacia wood is concerned, special mention should be made of the chemical composition of its two main components: bark and sapwood. The results obtained by Corlățeanu (1983) show that acacia bark contains 46.2 - 48.1 % lignin, 18.9 - 22.1 % cellulose and 8.7 - 12.1 % mineral substances (Ca, P, K, Mg, Fe, Zn, Cu). The author considers that it may be profitable to make use of the secondary free residues and bark from willow harvesting, precisely because of their particularly valuable chemical content.

6.3. Resistance to abiotic stress factors

Resistance to abiotic stress factors also constitutes a particularly important amelioration factor, for at least two reasons:

- ⇨ due to the expansion of acacia areas in our country, it has come to occupy areas that no longer present optimal pedoclimatic conditions for the cultivation of this species.
- ⇨ Major climate changes reported recently worldwide, especially those related to global warming, are putting new abiotic stresses on acacia.

From a climatic point of view, the south of Romania has a favorable climate for the cultivation of acacia, and the soils on which this species has settled in that area are also preferred by this plant (sandy soils). By contrast, the northward spread of acacia, including in the Apuseni Mountains at altitudes of 800 m, has brought it to areas with skeletal soils, high carbonate content in the surface layer and low winter temperatures which often lead to the young shoots drying out.

The resistance of acacia to early as well as winter frosts is not very high; usually in winters with severe frosts (minus 20 - 25ºC), the trees are affected by the appearance of cracks in the bark, but especially by the freezing of young shoots (one-year-old saplings). To assess frost hardiness, Mebrahtu and Hanover (1989) introduced the term "die back" which represents the portion of the one-year-old shoot in cm that has been affected by frost. The trait is considered quantitative, with a rather low heritability (H = 0.130-0.22) which greatly decreases the efficiency of phenotypic selection.

The resistance of young shoots to early autumn frosts is a characteristic that depends crucially on the weather during the growing season: in wet and cool seasons, which are quite common in the northern areas of the acacia's range, the shoots of the year in question do not get to lignify (store lignin) along their entire length and, in the event of early frosts, will be more or less affected. The heritability component of the resistance of acacia to early frosts is associated with the precocity of budding, with earlier biotypes usually more likely to enter the fall and winter with woody shoots.

Genetics of adaptation to new climatic conditions is another highly topical area of forestry research, especially since the effects of global warming have become increasingly evident. For our country, these effects may have particularly negative consequences for the cultivation of acacia in the sandy soil areas in the south of the country.

Populations of acacia in these areas have already adapted to low rainfall conditions, but a further reduction in the volume of rainfall would pose serious problems for many forest species, including acacia. Therefore, it is of utmost significance that exhaustive and thorough initiatives, both at the national level and on a global scale, are urgently necessitated to meticulously examine and elucidate the most crucial and notable components pertaining to the genetic mechanisms that govern the adaptive processes of forest species in reaction to the substantial and extensive climatic alterations that are intricately linked to the phenomenon of global warming.

A program like GENECAR, applied in the Baltic countries and Scandinavia, for joint research on genetics, breeding, conservation of genetic background, exchange of information in this field is probably a good example for other regions of Europe (www.nbforest.info, 2011).

6.4. Resistance to excessive soil salinization

Resistance to excessive soil salinization has recently become an increasingly pressing improvement objective due to the spread of acacia, particularly in the south-eastern parts of the country, on coarse sands with a high calcium carbonate content.

On such soils, the 22-year-old acacia has an average height of 13.5 m and an average tree diameter of 15 cm (Costin, 1979); (www.srs.fs.usda.gov). It seems that a possible solution to this problem would be to plant on such soils tetraploid forms of acacia which, in rigorous experiments, has shown remarkable resistance to saline stress (Meng et al, 2009).

6.5. Resistance to diseases and pests

Disease and pest resistance are a major breeding objective in acacia because, both in its country of origin and in the countries to which it has spread, this species is under constant pressure from pathogens and pests. By way of example, it is sufficient to show that pests and foliar diseases can cause a 75% reduction in the photosynthesizing surface area of attacked trees (Athey and Connor, 1989), with predictable negative consequences on their vegetative and generative development.

The number of pests of acacia is impressive when judged on the basis of collections of different species from affected trees. In the USA, for example, no less than 76 species of insects attacking acacia have been identified (DeGomez and Wagner, 2011), while in southern Slovakia, in three years of collection, 33 species of the order Lepidoptera alone have been identified on acacia (Kulfan, 1991).

In Hungary, a study published under the aegis of the Forest Research Institute (Toth, 2002) finds that acacia is attacked by two species of nematodes, 36 insect species, one species of parasitic plant (Viscum album) and two rodent species (rabbits, field mice). In addition to the aforementioned conditions, there exists a remarkably substantial and equally noteworthy multitude of diseases that are attributable to a variety of pathogenic agents, including but not limited to viruses, fungi, and bacteria, each of which plays a significant role in the etiology of numerous health-related complications.

In Romania, in a comprehensive study on the biology and control of acacia pests, Trăuțescu et al. (1969) identify more than 30 species of pests of roots, seeds and young seedlings obtained from seeds, 24 pests of young plantations and shoots of acacia, 33 species of pests on bark and wood of acacia and six species of pests of flowers and fruiting bodies of acacia.

It should be emphasized that, despite this impressive number of species constituting the entomofauna of the acacia, this tree is considered to have good resistance to attack by diseases and pests. Trăuțescu et al (1969) mention that only a very small number of the total number of species collected as entomofauna of acacia are really harmful, in the sense that most of them cause damage at a level well below 20%, which is considered to be the lower threshold of economic damage. Of these, the most important, in terms of magnitude of damage, are the following:

- ***The locust borer*** *(Megacyllene robiniae)* is a pest of the order Coleoptera that attacks the trunk and branches of the tree extremely severely. The adult specimens deposit their ova upon the surface of the acacia's bark, and subsequent to the hatching process, the larvae penetrate the bark as well as the cambial layer in which they undergo overwintering. In the spring the larvae continue their development by digging tunnels 2.5 cm in diameter and up to 12 cm in length, the tree rarely dies from the attack, but the quality of the wood is totally compromised, and it is only usable as firewood (Johnson and Lyon, 1991). It is quite fortunate and highly advantageous that the geographical distribution and habitat range of this particular pest species is confined solely to the continental United States, thereby limiting its potential impact and spread to other regions beyond this specific area.
- ***The locust leaf-mining larva*** *(Odonotota dorsalis) (Figure 17)* is a coleopteran larva that consumes the leaf mesophyll between the upper and lower epidermis as larvae, while the adults "graze" the epidermis and mesophyll thereby skeletonizing the leaf. Athey and Connor (1989) found that damage by adults can account for up to 50% of total damage. Damage can be so severe that trees appear scorched by a forest fire. If, after a first attack, the tree produces leaves a second time, a subsequent attack in the same year results in the death of the tree.

FIGURE 17. ATTACK BY THE LOCUST LEAF-MINING LARVA ON ACACIA LEAVES (ODONOTOTA DORSALIS) (SOURCE: RUBEN BUDĂU, 2022)

- ⇨ ***The locust twig borer*** *(Ectdytolopha insiticiana)* is a lepidopteran whose larvae bore into young branches feeding on vascular tissue. In young trees, they also attack the stem which, in most cases, becomes swollen and then breaks at the site of attack (Hoffard and Anderson, 1982).
- ⇨ ***The cracked cap polypore*** *(Phellinus robineae)* is a mycosis, considered the most damaging disease of acacia. Infection occurs through wounds in the bark of the trunk or branches (e.g. branch splinter holes or mechanical wounds). As a result of the attack, the wood turns brown, becomes spongy and loses all usability (Hoffard and Anderson, 1982).

Research on the genetic determinism of resistance to disease and pest attack has focused mainly on the locust borer, which in the USA is the most damaging pest of this forest species. The most interesting results were obtained by Harman and Dixon (1984) who found that two components of vegetative growth are negatively correlated with the degree of attack by the borer:

- ⇨ The borer prefers younger, thinner-barked trees that are easily punctured by newly hatched larvae. This means that the selection of fast-growing, vigorous clones, leading to early bark thickening, would reduce the pest's attack.

- Young, vigorous, actively growing trees have the ability to greatly reduce the severity of attack by closing the holes produced by the larvae at the entrance, leading to their asphyxiation.

Insect-resistant biotech crops, engineered for pest resistance, reduce pesticide use, thus lowering fossil fuel consumption and carbon dioxide emissions.

Advanced biotechnology employing genetically modified, stress-tolerant, high-yield transgenic crops can effectively mitigate the adverse impacts of climate change (Sărac, I., 2005).

Cultural measures for the maintenance of acacia stands, combined with a judicious choice of planting density, can ensure that acacia forests are in good health and can produce high yields of quality timber. In nurseries and young plantations, it is possible and advisable to apply chemical treatments to control diseases and pests, the effectiveness of which has been proven in rigorous experiments carried out both in Hungary (Toth, 2002) and in our country.

6.6. Nectar production

Nectar production is also a major amelioration objective, with acacia being one of the most important honey bearing plants in our country. In other countries, such as Hungary, acacia is the most important honey bearing plant, with the value of exported honey exceeding in some years the value of exported raw or processed acacia timber (Keresztesi, 1988).

The total nectar production per area unit of acacia plantation depends on a multitude of factors, some of which have a direct and others an indirect effect on this characteristic. Of these, the most significant are: nectar/flower yield, nectar sugar content, earliness of first flowering, flowering duration and age of trees.

According to Cîrnu (1980), the amount of nectar produced by an acacia flower in climatically normal years is between 1-4 mg, and its sugar concentration varies between 40 and 70%. It is clear that, in terms of these two characteristics, there is potential for the selection of clones with high nectar/flower yields and high nectar sugar content. Establishing plantations with such clones through vegetative propagation would maintain stable nectar production and quality.

The precocity of the first flowering is particularly important as it prolongs the total honey bearing life of the plantation. Barrett et al. (1990) it has been observed that robust seed-propagated Acacia trees commence flowering from their third year of development (the second year after field transplantation), which occurs 2-3 years earlier than that of alternative tree species. The flowering duration of acacia in climatically normal years is between 8 and 15 days.

The degree of variability observed in the characteristics of the subjects is sufficiently elevated, ranging from singular instances to dual occurrences, thereby facilitating the effective implementation of clonal selection processes aimed at identifying and promoting individuals with the most prolonged duration of flowering time. Permanently flowering (semperflorens) types of acacia, although maximizing flowering duration, do not increase the total amount of nectar harvested from the plantation, because the number of inflorescences formed by a tree is the same as in the normal (single flowering) type of acacia.

In addition, on a plantation of permanently flowering acacia, the production of honey exclusively from acacia flowers would be very difficult in midsummer when other honey bearing species are in abundant bloom.

