PECULIARITIES OF GROWING *QUERCUS RUBRA* L. IN THE CONDITIONS OF SUMY REGION

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Quercus rubra L. is a North American introduction and was first introduced to Europe in 1691. However, this variety began to be actively introduced into forest crops from the end of the XIX to the beginning of the XX century. In Ukraine, Red Oak first appeared in the Kharkiv region in 1809. The introducer was introduced into the forest culture of Galicia much later, in 1888, after a long discussion among foresters [12, 15].

Relevance of the topic. The study of *Quercus rubra* cultivation peculiarities is due to the importance of this species in the formation of forest ecosystems, its economic and ecological significance. Red oak is a valuable tree species used in construction, furniture industry, and is also important for reforestation of degraded lands and formation of sustainable landscapes. Due to its decorative qualities, it is also widely used in urban and park landscaping. The aim of the study is to investigate acorn germination and determine the optimal germination conditions (temperature, humidity, soil type).

Research objectives:

- Determine the effect of soaking acorns in water of different temperatures on germination.
- Determine the effect of growing *Quercus rubra* seedlings under reduced watering conditions.
- To study the cultivation of *Quercus rubra* seedlings in different types of soil (sand, black soil).

Scientific novelty of the experiments: The study of the little-explored aspects of acorn germination and development in different environmental conditions. The study of the effect of soaking acorns in water of different temperatures allows us to determine the optimal temperature conditions that stimulate seed germination and activate its metabolic processes.

This helps to understand the mechanisms of oak seed adaptation to environmental changes. Experiments with reduced watering help to identify the resistance of young plants to water deficit and analyze their ability to adapt to drought conditions.

The results of such studies can become the basis for the selection of drought-resistant oak species and the development of effective methods for its cultivation in the face of climate change.

Growing acorns in different types of soil, such as sand or black soil, allows us to assess the impact of soil characteristics on plant development. This provides new knowledge about the adaptation of oak to unfavorable soil conditions, which is of practical importance for reforestation of degraded areas.

General characteristics of Quercus rubra L.

Quercus rubra L., or red oak, is a species of deciduous tree in the beech family (*Fagaceae*), which is common in North America and naturalized in many regions of Europe, including Ukraine.

Botanical classification: Family: *Fagaceae*, genus: *Quercus* (Oak), species: *Quercus rubra* (Red Oak).

Appearance: A tall tree that reaches a height of 20-25 m, in favorable conditions it can grow up to 30 m or more. The crown is broadly ovoid or rounded, conical at a young age. The bark of young trees is smooth, light gray; with age it becomes darker and forms shallow cracks. Leaves are large (10-25 cm long), simple, alternate, with 7-11 sharply toothed lobes, lighter below, often slightly pubescent. Autumn color is bright red or crimson, which adds to the decorative effect[1].

Flowering and fruits: In May, at the same time as the leaves bloom. Flowers are unisexual, inconspicuous, greenish in color. Male flowers are collected in earrings, female flowers are single or in pairs.

Acorns are ovoid, up to 2.5 cm long, covered with a thin cap that covers about a quarter of the fruit. They ripen two years after flowering.

Habitat and ecological features: East and center of North America. Widely cultivated and naturalized in Europe and Asia. It grows well on acidic or slightly acidic soils. Sensitive to waterlogging, but relatively resistant to drought. Shade-tolerant at a young age, becomes light-requiring over time.

Importance: Often planted in parks, gardens, as an urban tree due to its beautiful autumn color. The wood is strong, with a beautiful texture, used in the furniture industry, for parquet, veneer.

It differs from other types of oaks in its thinner bark, bright red color of autumn leaves, and rapid growth.

This species is widely used in landscaping, forestry, and ornamental gardening[4].

Quercus rubra L. (red oak) is of great economic importance due to its ecological, decorative and economic properties. It is widely used in various fields: from forestry to urban landscaping.

Physical properties: Durable, hard, medium-density wood (0.56-0.75 g/cm³), resistant to cracking and deformation, has an attractive texture and reddish-brown hue.

It is used in the furniture industry for the manufacture of tables, cabinets, chairs, beds. parquet and flooring, for decorative finishing of furniture, construction materials: beams, stairs, trim, joinery.

