AGROSYM

BOOK OF PROCEEDINGS

XV International Scientific Agriculture Symposium
"Agrosym 2024"
Jahorina, October 10-13, 2024

AgroSym 2024

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Impressum

XV International Scientific Agriculture Symposium „AGROSYM 2024“

Book of Proceedings Published by

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CIP - Каталогизација у публикацији
Народна и универзитетска библиотека
Републике Српске, Бања Лука

631(082)(0.034.2)

INTERNATIONAL Scientific Agriculture Symposium "AGROSYM" (15 ; 2024 ; Jahorina)

Book of Proceedings [Електронски извор] / XV International Scientific Agriculture Symposium "AGROSYM 2024", Jahorina, October 10 - 13, 2024 ; [editor in chief Dusan Kovacevic]. - Onlajn izd. - El. zbornik. - East Sarajevo : Faculty of Agriculture, 2024

Системски захтјеви: Нису наведени. - Način pristupa (URL): https://agrosym.ues.rs.ba/article/showpdf/BOOK_OF_PROCEEDINGS_2024_FINAL.pdf. - Ел. публикација у ПДФ формату опсега 1552 стр. - Насл. са насловног екрана. - Опис извора дана 2.12.2024. - Библиографија уз сваки рад. - Регистар.

ISBN 978-99976-816-8-3

COBISS.RS-ID 141807105

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EFFECT OF COMMERCIAL BIOFERTILIZER ON THE GROWTH PARAMETERS OF TWO-YEAR-OLD NORTHERN RED OAK (*QUERCUS RUBRA* L.) SEEDLINGS

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Abstract

Microbiological biofertilizers are gaining more and more attention in the global market as an environmentally healthier substitute for conventional chemical fertilizers. This paper investigated the effect of treatment of two-year-old northern red oak seedlings with commercial biofertilizer Slavol® during one growing season. The medium was prepared according to the producer's instructions and applied foliar in late June. Seedling height and root collar diameter were measured as the prominent representatives of seedling quality growth parameters. The results confirmed the positive impact of the biofertilizer on seedling growth. Mann-Whitney U test showed a statistically significant difference in seedlings height ($U = 42.000$; $p < 0.001$) and root collar diameter ($U = 56.000$; $p < 0.001$) among the treated seedlings group at the beginning and the end of the experiment. In the control group, the statistically significant difference was noted for seedling root collar diameter ($U = 55.000$; $p < 0.001$), but not for seedling height ($U = 163.000$; $p = 0.624$) at the experiment beginning and end. The results indicate that Slavol® biofertilizer influenced two-year-old northern red oak seedling height enhancement at the end of the experiment, but not on seedling root collar diameter, which had significant growth in both control and treated plants.

Keywords: *northern red oak, biofertilizer, seedlings.*

Introduction

Northern red oak (*Quercus rubra* L.) is a deciduous tree species native to Northern America continent, and a common oak representative from the section *Lobatae* across Europe. Its introduction to this continent was done deliberately in the 17th century most likely from the northern part of its natural distribution and continued in the future (Marceron et al., 2017). During the 19th century, its usage for reforestation purposes and timber production started, in order to improve timber yields. It became one of the most common and commercially important alien species considering timber exploitation. Due to the symmetrical shape of a tree crown and large leaves that turn the foliage red in Autumn, red oak is also evaluated as a highly decorative species in urban parks, woods, and green areas. Acorns of red oak are a significant food source for a variety of birds and rodents found in those habitats.

Northern red oak in Europe is advantageous over native oak species for its modest environmental requirements, higher aridity and low-temperature tolerance (Isajev et al., 2006), and high adaptive potential. It produces plentiful acorns large in size and is more successful in regeneration due to its fast growth rate and tolerance to a wide range of different ecological factors in the habitat (Woziwoda et al., 2014). Nevertheless, in some European countries, it is considered to be an invasive alien species that suppresses native oaks, which combat with climate change issues. When established, red oak changes the environmental conditions by decreasing the understory light that further reduces its vegetation diversity and consequently impacting soil characteristics (Dyderski and Jagodziński, 2019). Moreover, the