Despite the obvious complexity of this breeding objective, the results obtained in our country by Bîrlănescu et al. (1977) in an acacia amelioration program carried out between 1972 - 1975, in which the first objective formulated by the authors was "the selection of acacia forms suitable for forestry and beekeeping". At the end of the program, it is reported that 50 clones of apicultural interest were selected to be tested alongside similar clones from Hungary and Bulgaria.

In Hungary, along these lines, Osvath-Bujtás and Rédei (2007), in a booklet popularizing acacia cultivars approved in Hungary, out of 12 such cultivars, two are described as having high nectar production and are recommended for the establishment of honey bearing plantations.

6.7. Methods for acacia amelioration

In all countries where acacia amelioration programs have been initiated, the starting point has been an inventory of the natural variability of native acacia stands. Certainly, at least as far as it was possible at the time, any acacia amelioration program had to start from a knowledge of the value of the initial material, especially that existing in the country, since it had already demonstrated its adaptability to local soil and climatic conditions.

Obviously, the variability of the traits of silvicultural interest in acacia introduced locally had to be assessed by comparison with the variability of acacia in its native range.

6.8. Naturally occurring phenotypic variability in traits of silvicultural interest

From the point of view of acacia improvement, the original material, present in all growing areas of the country, belongs to the species *Robinia pseudoacacia* L., var. rectissima, native to Long Island in North America.

In contrast to the typical form (Figure 18) of acacia on the American continent, var. rectissima has a cylindrical, rectilinear, upright, well-equalized, even to the top or near the top, with yellowish-colored, very durable wood; the crown is narrow and sparse, its branches being slender and inserted at 45º to the trunk. These characteristics have made the variety rectissima the principal supplier of masts for sailing vessels built on Long Island, for which reason it has also been called the "mast acacia".

FIGURE 18. TYPICAL FORM IN THE FORESTS OF VĂRĂDIA DE MUREȘ IN ARAD COUNTY, ROMANIA

FIGURE 19. ROBINIA P. VAR. RECTISSIMA IN THE FORESTS OF VALEA LUI MIHAI, BIHOR COUNTY, ROMANIA. 2023

Although the acacia was introduced to Romania almost 200 years ago, the study of the variability of the traits of silvicultural interest in this species began much later, after 1933, at the same time as the beginning of the work on the amelioration of forest trees initiated by ICEF (now ICAS).

Since there was only one variety (var. rectissima) in all acacia-growing areas in Romania (Figure 19), the study of its variability under local conditions started with the identification of the main biotypes described by Hopp (1941) for this variety in populations from Long Island and the southeastern USA. This identification was carried out by Enescu (1965, 1985), in the acacia stands on the continental sands of southern Oltenia, the description of these biotypes being very close to that of Hopp (1941):

- ⇨ The ***pinnata*** type was found to be the least widespread in the populations studied. It shows rapid growth, upright, cylindrical, straight trunks, satisfactorily slender, with a tendency to fork, especially in the crown, the forking being realized at very small angles, the two branches being practically parallel. This last characteristic does not agree with the description of the biotype by Hopp (1941).
- ⇨ The ***palmata*** type was found as the most widespread on the continental sands of Oltenia. It exhibits an often crooked, oval stem, with a sloping stance and broad crown. Qualitatively, it is inferior to the pinnata type but superior to the spreading type. It seems to be particularly efficacious in safeguarding agricultural terrain characterized by sandy soils from the detrimental impacts of wind erosion.
- ⇨ The ***spreading*** type has been quite common in acacia stands on the continental sands of Romania. The trunks are sinuous, sloping, unsatisfactorily slender, with very small growth; the crown is broad, irregular, very often tabular. Not recommended as initial material for acacia amelioration.

Apart from these well-known and accepted biotypes (Figure 20) for *R. pseudoacacia* var. rectissima, there is relatively little data on intraspecific variability in acacia. This particular assertion, which underscores the relevance and applicability of the statement in question, holds validity not solely within the confines of our nation, which is characterized by its unique cultural and agricultural practices, but rather extends to encompass a multitude of other nations that possess a longstanding and historically rich tradition of acacia cultivation, including but not limited to the United States of America, the Republic of France, the Federal Republic of Germany, Hungary, and, once again, France. In the USA, for example, until 1961 there was no comparative cultivation of acacia (Funk and Roach, 1961), and the same situation existed in western European countries.

FIGURE 20. BIOTYPES OF ACACIA IDENTIFIED AT VALEA LUI MIHAI IN BIHOR COUNTY (SOURCE: RUBEN BUDĂU, MARCH 2023)

In Romania, it is worth mentioning, however, the comparative culture with eight unknown acacia provenances, established at Lehliu in 1953. An initial evaluation of the results recorded by the eight provenances (Lăzărescu and Rubțov, 1962) shows that, after 10 years, they do not differ in terms of average tree height and trunk shape. Differences between provenances appear only in straightness, forking tendency, protuberances and other defects.

Special mention should also be made of the comparative cultures with 24 family progenies and one control, propagated by seed and located in four different localities, in a 5 × 5 balanced square grid (Bîrlănescu et al., 1977). The determination of the specific tree species from which seeds were harvested occurred across 24 distinct geographical locales, predominantly situated within regions renowned for the cultivation of Acacia.

After processing the data over five experimental years, the authors conclude that the differences in tree height between the family origins are apparent from the first 4-5 years after planting and become more pronounced as the trees get older. They also note that the values of significant differences for P5% are lower in homogeneous than in non-homogeneous sites.

The deficiency of extensive provenance investigations has been locally mitigated by analyses focusing on the dynamics of acacia populations in various ecological stations. In this respect, it is worth mentioning the 16 experimental blocks with acacia stands of different ages set up by ICEF in 1955-1956 in six forestry stations: Ianca, Săcuieni, Calafat, Lehliu, Miteeni and Craiova. The observations and measurements carried out at three-yearly intervals in these experimental blocks allowed interesting conclusions to be drawn concerning the growth in height, base diameter and growth peaks (Armășescu et al., 1969). It was found that, at the same stand age, these traits varied significantly from one station to another, which reveals the importance of the environment and genotype × environment interaction in the phenotypic manifestation of these traits.

In contemporary scholarly discourse, in numerous nations characterized by extensive expanses of acacia (notably China, the United States, and Hungary), the investigation into the comparative cultural properties of provenances from diverse origins is being progressively employed to elucidate clones or familial lineages exhibiting advantageous traits pertinent to one or multiple enhancement objectives. Examples include inter-family variability studies of photosynthesis intensity and tree growth in the USA (Mebrahtu and Hanover, 1989), regional comparative cultures in China with acacia forage clones (Zhang et al., 2013), and those in Canada and Hungary to determine the variability of timber quality in different acacia provenances (Stringer, 1992; Rédei, 2008).

One of the most compelling provenance investigations is the one documented by Liesebach et al. (2004), wherein the Institute of Forest Tree Genetics and Amelioration in Germany undertook the characterization of 18 acacia seed progenies (families) originating from the USA, Germany, Slovakia, and Hungary, utilizing enzyme markers as a methodological approach.

The results were surprising in the way they differentiated the respective provenances: high enzyme variability was reported within the six populations from Hungary, combined with very low inter-population genetic variability. In contrast, the eight German populations showed very low intra-population genetic variability at the enzyme level, while inter-population variability was very high.

The authors conclude that, for Europe, no generally valid model for the evolution of variability in acacia can be given, as it certainly depended in each country on the predominant propagation method used in the production of planting material for afforestation with this species.

6.9. Hybridization

As in other crop plants, artificial hybridization in acacia was the first method used by man to create genotypic and phenotypic variability in hybrid progeny that could be profitably exploited through selection. Among the first successful attempts at artificial hybridization in acacia, Enescu (1975) mentions those made in the former USSR by Frolova (1955), and in the beginning of the sixth decade of the last century, such work was successfully carried out (Redei, 1998). In Romania, it seems that the first successful attempts at hybridization, published by Bîrlănescu et al. (1977), were carried out by these authors in the early 1970s. Unfortunately, none of the authors cited above describes the technique for performing these artificial hybridizations.

From the point of view of the preferred type of pollination, acacia is considered a strictly allogamous species (Surles, et al., 1990) due, firstly, to the morphology of the stigma and anthers (the mature stigma is located well above the anthers) and, secondly, to the obvious proto-origin of the maturation of the sexual organs (the stigma matures 3-4 days before the anthers themselves). These two characteristics are fundamental for artificial hybridization and forced self-pollination, respectively.

From the literature consulted, the most detailed descriptions of the techniques for performing hybridization and self-pollination, respectively, were found in papers published by Yuan et al. (2013) and Dini-Papanastasi and Aravanopoulos (2008).

The selection of parental forms must be made with great care to facilitate the identification of truly hybrid individuals in hybrid progeny. Traits with a very high heritability (e.g. budding date, leaf set date, thorn length, cf. Mebrahtu and Hanover, 1989) or those with oligogenic determinism (many leaflets/few leaflets in the leaf) can be used as genetic markers for the identification of putative hybrids.

The selection process of inflorescences and the individual flowers contained within these inflorescences is subjected to rigorous examination. In both parents, inflorescences with unopened flowers on vigorous shoots in accessible positions are selected. The floral structures within each inflorescence undergo a meticulous visual examination, whereby those that have already reached anthesis are excised. In inflorescences with a large number of flowers on the maternal parent, removal of flowers at the base and at the top is preferred, after which the group of inflorescences or each individual inflorescence is isolated in gauze or parchment bags to avoid any accidental contamination with pollen. Bîrlănescu et al. (1977) recommend, for conditions in our country, the use of gauze bags which provide adequate protection against attack by the pest *Etiella zinckenella Tr.*

Neutering flowers of the maternal parent. Although, according to some authors (DeGomez and Wagner, 2011), the probability of self-pollination of acacia flowers is so low that it is not worth considering, most of those who perform artificial hybridizations in this species recommend neutering the flowers of the maternal parent in order to achieve artificial pollination with pollen from the paternal parent. In practice, the operation is carried out when the flower has reached the advanced bud stage (calyx: corolla ratio=1/1) by removing the corolla and then the anthers by cutting the staminal filaments to a third of their length. Inflorescences characterized by the presence of sterile flowers are once again subjected to isolation.

The pollen is collected from the paternal parent when the flowers reach the corolla elongation stage (calyx: corolla ratio=1/2). The corolla is removed with tweezers and the anther column is gently pulled off and placed in a Petri dish.

Artificial pollination of neutered flowers can be done when neutering is completed, a few hours after neutering or at the latest 48 hours after neutering depending on when the stigma reaches maximum receptivity for pollen (a colorless, sticky drop appears on the stigma). This can be done with a cotton swab, with which the pollen is taken from the petri dish and placed on the stigma.