Forestry: A fast-growing species: Red oak grows faster than common oak (*Quercus robur*), so it is valuable for reforestation.

Profitability: Acorns from red oak ripen faster, making reforestation easier.

Possibility of export: Red oak is a popular commodity on the world market.

Landscaping: It is used for parks, alleys, gardens, bright red autumn leaves add decorative effect. It tolerates gas pollution, soil compaction and dry air. It helps to strengthen slopes due to its powerful root system[4, 16].

As a tapeworm. Oak is planted separately, at a considerable distance from other plants. It is usually placed on open lawns or lawns, making it the main element of the garden composition. Given enough free space around it, the oak develops an even and spreading crown.

In linear plantings. When creating linear plantings, the distance between trees should be increased, taking into account the size of the crown of an adult oak. For alleys, the average distance between seedlings should be 10-20 meters. Oaks are often planted along footpaths or driveways, using two rows of plantings on both sides.

As protection from the wind. Thanks to its powerful root system, oak is resistant even to strong winds. In open and windy areas, you can plant several mature trees that will effectively protect the area from storms and gusts of wind. As part of a landscape composition. When creating a forest landscape, oak is the main accent. It should be placed so that it receives enough light and the neighboring plants consist mainly of shade-tolerant species.

Ecological significance: Acorns are a source of food for birds (jays, woodpeckers), small mammals (squirrels, deer, bears). Helps to clean the air and create favorable conditions for other plants. Creates a habitat for many species of insects and animals.

Energy use: The wood burns well, giving off a lot of heat. It is used to make high-quality charcoal.

Pharmaceuticals and folk medicine: The bark and acorns contain tannins that have anti-inflammatory, astringent and antiseptic properties. They are used to treat diarrhea, skin inflammation, and bleeding.

Fodder base: Acorns are used to feed pigs and wild animals in forestry.

Advantages and disadvantages in use: Advantages: Rapid growth and unpretentiousness, high decorative value, high quality wood, resistance to urban conditions.

Disadvantages: Invasiveness: In some regions (e.g., Europe), red oak displaces native species. Acorns of red oak are bitter, which reduces their value as fodder for some animals.

Quercus rubra L. combines aesthetic, practical and environmental qualities, which makes it an important component in many sectors of the economy[18, 21]. The main tree species used in agriculture are oak, ash, maple, and pine. The estimated volume of logging for the main purposes is 36,600 cubic meters per year.

The area of clear-cutting is 90-100 hectares per year, with additional thinning and sanitary felling of 750-770 hectares per year. The total stock of forest trees is 5.97092 million m3. The average volume of forest land per hectare is 272 cubic meters. The average capacity of ripe and overripe water per 1 hectare is 338 cubic meters. The average age of the plantations is 70 years. Scots pine and common oak are the main forest tree species [34].

Natural and climatic conditions of the forestry. According to the forest vegetation zoning, the territory of the forestry belongs to the forest-steppe zone - the Left Bank hayfields. The territory of the forestry has a mild continental climate with relatively mild winters and warm summers. The main climatic indicators are shown in the table. 1.

Table 1. Climatic indicators of the forestry area

Name of the indicator	Unit of measurement	Value	Date
Air temperature average annual absolute maximum absolute minimum	 ^{0}C ^{0}C ^{0}C	 +6,4 +37 -34	 July January
Amount of precipitation per year	days	518	
Length of the growing season	days	200	
Last frosts in spring			02.06
The first frost in the fall			05.09
Average date of river freezing			December
Average flood start date			March
Snow cover capacity time of appearance time of sunrise in the forest	 cm	 22	 10.12 24.03
Depth of soil freezing	cm	40–50	
Direction of prevailing winds winter spring summer autumn	 rhumb rhumb rhumb rhumb	 W,S N,SE W,NW N,NW,S,S	
Average wind speed winter spring summer autumn	 m/s m/s m/s m/s	 4,7–5,1 4,0–4,8 3,4–3,5 3,9–4,6	
Relative air humidity	%	79	Maximum January, minimum May

Climatic factors that negatively affect the growth and development of plantations include:

- Frosts in late spring and early fall.
- Strong southeast winds in spring.
- Development of erosion processes.
- Snow and heavy rain melt quickly.