Another method of artificial pollination is to grasp 2-3 columns of anthers in the petri dish with tweezers and use them as a kind of brush to deposit the pollen on the stigma of the neutered flowers. After artificial pollination, the inflorescences with the ' dressed' flowers are again isolated and labeled.

Forced self-pollination of acacia flowers can be carried out in two ways:

- ⇨ by opening the canopy of the corolla, releasing the anther column which detaches and is used as a small brush to deposit pollen on its own stigma.
- ⇨ the flowers of the maternal parent are isolated and not neutered, any pod formed by such flowers is considered a hybrid.

The pods, along with the hybrid seeds that they contain, undergo the process of harvesting during the autumn season, specifically at the point when they have reached their optimal level of maturity, which is essential for ensuring the highest possible quality and yield. It is preferable that the isolator used for hybridization is maintained until the pods are fully mature to avoid loss via scattering. The hybrid seeds must be extracted from their pods and subjected to treatment with insecticides and fungicides to safeguard them against infestations by storage pests and the onset of diseases. Prior to sowing, hybrid and self-pollinated seeds should be mechanically or chemically scarified to improve their ability to germinate. In seeds obtained by forced self-pollination, the inbreeding depression is manifested by smaller size and mass than hybrids and, more importantly, very poor germination capacity (Yuan et al., 2013).

The interest with which Romanian acacia breeders have approached the use of artificial hybrids to create increased variability, profitable for selection, is illustrated by the large number of combinations realized in different time periods. Thus, between 1972 and 1974, Bîrlănescu et al. report the realization of 25 hybrid combinations, and in 1975 another 11 combinations in which var. oltenica was one of the parental forms.

The resulting seeds yielded 1050 seedlings which were tested in comparative cultures. The best-performing combinations were vegetatively propagated and used for the establishment of new plantations or the reforestation with acacia of forest areas deforested by logging or by the destructive action of natural and/or artificial factors (prolonged floods, fires, landslides, etc.).

6.10. Mutations. Polyploidy

The use of mutations in acacia amelioration programs has long been routine practice. Obviously, it started by finding natural mutants, testing their value and propagating them vegetatively. A striking example is the Ohio prostrate cultivar. In 1958, in a common acacia plantation, the originator of this cultivar discovered a creeping habitus with a procumbent trunk and branches (Kriebel, 1960). Such a habitus was considered very suitable for the afforestation of mining dumps, characterized by a very thin fertile layer on the surface of the slag deposit. The mutant was consequently propagated vegetatively through the utilization of root cuttings and subsequently documented as a novel cultivar.

Artificially inducing mutations in acacia using physical and chemical mutagens is a more recent practice. Most often, this method of creating variability in acacia is used to obtain mutants resistant to abiotic (e.g. high soil salinity) or biotic (disease and pest attack) unfavorable factors (Keresztesi, 1994).

Regarding the use of physical mutagens (non-ionizing rays, ionizing rays, weightlessness, high energy fields, etc.), it should be pointed out that their application is largely restricted to seeds and/or seedlings obtained from seeds. Few countries have polygons specifically set up for the treatment of trees with ionizing radiation emitted by a Co60 source. One such country is Hungary, which has two such polygons, each with a 120 Curie Co60 source, in which in situ irradiated acacia cuttings or seeds can be harvested (Keresztesi, 1994).

Yuan et al. (2012) treated acacia seeds with cosmic rays (UV) for 15 days and found that plants obtained from such seeds showed much greater variability than the untreated control in height, basal diameter, number of branches, average shoot length and width. Molecular level analysis with SSR, AFLP and RAPD markers showed a much higher polymorphism in the mutant forms than in the control.

Among the various categories of chemical mutagens, which are compounds that can induce changes in the genetic material of organisms, colchicine stands out as the most extensively employed agent, and it is specifically utilized in the scientific and agricultural fields to induce mutations in chromosomal numbers, a phenomenon known as polyploidy, whereby cells acquire additional sets of chromosomes beyond the typical diploid state. Treatments can be applied to dormant, stratified or germinating seeds by immersion in colchicine solution at a concentration of 0.1- 0.6% for 5-144 hours (Hyun and Chung, 1963 cited by Enescu, 1975). Very low numbers of tetraploids and mixoploids were obtained due to the fact that the embryos of treated seeds were strongly affected by the treatment.

Keresztesi (1994) proposes a different methodology for colchicine treatments that avoids its destructive effects on the root of the seed embryo. The seeds are germinated in plastic pots, and when the first pair of leaves appear, the root tips of the plants are immersed in colchicine solution for 48-96 hours, after which the roots are washed by immersion in tap water for the same period of time. According to the author's results, the number of polyploid and myxoploid plants increased by 20% compared to the classical method of soaking the seeds in colchicine solution.

Tetraploids and triploids of acacia have a lower growth rate than diploid plants, whereas mixoploids grow faster than tetraploids, but slower than diploids (Enescu, 1975).

The interest in acacia tetraploids is mainly due to their ability to develop much richer foliage than diploids, sometimes with very large (gigas-type) and thick leaflets. This aspect is of importance in the use of acacia leaves as fodder not only for forests but also for farm animals. Zhang et al. (2013) introduced tetraploid acacia leaf meal of 40 g/ration into the ration of laying hens and found that egg size, weight and shape index were significantly increased ($p<0.05$) compared to control (0 g leaf meal/ration) eggs.

Lately a new direction of tetraploid utilization is emerging that could prove to be of great significance, Meng et al. (2009) organized a comparative experiment with diploid and tetraploid acacia grown under salt stress (NaCl and Na_2SO_4). Growth, shape index, electrical conductivity, leaf water content, enzyme activity, photosynthesis rate was practically unaffected by salinity in tetraploid acacia, whereas in the diploid control the effects were very strong, even to the point of plant death. The authors conclude that this performance of tetraploid acacia recommends it as a priority species for afforestation of areas with soils with a high degree of salinization.

Liu et al. (2012), Pakull et al.(2024), provide particularly valuable information on the genetic determinism of the resistance of tetraploid acacia to salt stress. Based on molecular level analyses (cDNS-AFLP and qRT-PCR) performed on plant material harvested from two-year-old acacia trees subjected to 5, 10 and 15 days of salt stress (300 mM NaCl), the authors conclude that the resistance of tetraploids to high salinity concentrations is controlled by six polygenes belonging to as many linkage groups. Acacia amelioration programs in this direction will benefit favorably from this information.

However, it should be emphasized that the use of acacia tetraploids in practice encounters serious difficulties due to extremely low seed germinability (Chung and Lee, 1972; Yuan et al., 2014) and low vegetative multiplication rates by root cuttings due to the small number of tetraploid mother plants available. Micro-multiplication could be a solution, but for now it is far too expensive. Under these conditions, the solution proposed by Nan et al. (2013) seems much more advantageous in concrete terms: the authors propose propagation of tetraploid acacia by juvenile shoot cuttings that can be harvested from the mother plants without difficulty, in much larger numbers than root cuttings and without weakening the mother plants.

6.11. Somaclonal variability

In vitro cell and tissue cultures in plants have become a fundamental research tool in the last three decades, used extensively for vegetative propagation, conservation and amelioration of plant resources. The presence of somaclonal variability in populations derived from cell and/or tissue cultures has both a negative and a positive effect (Ramirez, 2011). The negative effect is mainly felt in the propagation of cultivars where a very high genotypic and phenotypic uniformity of the propagated material is required (inbred lines, self-pollinated plant varieties, etc.). The positive effect results from the fact that somaclonal variation provides valuable initial material for the amelioration process, which can lead to the creation of new cultivars with superior traits to those already in cultivation.

In the context of Acacia, the phenomena of tissue culture and the somaclonal variations that emerge within populations derived from these cultures have not represented a novel area of investigation for an extended period.

Worldwide, the first molecular level analysis of somaclonal variability in acacia was performed by Shu et al (2003) using Rapd markers.

Subsequent methodological contributions by well-known researchers in the field of micro propagation (Bindlya and Kanwar, 2003; Nepazahaio, F. et al., 2006; Zhang et al., 2007; Corneanu Mihaela and G. Corneanu 2010) provide new evidence on the importance of somaclonal variability in acacia amelioration. In this regard, we note the results published by Corneanu et al. (2010), who, following selection applied to new acacia seedlings, obtained via tissue culture, succeeded in obtaining clones resistant to deuterium-polluted water.

In the context of reproductive practices, it is pertinent to note that in the field of in vitro methodologies applied to acacia species, parallels can be drawn with biotechnological approaches that are similarly used in various other forest species, thus illustrating the widespread use of these advanced techniques (Timofte, A. I., et al. 2011).

6.12. Amelioration of acacia through selection

In all crop plants, selection is the main method of exploiting the natural or artificial variability existing at any given time in the species being worked on. In forest species, selection, as a method of amelioration, has many particularities imposed by the specific biology of each species

The fundamental principles of selection in forest species were outlined by Wright (1963) and are discussed in detail in valuable treatises on local silvicultural amelioration (Enescu, 1975; 1985; 2002; Savatti, M. and Savatti jr., 2005)

In the broadest sense, selection involves the selection from a population of plants, on the basis of well-established criteria, of a certain number of plants that will participate in the next generation of that population. There are a large number of selection variants, differentiated according to a number of methodological criteria

Depending on how the selection criteria are assessed, they can be:

- ⇨ **Phenotypic selection,** based on the visible and possibly measurable manifestation, in the chosen individuals, of the favorable traits sought by the breeder.
- ⇨ **Genotypic selection** is based not only on the phenotypic appearance of the individuals chosen, but also on the performance of the offspring of these individuals. In most forest species this type of selection is rather difficult to apply due to the long life span of the respective species.

Based on the direction in which it is oriented, this type of selection may be:

- ⇨ **Pozitive**, in the sense that only selected individuals with the desired traits are retained for perpetuation. This type of selection is specific to amelioration works and to the production of propagating material.
- ⇨ **Negative** occurs when all the individuals that do not meet the desired traits are removed from the population. This particular form of selection methodology is frequently employed in the field of cultural studies, particularly when analyzing and evaluating stands that exhibit varying chronological ages. Two basic types of selection can be distinguished according to the way in which the performance of the selected individuals is tracked in the lineage, namely:
- ⇨ **Individual selection** involves the evaluation of the progeny of each individual chosen and the retention of those progenies in which all or most of the individuals exhibit the traits desired by the breeder. The retained progeny will be propagated (seminally or vegetatively) and tested in comparative crops (plantations) carried out with the most precise measurement of the traits sought and comparison of population averages.
- ⇨ **Mass selection** occurs when all the offspring of the chosen individuals are tested together, in admixture, for the desired traits. In effect, mass selection replaces the original population from which the selection was made with a new population made up of the offspring of the most valuable individuals from the original population.

Being a strictly allogamous species, acacia lends itself better to mass selection than to individual selection. Individual selection, by forcing the offspring of a single individual to pollinate each other, inevitably leads to inbreeding depression to varying degrees.

Mass selection encompasses three discrete variants, contingent upon the quantity of selections undertaken and the methodologies employed in the aggregation of seeds from the selected individuals:

- ⇨ Simple mass selection, characterized by a singular selection;
- ⇨ Repeated mass selection;
- ⇨ Mass selection conducted in cohorts of plants.

Regardless of the variant, mass selection efficiently exploits natural and/or artificial variability in populations of trees with obvious genotypic and phenotypic polymorphism. The efficiency of mass selection is expressed by the so-called genetic gain (CG) which, mathematically, is given by the relationship: CG = K.h2.i (Dudley and Moll, 1969) where: K is an index of the selection differential whose value is inversely proportional to the selection pressure; h2 = heritability of the trait being targeted; i = the selection bias calculated in this way; I = the mean of the trait in the chosen elites: the mean of the trait in the population under selection.

The implementation of positive mass selection on both naturally fertilized superior trees and those subjected to artificial pollination is subsequently complemented by the application of negative mass selection, manifested through the practice of thinning (culled specimens) within seedling populations. The resultant plantations can thereby serve as progenitors for the generation of forestry seedlings intended for afforestation initiatives.

Depending on the effects on the genetic structure of populations, the following types of mass selection are distinguished:

- ⇨ **Stabilizing selection** involves eliminating extreme variation and retaining the most representative genotypes in the population, which have the greatest capacity to adapt and survive.
- ⇨ **Directional selection** favors the group of extreme genotypes (plus variants or minus variants) leading to a shift of the population mean towards the favored group.
- ⇨ **Disruptive selection** favors one or two optimal phenotypes over intermediate ones. Gradually, the population splits into subpopulations, some very close to the optimum, others very close to the minimum.

In forest species, including acacia, mass selection, both positive and negative, also takes the form of cultural selection. The care of acacia trees through the application of pruning and thinning, together with the encouragement of the development of the most typical and vigorous saplings, are in fact forms of mass selection.

Mass selection in Acacia, in addition to its significance in the enhancement of this species, possesses equally substantial importance in the establishment of seed-source stands (plantations). In Romania, the identification of seed-source stands or the creation of new stands of this kind began after 1960, and after a few years we ended up with about 65,000 ha of such stands (Bumbu and Catrina, 1982).

Clonal selection involves multiplying valuable individuals, chosen during the selection process, by vegetative propagation (cuttings, saplings, grafts, etc.). The resultant clones undergo evaluation in comparative agricultural settings, with the most esteemed being utilized in the formation of seed-producing cultivation systems. In acacia this type of selection is very common, primarily because of the ease with which the species can propagate vegetatively. In all forest species, the application of clonal selection has led to so-called clonal silviculture. (Libby and Ahuja (1993), Enescu (2002), Savatti and Savatti Jr. (2005) have analyzed in detail the features of clonal silviculture, the benefits and disadvantages of this type of silviculture, noting that in species such as acacia, where vegetative propagation is easy to achieve at moderate cost, the benefits far outweigh the disadvantages.

Selection assisted via molecular markers enables the acceleration and streamlining of the selection process by diminishing its probabilistic character (Gallais, 1990). In principle, this type of selection involves "linking" a phenotypic trait to a specific molecular marker, which can be easily identified at any age of the plant by analysis of proteins, enzymes, DNA, RNA, etc.

In the case of arboreal species within forest ecosystems, the significance of this matter cannot be overstated, particularly when one considers the extensive duration that is typically necessitated for the comprehensive genetic analysis through traditional methodologies.

In addition, in trees for which intraspecific hybrids can be obtained, marker-assisted selection allows the choice of the combinations most likely to exhibit positive trans- heterosis in terms of wood mass production and wood quality.

It should also not be neglected that, unlike conventional selection, the efficiency of which is directly proportional to heritability size (h2), marker-assisted selection allows significant genetic gains in traits with low and very low heritabilities (Botez, 1994). The discussion of selection methods applicable in acacia amelioration does not imply that all these methods have been and are used with equal frequency. In this respect, we believe that the presentation of a few examples may be instructive.

In the United States, the identification of exemplary individuals (plus trees) within the Acacia genus commenced during the third decade of the previous century (1930), with the principal criteria for selection being the rate of growth and the characteristics of the trunk (including straightness, height, and diameter). Clonal, individual or mass selection was usually applied, depending on the traits to be phenotypically externalized by the new cultivar (Bongarten, 1992; DeGomez, 2011). More than 30 monoclonal and multiclonal cultivars were registered and released into cultivation during that period.

Subsequently, NRCS (National Resources Conservation Service, USDA) *** concentrated amelioration of acacia in four universities located in areas with widespread occurrence of these species: Georgia, Michigan, Kentucky and Maryland for common, red and misty acacia and Arizona for Mexican acacia. The methods used for amelioration were diversified (selection of half-sib and full-sib families, selection of artificially induced mutations and polyploids, exploitation of somaclonal variability by selection, gene transfer mediated by biological, physical and chemical vectors), resulting in an impressive number of local cultivars (more than 70), not only in *Robinia pseudoacacia* but also in the three other acacia species related to the common acacia: R. hispida (Wandel, 1989), R. viscosa (Isley and Peabody, 1984) , R. neomexicana (Isley and Peabody, 1984) .

In Hungary, the first acacia amelioration program was initiated in 1960 and its main objective was the selection of new clones with superior traits in terms of quantity and quality of industrial timber production (Rédei et al.,2013). In several plantations previously obtained from seed, three groups of individuals with these traits were identified, in each group the plus trees were nominated, resulting in a total of 40 such trees (Keresztesi, 2013). Vegetative material from these trees was used for propagation by grafting, and the resulting clones were tested in comparative cultures at Gödölfi Station. At the exploitation age, five of the most productive clones were registered as new cultivars under the names: Jászkisári, Kiscsalai, Nyirsági, Űllöi and Szajki (Keresztesi, 1994).

Since the areas with optimal soil and climatic conditions for acacia in Hungary are rather limited, acacia has come to occupy large areas with sub-optimal conditions. The timber production and quality in these areas is far below what the new acacia clones were producing in the areas of maximum suitability, therefore the next acacia amelioration program was mainly aimed at selecting new productive clones with good quality timber that are able to tolerate changing environmental conditions. This new selection cycle resulted in 12 new clones recommended for homologation and introduction into cultivation (Rédei et al., 2002).

Subsequent acacia amelioration programs (1983; 1996) used inter and intraspecific hybrids, populations obtained from Co60-irradiated cuttings, 136 polyploid forms as initial selection material. The comparative orientation cultures (6-10 years), with the best half-sib and full-sib families, with mutants and/or tetraploid forms were organized in eight forestry stations, with different pedoclimatic conditions, on a total area of 120 ha. Long-term (15-20 years) comparative competition crops were grown on more than 300 ha and organized in three research stations located in areas totally different in terms of favourability for acacia cultivation. The results of these programs were the homologation of seven more new acacia cultivars (by 1996) and the submission of proposals for the homologation of five new valuable clones (after 1996) (Osváth-Bujtás and Rédei, 2007).

Regrettably, there exists a paucity of empirical data regarding acacia amelioration initiatives and their corresponding outcomes within the Romanian scholarly literature. Results of short-term programs (1972-1975) were published by Bîrlănescu et al. (1977) and, fortunately, the authors also refer to the results of earlier periods, without specifying the time frame. One thing is certain about these programs: they were part of a National Program for the Conservation and Development of the Forest Fund between 1976-2010.

⇨ According to the authors cited, some notable results in the amelioration of acacia were achieved in our country in the period prior to 1972, among which they mention:

- the identification and selection of 29 plus trees which were vegetatively propagated and their clones were used in the creation of the first 15 ha of acacia plantations.
- identification of a new variety of acacia for the Romanian flora, *R. pseudoacacia*, var. oltenica, differentiated both morphologically and productively from the common acacia.
- creation of 11 intraspecific hybrids of acacia in which var. oltenica was one of the parental forms.
- selection of acacia forms of interest for beekeeping.

An analysis of these results indicates that, in the early period of acacia amelioration in Romania, as in the USA and Hungary, individual clonal selection was used, which involved identifying plus trees in stands with a clear variability in the traits sought, vegetative propagation followed by testing of the clones in plantations specially set up for this purpose in order to obtain seed source stands. Also from the work of the above-mentioned authors, we learn that, prior to 1972, intraspecific hybrids had already been obtained, in which selection in F1 half-sib and full-sib progeny was certainly applied, followed by vegetative multiplication of the elites and testing of the clones in comparative crops.

According to the data presented by Enescu (1975), by 1960, 79 plus trees had been identified whose clonal descendants were tested in comparative cultures at the Craiova Experimental Station. According to the same author, the first artificial hybridizations of acacia in our country were carried out by Bîrlănescu et al. in 1970, and the first artificial induction of polyploidy by colchicine and/or physical mutagenic agents was carried out by Leandru et al. in 1971.

The most significant results in terms of acacia amelioration of the 1972-1975 short-term program, reported by Bârlănescu et al. in 1977, are:

- Identification and selection of new plus trees, which increased the number of plus trees introduced as clones in plantations to 66, of which 59 were locally obtained clones.
- Selection of 50 new clones of apicultural interest to be tested with similar clones from Hungary and Bulgaria.
- The first tests were carried out with clones from half-sib (maternal) progeny, which showed that, due to hybrid vigor, from the age of 4-5 years, the clones of hybrid progeny significantly outperformed the control (common acacia).

7. FINAL CONCLUSIONS

- Acacia constitutes of considerable ecological and economic significance, which is distinguished by an extensive and multifaceted history of cultivation and utilization that spans in various contexts and applications. Originally native to the geographical region of the United States, this resilient species has effectively disseminated, demonstrating an impressive capacity to adapt to a wide array of climatic conditions as well as diverse soil types that characterize different ecological niches.

- In the context of Europe, and particularly within the borders of Romania, acacia has been methodically introduced and cultivated for a multitude of reasons, primarily owing to its myriad economic benefits and the social advantages that it provides to local communities and economies.

- The historical methodologies and practices associated with the cultivation of acacia within the defined geographical parameters of Europe, and more specifically Romania, serve to highlight its extraordinary adaptability while simultaneously emphasizing its vital importance as a forest species that not only supplies valuable timber resources but also acts as a highly efficient nitrogen-fixing organism that significantly enhances.