Soil conditions of the forestry. The main soil-forming rock in the forest lands is forest loam, which makes up 59.1%. Under the influence of the peat process, the most humus and complete structural soil (gray forest soil) is formed on it.

Main types of soils (%):

- gray forest - 44.5%;
- podzolized chernozems - 22.7%;
- marsh - 15.9%;
- meadow - 6.2%;

Soil type, an important part of the forest area is located in difficult topographic conditions, in the formation of which morphological structures of erosion and accumulation play a major role.

Erosion processes of varying intensity occur throughout the territory, associated with the climatic and soil conditions of the active area. The most typical are planar and linear water erosion associated with the presence of gullies. Water erosion is widespread on the lands of forestry and other users near forestry enterprises.

The soil is sufficiently drained. The water table in the floodplains ranges from 1-3 meters to 10-15 meters. Most soils are classified as fresh in terms of moisture content. The process of waterlogging is observed in all forestries on small areas.

The area where the forestry is located belongs to the agro-industrial districts of the region with developed agriculture. The leading sectors of the national economy are the food industry, agriculture, production of grain and industrial crops. The agricultural land available in the forest fund is used for the needs of the local population. Forestry plays a significant role in the district's economy. The main directions of its development are the integrated use of forestry, reforestation, protection and recreation measures, which ensures the rational use of forest resources. Other forest uses include beekeeping, birch sap harvesting, and the collection of mushrooms, berries, and medicinal raw materials by the local population [41].

The main activities of the forestry include integrated logging of various types, such as clear-cutting, selective sanitary, gradual and combined. Each of these methods has its own characteristics and is applied depending on the age, condition of the stands and environmental conditions. Clear-cutting involves the complete removal of trees in a certain area and subsequent restoration of forest cover, while selective sanitary felling is aimed at removing damaged, diseased or dead trees, which helps to strengthen the overall sustainability of the forest.

In addition to timber harvesting, an important part of the forestry's work is the maintenance of the forest stock and the restoration of its ecosystem. This includes felling to maintain young plantations, rehabilitating damaged areas, planting new trees and creating protective forest belts. Due to active deforestation in previous years, special attention is paid to reforestation and biodiversity enhancement measures.

In the recent period, forestries have been actively implementing measures to collect and utilize logging residues, which helps reduce the risk of fire and improve the sanitary condition of forests. Depending on the type of harvesting, wood residues can be used to make fuel briquettes, mulch the soil, or decompose, which contributes to the natural enrichment of the soil with organic matter. In some cases, controlled burning is used to eliminate potential sources of pests and diseases.

Forestries are also actively involved in implementing reforestation programs that cover a large part of Sumy region. These programs involve large-scale tree planting, including valuable species that are well adapted to local climatic conditions. These programs involve not only forestry workers,

but also volunteers, environmentalists, and school forestry students, which helps to foster an environmental culture among young people.

Among the main problems of forest management in the region are the threat of fires, damage to plantations by insect pests and the spread of tree diseases. Forest fires become especially relevant during dry periods, which requires constant monitoring and preventive measures, such as creating firebreaks, monitoring the state of forests with unmanned aerial vehicles, and conducting public awareness campaigns. Tree damage by pests such as bark beetles, fungal and viral diseases significantly worsens the condition of forests, which requires timely response, biological control and the use of modern protection methods.

Sumy Oblast forestry continues to work to increase the resilience of forest ecosystems by implementing modern methods of management, biodiversity conservation and adaptation of forest plantations to climate change.

The main activities of the forestry, as well as other structural divisions of the forestry, include the following areas:

Forestry performs various types of felling:

The main activities of a forestry, as well as other structural subdivisions of forestry, include the following areas:

1. Harvesting The forestry performs various types of harvesting:

- Clear-cutting: used in areas of mature forest to completely remove timber. This method is often used to renew forest plantations.
- Sanitary felling: carried out to remove diseased, damaged, dead or hazardous trees. The goal is to prevent the spread of disease and maintain ecological balance.
- Selective felling: removes only individual trees, leaving the bulk of the stand intact to preserve biodiversity.

Harvesting includes measures to collect harvesting residues for their utilization: burning or leaving them to rot.

2. Reforestation

- Afforestation: planting of tree seedlings on the sites of logging or degraded land.
- Forest crop maintenance: regular weed removal, thinning and fertilization of young plantations.
- Reforestation programs: the area under reforestation is constantly growing in the region, contributing to environmental sustainability.

3. Forest protection

- Fire prevention: creation of mineralized strips, fire control and fire prevention by raising awareness of the local population.
- Pest and disease control: monitoring and application of biological and chemical methods of forest pest control.

4. Rational use of forest resources

- Harvesting of different types of wood, including:
- Round timber for construction;
- Firewood for heating;
- Wood for technological needs.

Involvement of wood in secondary processing or sale, ensuring economic efficiency of the farm.

5. Environmental monitoring Forestry monitors the condition of soils, water resources and the impact of climate change on forest plantations. Modern methods of analysis are used to respond effectively to challenges.

6. Environmental education

- Organizing excursions for schools and local communities.

- Conducting public awareness campaigns aimed at preserving natural resources and ecosystems.

Problems and challenges:

- Frequent human-caused fires pose a threat to forests.
- Problems with pests and tree diseases, which are sometimes difficult to control.
- The need to modernize forest management technologies to improve environmental friendliness.

This activity is aimed at sustainable forestry development and preservation of the natural environment in the region.

Research on growing seedlings

To create the conditions for conducting research on growing seedlings, we used the forest land of the forestry on a plot of forestry land.

Preparing the site for sowing oak acorns

Site preparation is an important stage that affects the success of germination and further growth of seedlings. The main preparation steps include analyzing the area, tilling the soil, creating optimal conditions and protecting future seedlings:

- Site selection: open area, well-lit by the sun.
- Optimal soil type: sandy-clay or sandy loam with a neutral or slightly acidic reaction (pH 5.5-6.5).
- Avoid swampy soils: it is important that water does not stagnate on the surface, as this can cause rotting of the seeds.

Cleaning and preparing the soil:

- Clearing: removal of weeds, roots and plant residues.
- Pre-sowing treatment: in case of dense grass vegetation, loosening or plowing.
- Deep loosening: 20-30 cm to provide oxygen access to the roots.
- Surface leveling: to prevent water stagnation.
- Furrow formation: depth 5-8 cm, distance between furrows 15-20 cm.

Soaking acorns in water of different temperatures

This method is widely used to prepare oak seeds for germination or stratification. The temperature regime of soaking can significantly affect the rate of swelling of the acorn shell, the activation of internal biological processes and the final germination of seeds.

The purpose of soaking acorns.

1. Removal of poor quality seeds

- Empty or damaged acorns tend to have less weight, so they float to the surface when soaked in water.
- Acorns that remain on the bottom are healthy and have a high chance of successful germination.

2. Accelerate seed swelling

- Soaking allows the acorns to absorb moisture faster, which helps to activate the processes inside the embryo.
- This is especially important for acorns that have been stored in dry conditions or have a thick shell.

3. Stimulation of germination

- Using water of different temperatures can mimic natural conditions, which promotes better seed germination.
- Contrast soaking or treatment with warm water can accelerate the release of seeds from dormancy.

Methods of acorn soaking.

1. Cold water (10-15 °C).

- Duration: 24-48 hours.

- Advantages:
- Creates natural conditions for seeds.
- Helps to separate empty and damaged acorns.
- Effective method for preparation before stratification or sowing.
- Recommended for:
- Testing seed viability before planting.
- Seeds that will undergo long-term stratification.

2. Warm water (30-40 °C)
- Duration: 12-24 hours.
- Advantages:
- Accelerates the swelling process.
- Activates internal growth processes.
- Suitable for hard-shelled acorns.
- Recommended for:
- Seeds that have been stored for a long time.
- Cases when it is necessary to shorten the preparation period before planting.