- The thorough and extensive examination of the origins, distribution patterns, and overall significance of the acacia species elucidates its inherently multifaceted role within a plethora of ecological frameworks and economic contexts, thereby demonstrating its importance across a range of disciplines.

- Furthermore, the myriad ecological advantages conferred by acacia, including but not limited to its significant contributions to enhancing soil health, mitigating soil erosion, and promoting biodiversity within various ecosystems, serve to underline its indispensable value in the realm of sustainable land management methodologies and practices.

- This comprehensive research underscores the imperative necessity for sustained study and cultivation of the acacia species, as it is crucial to ensure that its multitude of benefits are fully realized for the enrichment of future generations, all the while maintaining the delicate balance of ecological integrity.

- The propagation of acacia is carried out through a dual approach that includes both the use of seeds and various methods of vegetative reproduction, thus ensuring not only the continuous continuity of the species, but also contributing significantly to the maintenance of its genetic diversity in different populations.

- The acacia breeding practice focuses primarily on improving various characteristics, such as improving wood quality, fortifying against a range of abiotic and biotic stressors that threaten plant health, and increasing nectar production, which is crucial for pollinator attraction and ecological interactions.

- In conclusion, it can be said that acacia is a highly multifunctional species that holds significant importance in several areas, including but not limited to forestry, agriculture, medicinal applications and ecological systems; Thus, the continuous cultivation and selective breeding of acacia are of paramount importance for maximizing its inherent potential and ensuring its substantial contributions to both environmental integrity and economic sustainability.

8. BIBLIOGRAPHY

1. Albulescu, D., M. Palade, Şt, Drăgan, 1978, Contribuții la studiul derivaților ortodihidroxifenolici şi flavonoidelor din florile de *Robinia pseudo-acacia*, Farmacia 26(1), 33-38.

2. Arrillaga I., and Merkle SA (1993) „Regenerating plants from *in vitro* culture of black locust cotyledon and leaf explants”, *HortScience*, 28:942-945.

3. Alfred, R., (1962). Manual of cultivated Trees and Shrubs (Vol. Second Edition Revised and Enlargesd). New York: The Macmillian Company.

4. Ashe WW, (1922) „The eastern shrubby species of *Robinia*”, Elisha Mitchell Sci. Soc., 37(3):175-177.

5. Ashe WW, (1923) „Notes on trees and shrubs of the southeastern United States”, Rhodora, 25:180-183.

6. Armăşescu S, Țabrea A, Decei I și Bîrlănescu E (1969), „Cercetări asupra creșterii producției şi calității arboretelor de salcâm”, in Editor E (ed.) *Cercetări privind cultura salcâmului (Robinia pseudoacacia L.)*, Ed. Agro-silvică, Bucureşti.

7. Athey LA and Connor EF (1989) „The relationship betweeen foliar nitrogen content and feeding by *Odontota dorslis* on *Robinia pseudoacacia L.*”, *Oecologia*, 79:390-394.

8. Barrett RP, Mebrahtu T and Hanover JW (1990) „Black locust: a multi-purpose tree species for temperate climates”, in: Janick J and Simons JE (eds) *Advances in New Crops*, Timber Press, Portland, 278-283.

9. Bartha Szilárd (2024), ARBORI ȘI ARBUȘTI DE RĂȘINOASE DIN PĂDURILE ȘI SPAȚIILE VERZI ALE ROMÂNIEI, Editura Universităţii din Oradea.

10. Băbeanu C, Ciobanu G, Corneanu M, Marinescu G and Corneanu CG (2006) `Isoperoxidases pattern of *Robinia pseudoacacia* L. var. O*ltenica* in vitro culture on different media`, *Bul. USAMV-CN*, 62:24-28.

11. Bălteanu, D., 2005, Sistemul terestru global într-o etapă de cercetare, in: Silvologie, (red. V.Giurgiu), vol IV A, 43-56.

12. Beldeanu, E.C., 2004, Specii de interes sanogen din fondul forestier, Ed. Univ. Transilvania, Brașov.

13. Bereziuc R., Pascu G, Neagu V, Olteanu N and Zidaru C (1976) „(*Robinia pseudoacacia* L.) rezultată din arboretele exploatate”, *Noutăți în România Forestieră*, Ed. Universității Transilvania, Braşov, 18:207-212.

14. Bernáth, J., 2001, Gyógy- es aromanövenek, Mezö Gazda Kiado, Budapest.

15. Bindlya K and Kanwar K (2003) „RAPD markers for genetic analyses in micropro-pagated plants of *Robinia pseudoacacia L.* ”, *Euphytica*, 132:41-47.

16. Bîrlănescu E, Costea A and Stoiculescu C (1966) „O nouă varietate de salcâm identificată în România, *R. pseudoacacia* L., var. *Oltenica*”, *Revista Pădurilor*, 89(9):483-486.

17. Bîrlănescu E, Costea A, Armăşescu S and Tănăsescu S (1969) „Experimentări privind aplicarea răriturilor în salcâmetele din Oltenia”, in *Cercetări privind cultura salcâmului (Robinia pseudoacacia L.)*, Ed. Agrosilvică, Bucureşti.

18. Bîrlănescu E, Costea A, Ivanschi T and Tănăsescu S (1969) „Studii asupra sortimentelor de salcâm în raport cu tipurile de culturi şi ciclurile de producție”, în *Cercetări privind cultura salcâmului (Robinia pseudoacacia L.)*, Ed. Agrosilvică, Bucureşti.

19. Bîrlănescu E., Diaconu M, Costea A and Cojocaru I (1977) „Cercetări privind ameliorarea salcâmului (*Robinia pseudoacacia*, L.)”, *Analele ICAS*, 34(1):41-54.

20. Bongarten B (1992) „Genetic variation of black locust within its native range”, in *Proc. Intl. Conf. On Black Locust Biology, Culture and Utilization*, East Lansing, Mich, 1991:78-97.

21. Boring, L.R. and W.T. Swank, 1984, Symbiotic nitrogen fixation in regenerating black locust (*Robinia pseudoacacia*) stands. For. Sci. 30: 528-537.

22. Botez C, Ardelean M and Savatti M (1994) „Noi orientări ale cercetărilor fundamentale şi aplicative în genetica şi ameliorarea plantelor” *Buletinul USAMV-CN, A-H*, 48:5-11.

23. Bridgen, M.R., 1992, Plantation of black locust, in: Hanover,Miller and Plesco (Eds), Proc. Intl. Conf. on Black Locust, Biology, Culture and Utilization, East Lansing, Mich,. USA, June 1991, p.21-32.

24. Budău R., 2023 Cultura salcâmului, Editura Universităţii din Oradea. ISBN 978-606-10-2255-7

25. Budău, R., Bei, M., Onet, C., Agud, E., Mintas, O.S., Timofte, A.I., Rosan, C.A., Laslo, V., Vicas, S.I., In Vitro Propagation of Several Valuable Selections of Robinia pseudoacacia L. as a Fast and Sustainable Source for Wood Production. Sustainability **2023**, 15, 15243. https://doi.org/10.3390/su152115243

26. Budău, R., Apăfăian, A., Caradaică, M., Bratu, I.A., Timofte, C.S.C.; Enescu, C.M., Expert-Based Assessment of the Potential of Agroforestry Systems in Plain Regions across Bihor County, Western Romania. Sustainability 2023, 15, 15724. https://doi.org/10.3390/su152215724

27. Budău R., Timofte A.I., Study regarding the development of the seminal offspring of acacia in the second vegetation year from the hill area of Codru Moma Mountains. International Symposia Risk Factors for Environment and Food Safety & Natural Resources and Sustainable Development, Faculty of Environmental Protection, November 6-7 Oradea 2012. P. 339-342. ISSN 1224-6255

28. Budeanu M, Dala M, Marin M and Găbrian S (2013) „Variabilitatea fenotipică a descendenţilor din 33 de rezervaţii de seminţe de molid (*Picea abies* L) în testul Nehoiu. II. Caractere calitative", *Revista pădurilor*, 3:8-13.

29. Bujtas Z (17-21 June1992) „Seed and root propagation of black locust", [conference presentation] in Hanover J, Miller K and Plesco S (eds) *Proceedings of Int. Conf. on Black Locust: Biology, Culture and Utilization*, East Lansind, Mich., 49-53.

30. Bumbu Gh and Catrina I (1982) „Orientări şi rezultate ale cercetării ştiinţifice din perioada 1976-1980 privind sporirea productivităţii şi utilităţii pădurilor", *Revista Pădurilor*, 6:5-14.

31. Carbonnière, T., J-N. Debenne, D. Merzeau, M. Rault, 2007, Le robinier en Aquitaine. Forêt-entreprise, nr. 177, Nov., pp.13-174.

32. Catrina, I. (2005), Compoziţii optime şi scheme de plantare a perdelelor forestiere de protecţie, in: Giurgiu V., Editor, Compoziţii optime pentru pădurile României, 27 – 42.

33. Cernelea, E. (1982) Salvaţi jnepenii. Ei preîntâmpină efectele multor capricii ale naturii, Drumul Socialismului, anul 35, nr. 7707, Deva.

34. Ciortuz, I. (1981) Amelioraţii silvice, Ed. Didactică şi Pedagogică, Bucureşti.

35. Ciuvăț, A.L., I..V. Abrudan, V. Blujdea, Cristina Marcu, Cristina Dinu, M. Enescu, I.S. Niță (2013) Distribution and peculiarities of black locust in Romania, Rev. de Silvicultură şi Cinegetică, 32, 76 - 85.

36. Ciuvăț A.L,. 2013, Producția de biomasă şi stocarea carbonului în arboretele tinere de salcâm (*Robinia pseudoacacia* L.) din sudul României, Teză de doctorat, Univ. „Transilvania" din Braşov, Departamentul de Silvicultură.

37. Chalupa V (1983) „*In vitro* propagation of willows (*Salix ssp.),* European mountain ash (*Sorbus aucuparia*) and black locust (*Robinia pseudoacacia* L.*)*", *Biologia Plantarum*, 25:305-307.

38. Chapman AG (1936) „Scarification of black locust seed to increase and hasten germination", *J.For.*, 34:66-74.

39. Chung SK and Lee SK (1972) „Studies on Artificial Poliploid Forest Trees. IX On Chromosome Parting in Teraploid Plants of *Robinia pseudoacacia* L.", *IUFRO- Genetics – SABRAO join symp.*, Tokio, D-8(5).

40. Cîrnu I (1980) *Flora meliferă (apicultură, stupărit)*, Ed. Ceres, Bucureşti.

41. Clinovschi F. (2004) *Dendrologie pentru învăţământul la distanţă*, Ed. Universității „Ştefan cel Mare", Suceava.

42. Clinovschi F. (2005) *Dendrologie,* Editura Universității „Ştefan cel Mare", Suceava.

43. Constantinescu, C. and A. Agopian, 1967, Plante medicinale din flora spontană, Ediţia a II-a, Ed. Centrocoop, București.