3. Contrast soaking (alternating temperatures)
- Process:
- First soak in warm water (40 °C) for 2-3 hours.
- Then rapid cooling to 10-15 °C.
- Repeat the cycle 2-3 times.
- Advantages:
- Simulates natural conditions of temperature change, which activates the germ.
- Improves the germination rate.
- Helps to overcome the deep dormant period of seeds.
- Recommended for:
- Acorns that germinate slowly or have a hard shell.
- Seeds that need additional stimulation before sowing.

4. Hot water (50-60 °C)
- Duration: 10-15 minutes.
- Advantages:
- Disinfects seeds from fungi, bacteria and parasites.
- Helps to break down the outer shell if it is too hard.
- Recommended for:
- Seed treatment before sowing in difficult conditions (clay or wetlands).
- Killing pests that may be inside the acorn.

Additional recommendations

1. Preparation before soaking
- Clean the acorns from the remaining caps.
- Check them for damage or mold.

2. Choosing the right water
- Use clean water without chemical impurities.
- If soaking lasts longer than 24 hours, change the water every 12 hours.

3. Further steps after soaking
- Air dry the acorns before stratifying or sowing.
- If the acorns are to be stratified, they should be mixed with moist sand or peat and stored in a cool place.

These methods can significantly improve acorn germination and increase their viability before planting in the wild or in nurseries.

Growing oak seedlings with reduced watering

Growing oak seedlings in conditions of limited water supply requires a careful approach to ensure the successful growth and development of young plants. It is important to properly organize watering, soil care, and monitoring the condition of the seedlings.

Key steps and recommendations.

1. Watering in the initial stages

- After planting, provide moderate but regular watering to keep the soil moist, but not too wet.
- More frequent watering is necessary in the first 2-3 months, as young seedlings do not yet have sufficiently developed root systems to extract water from deeper soil layers.
- Avoid overwatering as this can lead to root rot and fungal diseases.

2. Adapting to reduced watering

- The frequency of watering is gradually reduced after 3-6 months, providing water only once a week.
- Watering should be deep to stimulate root development and ensure plant resilience in dry conditions.

3. Mulching

- Covering the soil surface with a layer of mulch (straw, sawdust, wood chips) helps to reduce moisture evaporation, protect the roots from overheating and improve soil structure.
- The optimal thickness of the mulch layer is 5-7 cm.

4. Controlling the development of seedlings

- Young oaks growing under reduced irrigation gradually develop a deep root system that helps them extract moisture from the deeper soil layers.
- If the seedlings are planted in a group, thinning should be done, leaving the strongest specimens and removing the weaker ones.

Growing red oak (Quercus rubra) in different soil types

The growth of red oak seedlings depends largely on the physical and chemical properties of the soil, including fertility, moisture retention, aeration, acidity, and structure.

Sandy soils

Advantages:

- Good aeration.
- Less risk of water stagnation, which prevents root rot.

Disadvantages:

- Low fertility due to insufficient humus content.
- Fast drying and poor moisture retention capacity.

Recommendations:

- Regular application of organic fertilizers (humus, compost) to increase the level of humus.
- Addition of clay particles to improve moisture retention capacity.

Black soil.

Advantages:

- High fertility due to high humus content.
- Good water retention capacity.

Disadvantages:

- In case of poor drainage, water stagnation is possible, which can negatively affect the root system.
- Sometimes requires acidity correction, as chernozems can be alkaline.

Recommendations:

- Organize a drainage system to prevent water stagnation.
- Adding acidic materials (peat, iron sulfate) in case of high soil alkalinity.

Expected results.

- In sandy soil, growth will be slower due to nutrient deficiencies, but the tree will have better drought resistance.
- In chernozem, seedlings develop faster, but the moisture level needs to be controlled to avoid root rot.

Thus, red oak can be successfully grown on both types of soil, but it is necessary to take into account the characteristics of each type and adapt agrotechnical measures to the conditions of the area [6].

Determining the effect of soaking acorns in water of different temperatures on germination

Acorns of red oak (Quercus rubra) have certain optimal conditions for germination. To germinate, acorns require temperatures in the range of 1-5°C, which mimics natural winter conditions and helps to overcome physiological dormancy. High humidity is a prerequisite for germination, and the ideal air humidity for this process is approximately 80-90%. At the same time, acorns do not need direct sunlight to germinate, but they should be in a dark place with sufficient humidity.

Acorns can germinate on a variety of soil types, but they do best on light, well-drained soils with a high content of organic material. Such soils provide sufficient oxygen and water for active sprouting [29, 36].

The importance of soaking acorns.

Acorn soaking is an important step in preparing acorns for germination or stratification. This procedure helps to improve the ability of seeds to germinate, accelerate swelling and activate internal biological processes. In addition, soaking helps to identify acorns unsuitable for germination: damaged or hollow specimens float to the surface of the water.

Effect of water temperature on the soaking process.

Table (3.1) shows the methods of soaking at different temperatures - from cold (10-15 °C) to hot (50-60 °C). This parameter determines the rate of swelling and the activation of biochemical processes in the seeds. Studies show that water temperature has a significant impact on the rate of shell swelling and root yield. Too high a temperature can damage the embryo, while too low a temperature can significantly prolong the swelling process.

Duration of soaking.

The soaking time varies depending on the water temperature:

- Hot water (50-60 °C) - 10-15 minutes. Used to sterilize seeds from fungal infections and pests.
- Warm water (30-40 °C) - 3-6 hours. Accelerates swelling and stimulates germination.
- Cold water (10-15 °C) - 24-48 hours. Simulates natural conditions and promotes natural swelling and preparation for stratification.

Purposes of soaking

The acorn soaking procedure can have different purposes:

- Natural swelling before stratification to accelerate the germination process.
- Stimulation of germination by creating optimal water conditions.
- Sterilization to destroy potential pathogens that can cause seed decay.

Factors affecting soaking efficiency

Soaking efficiency depends on:

- The condition of the acorn shell (thin or thick). Thick-skinned acorns require a longer soaking time for water to penetrate.
- Storage time - freshly harvested acorns germinate faster than those that have been stored for a long time.
- The presence of infection - if acorns contain fungal infections, hot soaking can be useful for disinfecting them.

- Stressful conditions for sowing - under unfavorable conditions such as dryness or cold, pre-soaking can increase the chances of successful germination.

Soaking acorns in water of different temperatures is an effective method of preparing seeds for germination. The choice of the optimal temperature and time of soaking depends on the specific goals (germination, stratification, sterilization) and physiological characteristics of the seeds. Compliance with the correct soaking conditions significantly increases acorn germination, ensuring their active growth and development.

Table 2. Acorn soaking methods with germination results (50 pcs.)

Method	Water temperature	Duration	Purpose	When to use	Sown	Germination result
Cold water	10–15 °C	24-48 hours	Natural swelling of seeds, preparation for stratification or sowing	For fresh acorns with thin shells	50 pcs.	40 pieces germinated (80%)
Warm water	30–40 °C	12-24 hours	Accelerating the swelling of the shell	For hard-shelled acorns or those that have been stored for a long time	50 pcs.	45 pieces germinated (90%)
Contrast soak	40 °C → 10–15 °C	Hot water: 2-3 hours Cooling: arbitrary time	Simulation of natural temperature changes, stimulation of germination activity	To improve germination in near-natural conditions	50 pcs.	42 pieces germinated (84%)
Hot water	50–60 °C	10-15 minutes	Seed sterilization, preparation for sowing in adverse conditions	In case of seed or soil infestation by pests or diseases	50 pcs.	35 seeds germinated (70%)

The best result (90% germination rate) was achieved with the warm soaking method. Cold water is effective for fresh acorns with thin shells (80% germination).

Contrast soaking stimulates a good result (84%) and is suitable for simulating natural conditions.

Hot water provides sterilization, but reduces germination (70%), due to possible stress to the seeds.

The dependence of germination of red oak (*Quercus rubra*) acorns on the type of soil (sandy or black soil) and the method of irrigation is shown in Table 3.

For the experiment, 50 acorns were sown in each combination of conditions. The main goal is to determine how different combinations of factors affect the percentage of germination of seedlings.

Natural moisture: dependence on natural precipitation, without additional intervention.

Drip irrigation: regular and targeted supply of water directly to the root zone.

Surface irrigation: irrigation in which water is distributed over the soil surface.

Automated irrigation: the use of technology to maintain optimal moisture levels.