44. Corneanu M., Corneanu GC., Blejoiu SI., Atym P., Netoiu C and Bica D (2001) „*In vitro* micropropagation of *Robinia pseudoacacia* L. Var. *Oltenica* on new culture media", *Acta Hort. Bucharest*, 29:307-315.

45. Corneanu Mihaela, G.C. Corneanu, I. Iliev, O. Danci, I. Ştefănescu, M. Popa., 2010, Micropropagation of *Robinia pseudoacacia*, L. var. Oltenica selected stress resistant clones on media with deuterium depleted water, Journal of Horticulture, Forestry and Biotechnology, 14: 141-144.

46. Corneanu M and Niculescu M (2008) Studiu biologic complex comparativ al unor genotipuri valoroase de *Robinia pseudoacacia* L. var. *Oltenica*, Raport cercetare, Grant CNCSIS 1180, 2007-2008.

47. Corneanu M and Corneanu G (20 martie 2008) „Utilizarea fluidelor nano-magnetice în rizogeneza *in vitro* a speciilor lemnoase" [Poster], *Al 7-lea Seminar Naţional de nanoştiinţă şi nanotehnologie*, Biblioteca Academiei Române.

48. Corneanu M, Corneanu GC, Iliev I, Danci O, Ştefănescu I and Popa M (2010) „Micropropagation of *Robinia pseudoacacia*, L. var. *Oltenica* selected stress resistant clones on media with deuterium depleted water", *Journal of Horticulture, Forestry and Biotechnology*, 14:141-144.

49. Corlățeanu, S., 1983, Cercetări cu privire la producţia, calitatea şi posibilităţile de valorificare ale liberului secundar și ale ritidomului de salcâm exploatabil. Teza de Doctorat, Universitatea din Braşov, Facultatea de Sivicultură şi Exploatări Forestiere.

50. Corlățeanu, S., 1984, Produsele accesorii ale pădurii, Ed. Ceres, Bucureşti.

51. Costea, A., C. Lăzărescu, E. Bîrlănescu, T. Ivanschi, Z. Spîrchez, 1969, Studii asupra tipurilor de culturi de salcâm, in: Cercetări privind cultura salcâmului (*Robinia pseudoacacia* L.), Ed. Agro Silvică, Bucureşti.

52. Costin E (1979) *Condiții ecologice ale culturilor forestiere de pe nisipurile litorale din Delta Dunării*, Ed. Agro-Silvică, Bucureşti.

53. Cotta, N.L., I. Curtu, A. Şerbu (1990) Elemente de construcții şi case prefabricate din lemn, Ed. Tehnică, Bucureşti.

54. Darlington CD and Wylie AP (1955) *Chromosome atlas of flowering plants*, Ed. Allen & Unwin, London.

55. Davis JM and Keathley DE (1987) „Different responses to *in vitro* bud culture in mature *Robinia pseudoacacia* L. (black locust)", *Plant Cell Rpt.*, 6:431-434.

56. Decei I şi Armăşescu S (1959) „Proporţia şi volumul cojii la salcâm", *Revista Pădurilor*, 74(7):397-400.

57. DeGomez T and Wagner MR (2011) *Culture and use of black locust, Comprehensive Crop Reports*, www.horttech/ashspublications.org.

58. Dini-Papanastasi O. and Aravaopoulos FA (2008) „Artificial hybridization between *Robinia pseudoacacia* L. and *R. pseudoacacia* var. *monophylla* Carr.", *Forestry*, 81(1):43-54.

59. Dobre, T. (2009) Povestea salcâmului oltenesc, Lumea satului, nr.8, 1-2.

60. Doniţă N (1999) *Dendrologie – Note de curs*, Universitatea din Oradea, Oradea.

61. Doniţă N and Radu S (2013) „Creşterea suprafeţei cu vegetaţie lemnoasă (păduri, perdele forestiere, tufărişuri), imperativ ecologic şi necesitate economică pentru ameliorarea factorilor de mediu şi prevenirea efectelor schimbărilor climatice", *Revista Pădurilor*, 128(3):19-22.

62. Dragomirescu Andreea (2014) Flori de salcâm (*Robinia pseudoacacia*), Fitoterapie, www.mirabilis-magazin.ro.

63. Drăcea M (1926/1928) *Beitraege zur Kenntnis der Robinie Rumaenien unter besonder Berücksichtigung ihre Kultur auf sandböden in der Oltenia,* Ed. Stereotipia, Bucureşti.

64. Drăcea M (2008) *Contribuţii la cunoaşterea salcâmului în România, cu privire specială asupra culturii sale pe solurile nisipoase din Oltenia*, Ed. Silvică, ICAS, Bucureşti.

65. Dudley JW and Moll RH (1969) „Interpretation and use of estimates of heritability and genetic variances in plant breeding", *Crop Sci.*, 9:257-262.

66. Dumitraşcu Monica., 2008, Dendrologie pentru peisagistică, Editura Invel Multimedia, Bucureşti.

67. Enescu C.M., Dănescu A., (2013), Black locust (*Robinia pseudoacacia* L.) – an invasive neophyte in the conventional land reclamation flora in Romania. Bulletin of theTransilvania University of Braşov Series II: Forestry • Wood Industry • Agricultural Food Engineering • Vol. 6 (55) No. 2

68. Enescu V (1965) „Contribuţii la studiul variabilităţii salcâmului de pe nisipurile continentale din sudul Olteniei", în *Cercetări de genetică*, Ed. Didactică şi Pedagogică, Bucureşti, 136 – 139.

69. Enescu V (1975) *Ameliorarea principalelor specii forestiere, Partea specială*, Ed. Ceres, Bucureşti.

70. Enescu V (1985) *Genetica ecologică*, Ed. Ceres, Bucureşti.

71. Enescu V (1989) „Micropropagarea *in vitro* în ameliorarea prin selecţie clonală a salcâmului (*Robinia pseudoacacia* L.)", *Revista pădurilor,* 104:6-8.

72. Enescu V (1991) „O tehnologie nouă de micropropagare *in vitro* a salcâmului (*Robinia pseudoacacia* L.)", *Revista Pădurilor,* 106(1): 2-3.

73. Enescu V (2002) *Silvicultura durabilă*, Ed. Agris, București.

74. Fitschen, J., 1994, Gehöltzflora mit Früchteschlüssel, Quelle & Meyer Verlag, Heidelberg – Weisbaden, Deutschland.

75. Funk TD and Roaach BA (1961) *Black locust – A bibliograpfy,* U.S. Forest Service, Release 33, 40 p.

76. Furdui, C. and Luminița Fekete-Nagy (2009) Structuri din lemn, Curs pentru studenţii anului III CCIA, Ed. Politehnica, Timişoara.

77. Furdui, C. (2011) Construcții din lemn, Materiale şi elemente de calcul, Editura Politehnica, Timişoara.

78. Gallais A (1990) *Théorie de la sélection en amélioration des plantes*, Ed. Masson, Paris.

79. Giurgiu, V. (2005) Editor, Compoziţii optime pentru pădurile României, Ed. Ceres, București

80. Giurgiu, V. (2005) Cu privire la relația dintre pădure şi modificările de mediu, in: Silvologie, IV A, Editor V.Giurgiu, Ed. Academiei Române, Bucureşti, 11-42.

81. Giurgiu, V. (2013) Pentru o legislaţie silvică performantă, Curentul, 22 febr.2013.

82. Goldblat P and Johnson DF (1998), „Index to plant chromosome numbers 1994-1995", *Monogr. Syst. Bot.*, Missouri Bot. Garden, 69.

83. Gruber KF and Hanover JW (1992) „An effective protocol for large scale micropropagation of black locust (*Robinia pseudoacacia*)", in Hanover J, Miller K and Plesco S (eds.), *Proceedings of Int. Conf. on Black Locust: Biology, Culture and Utilization*, East Lansind, Mich.USA, June 17-21(1991):126-135.

84. Hanover JW (1990) „Physiological genetics of black locust (*Robinia pseudoacacia* L.) a model multipurose species", in *Proc. of Intl. Conf. "Fast Growing Trees and Nitrogen Fixing Trees*", 1989, Marburg, Germany, 173-183.

85. Haralamb A (1965) *Cultura speciilor forestiere*, Ed. Didactică şi Pedagogică, Bucureşti.

86. Harman DM and Dixon KB (1984) „External manifestation and closure ofwounds caused by locust borers (Coleoptera, Cerambycidae) on black locust subjected to certain wood decay fungi", *J. Econ. Entomology*, 77:1412-1420.

87. Hartmann HT, Kester DF, Davis Jr. FT and Geneve RI (1997) *Plant propagation principles and practices*, 6th edition, Prentice Hall, Upper Sadle River, N.J.

88. Hernea C, Corneanum and Visoiu D (2009) „Reserches concerning the wood density of *Robinia pseudoacacia*, L. var. *Oltenica*", *Journal of Horticulture, Forestry and Biotechnology*, 13:334-336.

89. Hernea, C.; Poșta, D.S.; Dragomir, P.I.; Corneanu, M.; Sărac, I. Aspecte privind testele de germinare ale *Robinia pseudoacacia* var. Oltenica. J. Hortic. Pentru. Biotehnolog. 2010, 14, 138–142.

90. Hoffard WH and Anderson RI (1982) „A guide to common insects, diseases and other problems of black locust”. *S.F. Area Forest Rpt.*, SAFR 19, USDA Forest Service, Atlanta.

91. Holonec L (2007) *Împăduriri Semințe forestiere*, Ed. AcademicPres, Cluj-Napoca.

92. Horneanu, C.L. (1996) Dendrologie, Curs litografiat, Universitatea „Ştefan cel Mare” Suceava, Facultatea de Silvicultură.

93. Hristea, L.C. (1976) Stupăritul nou, Ed. Inst. Internațional de Tehnologie şi Economie Apicolă, APIMONDIA, Bucureşti.

94. Hopp H (1941) „Growth-form variation in black locust and its importance in farm planting”, *Jour. Forestry*, 38:40-46.

95. Hu, Y., Zhao, J., Li, Y., Tang, P., Zhou, Y., Zhang, J., & Sun, R. (2024). Biomass and Carbon Stock Capacity of *Robinia pseudoacacia* Plantations at Different Densities on the Loess Plateau. *Forests*, *15*(7), 1242. https://doi.org/10.3390/f15071242

96. Iliescu AF (1994) *Arboricultură ornamentală*, Ed. USAMV, Bucureşti.

97. Iliescu AF (2005) *Cultura arborilor şi arbuștilor ornamentali*, Editura Creres, Bucureşti.

98. Isley D and Peabody FJ (1984) ”*Robinia* (Leguminosae; Papilionoidea)”, *Castanea*, 49:1877-202.

99. Ivanova D and Vladimirov V (2007) „Chromosome numbers of some woody species from the Bulgarian flora” *Phitologia Balcanica*, 13(2):205-207.

100. Ivanschi, T., A.Costea., E. Bîrlănescu, A. Mărcoiu, I. Nonuțe, 1992, Cercetări privind stabilirea stațiunilor apte pentru cultura salcîmului (*Robinia pseudoacacia* L.), Ed. Agrosilvică, Bucureşti.

101. Jacamon, M. (1966) Guide Dendrology: arbres, arbustes, arbisseaux des forêts françaiseses. E.N.G.R.E.F. Nancy, France.

102. Jacobson AL (1996) *North American landscape trees*. Ten SpeePress, Berkeley, Calif.

103. Johnson WT and Lyonh H (1991) *Insects that feed upon trees and shrubs*. 2nd ed., Cornell University Press, New York.

104. Kellezi, M.K.; Kortoci, Y. Comparison of Growth Rate of Black Locust (Robinia pseudoacacia L.) on Productive and Marginal Cultivated Lands for Sustainable Agroforestry Systems. Ecol. Eng. Environ. Technol. 2022, 23, 206–

212. [CrossRef]

105. Keresztesi B (1983) „Breeding and cultivation of black loucust in Hungary”, *Forest Ecology and Management*, 6:217-244.

106. Keresztesi B (1988) *The Black Locust*, Akademiai Kiadó, Budapest.

107. Keresztesi B (1994) „Forest tree improvement in Hungary”, *Unasylva*, 88:33-38.

108. Keresztesi B (2013) *The Black Locust*, FAO Corporate Document Depository, www.fao.org/doc.

109. Kriebel HB (1960) „A prostrate mutant of Black Locust”, *Journal of Forestry*, 58(3):222-223.

110. Kulfan, M. (1991) The larvae of leaf-eating insects (Lepidoptera, Hymenoptera) on black locust (*Robinia pseudoacacia* L), in South Slovakia. Biologia (Bratislava), 46(10) 927-935.

111. Kumari S and Bir. SS (1990) „Karyomorphological evolution in Papilionaceae” *J.Cytol. Genet.*, 25:173-219.

112. Lavin M, Wojciechowski F, Gasson P, Hughes C and Wheeler E (2003) *Systematic Botany*, 28 (2):387 – 409.

113. Lăzărescu C and Rubţov ŞT (1962) „Comportarea salcâmului de diferite provenienţe în culturi tinere la Lehliu”, *Revista Pădurilor*, 11: 12-16.

114. Lăzărescu C (1968) „Rezultate privind înmulțirea salcâmului prin butășire repetată”, *Revista Pădurilor*, 83(2): 57-59.

115. Li Guoqing, Guanghua Xu, KE Guo and Sheng Du. “Mapping the Global Potential Geographical Distribution of Black Locust (*Robinia Pseudoacacia* L.) Using Herbarium Data and a Maximum Entropy Model.” Forests 5 (2014): 2773-2792.

116. Libby WJ and Ahuja MR (1993) „The genetic of clones”, in *Clonal Forestry*, I Springer-Verlag, Berlin.

117. Liesebach H Yang MS and Schneck V (2004) „Genetic diversity and differentiation in a black locust (*Robinia pseudoacacia* L.) progeny test”, *Forest Genetics*, 11(2):151-161.

118. Lin, Y. and M.R. Wagner (1996) Regeneration of plantlets from axilary buds of *Robinia neomexicana*, Forest, Farm and Community Tree, Res.Rpr., 1:107-111.

119. Lin, Y., M.R. Wagner, C.H. Seweyestewa, A. Honahni, M. DeGomez, and J.D. McMillin (1996) Influence of culture treatments on seed germination and seedling growth of R.neomexicana, Forest, Farm and Community Tree, Res. Rpr., 1:112-116.

120. Liu, L., F.L. Huang, Q.X. Luo, H, Y, Pang, F.J. Meng., (2012) CDNA-AFLP Analysis of the response of tetraploid black locust (*Robinia pseudoacacia* L.) to salt stress. African. J. of Biotechnology, 11(13): 3116-3124.

121. Manusciac, D. (1997) Construcții moderne din lemn, Ed. Tehnică, Bucureşti.

122. Mebrahtu T and Hanover JW (1989) „Heritability and Expected Gain Esimates for Traits of Black Locust in Michigan", *Silvae Genetica*, 38(3-4):125 - 130.

123. Mabberly, D.J. (1977) The plant book: A portable dictionary of the vascular plants, Cambridge Univ. Press, UK.

124. Mănescu Cristina. (2010) Arboricultură ornamentală, Curs, Ed. USAMV, Bucureşti.

125. Meginnis HG (1937) *Sulfuric acid treatment to increase germination of black locust seeds*. USDA Circ.453, US Gov.Printing Office, Washington, D.C.

126. Meng, F., Q. Wang, C. Yang, J. Liu. (2009) Investigation of anti-salt stree on tetraploid *Robinia pseudoacacia* L. Front. For. China, 4(1): 227-235.

127. Mihai, Gh. and Oana Ionescu (2011– 2012) Curs de estetica lemnului, www.academia.edu/estetica lemnului.

128. Milescu, I. (2006) Cartea silvicultorului, Ed. Univ. „Ştefan cel Mare", Suceava.

129. Montagnini, F., B. Haines, L. Boring, W. Swank (1986) Nitrification potentials in early successional black locust and in mixed hardwood forest stands in the southern Appalachians, USA Journal of Biogeochemistry, 2(2): 197-210.

130. Nan, L., X. Zhaohe, B. Meng, Y.Sun, J. Zhang, S. Wang, Y. LI. (2013) Proteomic Analysis of Etiolated Juvenile Tetraploid *Robinia pseudoacacia* L., Branching during Different Cutting Periods, J. Mol.Sci., 15(4) 6674-6688.

131. Negulescu, E. şi V.Stănescu, 1964, Dendrologia, cultura şi protecția pădurilor, vol.I, Ed. Didactică şi Pedagogică, Bucureşti.

132. Negulescu, E. şi Al. Săvulescu, 1965, Dendrologie, Ed. Agro-Silvică, Bucureşti.

133. Nepazahaio F, Guo W, Cong L, Li F, Liu L and Dong Y (2006) „Genomic variation in micropropagated *Robinia ambigua* „Idahoensis" revealed by RAPD analysis". *Hortsci.*, 41(6):1466-1468.

134. Németh R. and Molnár S (2005) Utilization of walnut (Juglans), black locust (*Robinia*) and ash (*Fraxinus*) on the bases of Hungarian Experiences, COST Action E 42, Growing Valuable Broadleaf Tree Species, Thessaloniki, Greece.

135. Neşu, I. (2000) Perdele forestiere de protecţie, Ed. Pod peste suflete, Slobozia.

136. Osvath-Bujtás Z. és Rédei K (2007) *Akac fajtaismertetö,* Agroinform Kiadó, Budapest.

137. Pakull, B., Schneck, V., & Liesebach, H. (2024) Clonality in black locust (Robinia pseudoacacia L.) and implications for seed production. *Annals of Forest Science*, *81*(1). https://doi.org/10.1186/s13595-024-01257-4

138. Porojan M (2011) „Cercetări privind rezistenţa la forfecare a lemnului de salcâm", *PRO LIGNO*, 7(2):30-38.

139. Putman, L.J., M.S. Pruner, P.E. Lakes (1991) Proprieties of protein constituents of black locust bark. Journal of Wood Sciences and Technology, 25: 1-6.

140. Raber O (1936) Shipmast locust. A valuable underdescribed variety of *Robinia pseudoacacia* L., USDA Circ. 379, USDA, US Gov. Printing Office, Washington DC, p.8.134

141. Rameau, J., C. Mansion, D. Dumé.(1993) Flore Forestiére Française: Guide écologique illustré, Institut pour le Dévelopement Forestier, France.

142. Ramirez JG (2011) „Somaclonal variation in plants: causes and detection mathods", *Plant Growth Regul.*, 163:42-47.

143. Rédei, K. (ed.). (1998) Black Locust (*Robinia pseudoacacia* L.). Growing in Hungary. Bul., No. 11, Publ. Hungarian Forest Res. Inst., Budapest. Pp. 50.

144. Rédei K, Osvath-Bujtás Z and Balla I (2002) Clonal approaches to growing black locust (*Robinia pseudoacacia*) in Hungary; a review, *Forestry*, 75(5):548-552.

145. Rédei K (2007) *Az akác termesztés-fejlesztésének biológiai alapjai és gyakorlata*, Agroinform Kiadó, Budapest.

146. Rédei K, Osvath-Bujtás Z and Veperdi I (2008) Black Locust (*Robinia pseudoacacia* L.) Improvement in Hungary: a Review, *Acta Silv. Lign. Hung.*, 4:127-132.

147. Rédei K, Csiha I, Keserű Z, Végh AK, Győri J (2011) The Silviculture of Black Locust (*Robinia pseudoacacia* L.) in Hungary: a Review. South-east Eur for 2 (2): 101-107. DOI: https://doi.org/10.15177/seefor.11-11

148. Rédei K, Csiha I, Keserű Zs, Végh Á and Gyōry J (2013) The Silviculture of Black Locust (*Robinia pseudoacacia* L.) in Hungary: a Review, *South Eastern European Forestry (SEEFOR)*, 101-107.

149. Rice, S.K., B. Westermann, R.Federici (2004) Impacts of the exotic nitrogen-fixing black locust (*Robinia pseudoacacia* L.) on nitrogen- cycling in a pine-oak ecosystem, Journal of Plant Ecology, 174(1): 97-107.

150. Roman, A.M.; Truta, A.M.; Morar, I.M.; Viman, O.; Dan, C.; Sestras, A.F.; Holonec, L.; Boscaiu, M.; Sestras, R.E. From Seed to Seedling: Influence of Seed Geographic Provenance and Germination Treatments on Reproductive Material Represented by Seedlings of *Robinia pseudoacacia*. Sustainability 2022, 14, 5654. https://doi.org/10.3390/ su14095654

151. Rydberg, P.A. (1924) Fabaceae: Galageae, North America Flora, 24:201-250.

152. Savatti M and Savatti jr. M (2005) *Ameliorarea arborilor forestieri*, Ed. AcademicPres, Cluj-Napoca.

153. Sărac, I. (2005) Genetica și ameliorarea speciilor forestiere, Editura Mirton, Timişoara.

154. Simionescu, I. (1961), Flora României, ediţia a III-a, Ed. Tineretului, București.

155. Sîrbu, C. şi A. Oprea, 2011, Plante adventive în flora României, Editura „Ion Ionescu de la Brad”, Iaşi.

156. Shu QY, Liu GS, Qi DM, Chu CC, Liu J and Li HJ (2003) „An effective method for axillary bud culture and RAPD analysis of cloned plants in tetraploid black locust”, *Plant Cult. Rep.*, 22:175-180.