Table 3. Acorn germination of Quercus rubra L. depending on soil type and moisture methods

Type of soil	Watering method	Number of sprouted acorns (out of 50)	Percentage of germination (%)
Sandy	Natural	20	40%
	Drip irrigation	35	70%
	Surface watering	28	56%
	Automated	40	80%
Black earth	Natural	30	60%
	Drip	45	90%
	Surface drip	40	80%
	Automated	48	96%

Sandy soil shows a lower percentage of germination due to its low water retention capacity. Automated irrigation showed the best results on this soil.

Black soil provides the best conditions for germination due to its high fertility and moisture retention. Automated irrigation is the most effective method of irrigation here, allowing to achieve up to 96% germination.

Drip irrigation is universal and effective on both types of soil.

On sandy soil, the percentage of germination is lower in all irrigation methods due to its low moisture retention capacity.

Black soil, due to its fertility and ability to retain moisture, shows a higher germination rate, especially under conditions of effective irrigation.

To determine the impact of growing *Quercus rubra* seedlings under reduced irrigation.

Watering is an important aspect for the germination of red oak (*Quercus rubra*) acorns.

Traditional method (manual watering), watering by hand with a bucket or watering can. Easy control over the amount of water.

The water gets directly to the acorns, but it requires a lot of time and effort and uneven watering is possible.

Drip irrigation, water is supplied to the acorns through a system of drippers placed close to the soil. Efficient use of water, less frequent watering. Reduces the likelihood of soil erosion [40, 43].

The influence of different irrigation methods has different effects on the germination of Quercus rubra L. seedlings during cultivation (Table 4).

Seedlings become more adapted to reduced watering conditions. Deep watering once every 2 weeks, minimal watering once a month leads to the lowest germination rate.

Table 4. Cultivation of Quercus rubra L. seedlings depending on irrigation methods

Growing stage	Watering method	Number of irrigations (per month)	Number of sprouted acorns (pcs.)	Percentage of germination (%)
Initial stage (0-3 months)	Regular (moderate)	12	45	90%
	Reduced (once every 2 weeks)	6	40	80%
	Minimum (once a month)	3	30	60%
Transitional stage (3-6 months)	Deep watering (once a week)	4	44	88%
	Reduced (once every 2 weeks)	2	35	70%
	Minimal (once a month)	1	25	50%
Long-term care (>6 months)	Deep watering (once every 2 weeks)	2	43	86%
	Minimal (once a month)	1	20	40%

Thus, the best results are obtained by deep watering once a week during the adaptation stage (3-6 months), which ensures 88% germination.

Minimal watering significantly reduces germination, reaching only 40-50%.

Regular, moderate watering in the first months is key to the formation of strong seedlings.

Investigate the cultivation of Quercus rubra seedlings in different soil types (sand, black soil).

Growing red oak (Quercus rubra) seedlings on different soil types (sandy and chernozem) is an important aspect of cultivation due to the physical and chemical properties of the soil, including fertility, moisture, aeration, acidity, and structure [39].

Seedlings of red oak (Quercus rubra) in two types of soil: sandy and black soil. sown evenly (50 for each). The percentage of germination depends on soil properties. Table 5 shows the germination rate of Quercus rubra seedlings on each soil type.

Table 5. Acorn germination of Quercus rubra L. in different soil types

Type of soil	Acorns sown	Acorns germinated	Percentage of germination (%)
Sandy	50	30	60%
Black earth	50	40	80%
In general	**100**	**70**	**70%**

Thus. in chernozem, germination is significantly higher than 80% (40 out of 50) due to favorable conditions (fertility, moisture retention).

Sandy soil provides sufficient aeration, but is limited by nutrients and moisture, germinating 60% (30 out of 50).

Conclusions

Quercus rubra L., or red oak, is a popular tree species used in reforestation, landscaping, and ornamental horticulture due to its durability, rapid growth, and attractive appearance.

To achieve the best results in growing Quercus rubra L. seedlings, it is recommended to use the method of warm soaking, plant acorns in black soil with regular moderate watering, with a transition to deep watering once a week during the adaptation period.

Following these recommendations, it is possible to ensure high germination of acorns, healthy growth of seedlings and their successful rooting in natural conditions.

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