157. Small JK (1933) „Fabaceae”, in *Manual of southeastern flora*, Ed Small, New-York, 669-743.

158. Stănescu V (1979) *Dendrologie*, Ed. Didactică şi Pedagogică, Bucureşti.

159. Stănescu V (1983) *Genetica şi ameliorarea speciilor forestiere*, Ed. Didactică şi Pedagogică, Bucureşti.

160. Stănescu V, Şofletea N ȘI Popescu O (1997) *Flora forestieră lemnoasă a României*, Ed. Ceres, Bucureşti.

161. Stringer JW (1992) „Wood properties of black locust (*Robinia pseudoacacia* L.): physical, mechanical and quantitative chemical variability”, in Hanover JW, Miller K and Plesco S (eds), *Proceedings of International Conference on Black Locust: Biology, Culture and Utilization*, 197– 207.

162. Surles SE, Arnold J, Schnabel A, Marick JL Bongarten BC (1990) „Genetic relatedness in open-pollinated families of two leguminous tree species, *Robinia pseudoacacia* L. and *Gleditsia triacanthos* L.”, *Theor. Apl. Genet.*, 80(1):49-56.

163. Surles SE and Bongarten BC (1990) „Mating systems in open-pollinated families of black locust, (*Robinia pseudoacacia* L)”, *Silvae genet*, 39:35-40.

164. Strode, D., 1977, Black locust/ *Robinia pseudoacacia* L. In: Woody plants as wildlife food species. SO-16. Atlanta, GA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 215-216.

165. Şofletea N. şi Curtu I (2000) *Dendrologie,* vol. I şi vol. II, Ed. Pentru viaţă, Braşov.

166. Tămăşdan, S., E. Cristea, D. Mihele (1981) Acțiunea supra secreției gastrice a extractelor din Robiniae flores, Farmacia 29(2), 71-78.

167. Tănăsescu (1967) „În legătură cu regenerarea naturală din sămînţă a salcâmului”, *Revista Pădurilor*, 82, 7:349-352.

168. Tănăsescu (1970) „Contribuţii în legătură cu fructificaţia salcâmului pe nisipurile Olteniei”, *Revista Pădurilor,* 85, 7:363-366.

169. Timofte A.I., (2007) *Exploatarea pădurilor*, Editura Universității din Oradea, Oradea.

170. Timofte A.I., and Budău R., (2008) *Prelucrarea primară a lemnului*, Editura Universității din Oradea, Oradea.

171. Timofte A.I., and Budău R., (2008) *Exploatarea pădurilor. Îndrumător de lucrări practice şi de proiectare,* Ed. AcademicPres, Cluj-Napoca.

172. Timofte, A. I., Pamfil, D., Palada-Nicolau, M., & Timofte, C. S. (2011). The Effect of Different Factors upon the in vitro Propagation in Quercus robur and Q. frainetto by Somatic Embryogenesis. *Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 39*(1), 288–291. https://doi.org/10.15835/nbha3915481

173. Toth J (2002) *Az akác növényvédelme*, Agroinform Kiadó, Budapest.

174. Trăuţescu G, Ceianu I și Badea N (1969) „Cercetări privind biologia şi combaterea dăunătorilor salcâmului”, in *Cercetări privind cultura salcâmului (Robinia pseudoacacia L.)*, Ed. Agrosilvică, Bucureşti.

175. USDA, NRCS (2023) Baza de date PLANTE (https://plants.sc.egov.usda.gov).

176. Vadas E (1911) „L'importance du Robinier dans la foresterie hongroise", *Les Annales de la science agronomiqeu française et etrangère*, 2.

177. Vadas E (1914) *Die Monographie der Robinie*, Ed. Joerges u. Sohn, Selmecbanya.

178. Vintilă E (1944) „Cercetări pe cale micologică asupra durabilităţii naturale a lemnului de salcâm în comparaţie cu lemnul de stejar", *Annals of Forest Research,* 10, 1: 103-128.

179. Vintilă E. and Galbenu E (1944) „Contribuţii la cunoaşterea structurii lemnului de salcâm", *Revista Pădurilor*, 567-9, 176-182.

180. Vlad, V., N. Ion, G. Cojocaru, V. Ion, A. Lorenț. (2012) Model and support system prototype for scheduling the beehive emplacement to agricultural and forest melliferous resources, Scientific Papers, Ser. Agronomy, vol. LV, 410-415.

181. Wandel WN (1989) *Handbook of lansscape cultivars*, Easr Prairie Pub. Co. Ill, USA.

182. Wright JW (1963) „Aspectes genetiques de l'amelioration des arbres forestièrs", in *Études de forèts et de produts forestières*, FAO, Roma.

183. Zhang J, Zhang S, Liu Y and Wang H (2007) „Micropropagation of Back locust (*Robinia pseudoacacia* L.", în Jain SM and Haggeman H (eds.), *Microptopatation of woody trees and fruits,* Springer-Verlag, Berlin, 193 – 218.

184. Zhang G, Zhang S, Sun Y, Li L, Xin H and Yuan C (2013) Regional trial of superior clones for fodder in *Robinia pseudoacacia* L., http://118.145.16.238.81 zk/EN abstract, 35(5):8-14.

185. Zeven AC and Zhukovsky PM (1975) *Dictionary of cultivated plants and their centres of diversity,* Centre for Agr. Publishing and Documentation, Wageningen, The Netherlands.

186. Yuan CQ, LI YF, Sun P, Sun YH, Zhang GJ, Yang MS, Zhang YY, LI Y and Wang L (2012) „Assesment of genetic diversity and variation of *Robinia psudoacacia* seeds induced by short-term spacelight based on two molecular marker systems and morphological traits", *Genetics an Molecular Research (GMR),* 11(4):4268-4277.

187. Yuan CQ, LI YF, Wang L, Zhao KQ, Hu RY, Sun P, Sun YH, Li Y, Gu WX and Zhou ZY (2013) „Evidence for imbreeding depression in ree *Robinia* *pseudoacacia* L. (Fabaceae)”, *Genetics and Molecular Research (GMR)*, 12(4):6249-6256.

188. Yuan CQ, Sun YH, Li YF, Wang L, Zhao KQ, Hu RY and Li Y (2014) „Selection occurs within linear fruit and during the early stages of reproduction in *Robinia pseudoacacia* L. BioMedCentral (BMC)”, *Evolutionary Biology*, 14:53-54.

189. NRCS (National Resources Conservation Service, USDA)

190. USDA, NRCS (2023) Baza de date PLANTE (https://plants.sc.egov.usda.gov/, 19/10/2023). National Plant Data Team, Greensboro, NC 27401-4901 SUA.

191. ***www.amosnews.ro (2003) Perdele forestiere de protecție în jud, Constanța, arhiva/perdele-forestiere, 1/5.

192. ***www.amosnews.ro (2006) Plantații forestiere pentru protejarea drumurilor naționale, arhiva/plantații-forestiere, 1/4.

193. ***www.europe-aliens/robinia/2006

194. ***www.europe-aliens org/Robinia pseudoacacia, Delivering Alien Invasive Species, Inventories for Europe, 2006.

195. *** PHOTO ANNEX pag.148-149., KOPACZ NANDOR, 2014.

196. ***(HG 994/2004) *Programului de înfiinţare a perdelelor forestiere de protecţie a căilor de comunicaţie împotriva înzăpezirii*

197. ***http:/rubenbudau. wordpress.com, 2011.

198. ***www.nbforest.info, 2011

199. *** Legea 46/2008 (Codul Silvic), M.O. 238 din 27.03.2008.

200. ***ttps://www.srs.fs.usda.gov/pubs/misc/ag_654/volume_2/acacia/koa.ht m

201. ***https://en.wikipedia.org/wiki/Robinia_neomexicana#/media/File:Robinia_neomexicana1.jpg /10.03.2025

202. ***https://en.wikipedia.org/wiki/Robinia_hispida#/media/File:Robinia-hispida2.jpg /10.03.2025

203. ***www.wikipedia.org/*Robinia_pseudoacacia*, 1/6 – 5/6, 2013.

204. ***www.wikipedia.org/*Robinia_neomexicana,* 1/1- 2/1, 2013.

9. PHOTO ANNEX

ACACIA BIOTYPES IDENTIFIED AT VALEA LUI MIHAI, BIHOR, ROMANIA

(PHOTO: RUBEN BUDĂU, 2023)

ACACIA BIOTYPES IDENTIFIED AT VALEA LUI MIHAI, BIHOR, ROMANIA

(PHOTO: RUBEN BUDĂU, 2023)

THE BARK AND TRUNK OF AN ACACIA TREE IDENTIFIED AT VALEA LUI MIHAI, BIHOR ROMANIA, (PHOTO: RUBEN BUDĂU, 2023)

HARVESTING SEEDS FROM AN ACACIA TREE

(PHOTO: RUBEN BUDĂU, 2023)

ACACIA BIOTYPES IDENTIFIED IN THE SĂCUENI FOREST DISTRICT, BIHOR, ROMANIA IN 2008. (PHOTO: RUBEN BUDĂU)

ACACIA BIOTYPES IDENTIFIED IN THE SĂCUENI FOREST DISTRICT, BIHOR, ROMANIA IN 2008. (PHOTO: RUBEN BUDĂU)

ACACIA FOREST DURING THE FLOWERING PERIOD, BÂRZEȘTI, ARAD COUNTY, ROMANIA. PHOTO: RUBEN BUDĂU, 2018

SPECIMENS OF GLOBULAR ACACIA (ROBINIA SEUDOACACIA UBRACULIFERA) USED IN GREEN SPACES IN ORADEA, BIHOR, ROMANIA. (PHOTO: RUBEN BUDĂU 2020)

ACACIA PLANTATION FOR THE PRODUCTION OF WOODY BIOMASS, LUGOJ, TIMIȘ COUNTY, ROMANIA. (PHOTO: KOPACZ NANDOR, 2014)

ACACIA PLANTATION FOR THE PRODUCTION OF WOODY BIOMASS, LUGOJ, TIMIȘ COUNTY, ROMANIA. (PHOTO: KOPACZ NANDOR, 2014)

SOWING OPERATION AND ACACIA SEEDLINGS OBTAINED IN THE NURSERY

(SOURCE: RUBEN BUDĂU, 2016)

EDITURA UNIVERSITĂŢII DIN ORADEA

ISBN 978-606-10-2404-9.