abundant slowly decaying leaf litter of red oak is a challenge for decomposers, leading to the impediment of common ecosystem processes and the development of autochthonous species.
In Serbia around 60 ha of territory is under northern red oak (Živanović et al., 2023) and it is mostly located in city parks and urban gardens where is used as an ornamental. However, in the vicinity of Belgrade, significant stands of red oak can be found (Lazarević, 2020). Along with its contribution to the beauty of landscape, it is also used as material for processing in the wood industry.
Northern red oak seedlings are produced in nurseries under common practice that includes watering and chemical fertilizer and pesticide usage. Aspirations for a healthier environment led to the development of alternative strategies that will enable production of high-quality seedlings, but in sustainable and ecologically safe mode, and were supported both legally through management policies that regulate chemical utilization in forest nurseries. Biofertilizers are one of the well-known substituents in today's global market, that are still rather applied in agriculture than in forestry. The tendency toward clean technologies encourages research in this direction, and numerous commercial products such as Slavol®, Rizokyl Simplex®, Aegis mycrogranule®, Bacillomix original®, etc. can be found in trade. Biofertilizers contain different microorganisms that help and support plant well-being through hormone production, effective nutrient and essential elements acquisition, induction of plant immunity, and are completely harmless. When studying their effect on plant organisms, different morphological and physiological growth parameters are being monitored, and in forestry seedling height and root collar diameter are most commonly measured.
Slavol® is an organic, microbiological fertilizer registered for foliar feeding of agriculture and horticulture species. Its liquid formulation contains bacteria that are nitrogen-fixators, phosphate solubilizers, and auxine producers.
In this study, we analyzed the effect of Slavol® biofertilizer application on two-year-old red oak seedlings and their growth parameters, seedling height, and root collar diameter.

Material and methods

Two-year-old northern red oak seedlings were produced from the acorns collected in the Autumn of 2021 from local woods in Košutnjak, Belgrade, Serbia. Acorns were sown in pots filled with white and black peat mixture (70:30 ratio) (Free Peat BV, Netherlands). Seedlings were watered daily and nurtured in half-shadow conditions in the nursery of the Institute of Forestry.
In late June of 2023, seedlings were treated with a Slavol® preparation applied on leaves, made according to manufacturer instructions (100 ml Slavol®/10 l water). Nineteen plants were chosen per treatment, and the control group was treated with tap water. Both treatments were repeated seven days later. No additional fertilizers or pesticides were used.
At the beginning of the experiment, seedling height and root collar diameter were measured. Seedling height was measured by a ruler with an accuracy of 0.5 cm. The seedling root collar diameter was estimated by Vernier caliper with an accuracy of 0.1 mm.
At the end of the same growing season, identical growth parameters were evaluated again by the same method.
Descriptive statistics and a Mann-Whitney U test were performed for statistical estimation of Slavol® impact on seedling growth. All statistical analyses were performed using the SPSS 27 software package (IBM, Armonk, NY, USA), and Microsoft Office Excel 2021 (Redmond, Washington U.S.).

Results and discussion

The growth of a total number of 38 two-year-old northern red oak seedlings was measured at the beginning and the end of the experiment. Descriptive statistics for estimated traits are presented in Table 1.

Table 1. Descriptive statistics values for measured seedling traits

		Beginning of the experiment		End of the experiment	
		D	H	D	H
Control treatment	average	4.72	21.24	7.45	44.68
	min	2.22	12	3.94	26
	max	8.24	32.5	11.59	80
Slavol® treatment	average	4.76	23.45	7.21	43.26
	min	2.6	8	2.95	18
	max	7.84	35.5	10.32	62

D - root collar diameter
H - seedling height

At the beginning and the end of the experiment, there was a statistically significant difference in seedlings' height ($U = 42.000$; $p < 0.001$) and root collar diameter ($U = 56.000$; $p < 0.001$) among the treated seedlings based on the Mann Whitney U test. In the control group, a Mann Whitney U test showed a statistically significant difference in seedling root collar diameter ($U = 55.000$; $p < 0.001$), while there was no significant difference in seedling height ($U = 163.000$; $p = 0.624$) at the beginning and end of experiment.

Based on the obtained results it can be concluded that the application of biofertilizer influenced the increment of seedlings' height, which did not significantly change in the control group, in comparison with the treated group. Although initial diameter and height are equally important in the first year after planting (Ivetić et al. 2016), seedling height is an important parameter for faster competition endangerment overcoming and later sylvicultural measures (Grossnickle and MacDonald 2018a). These findings point to the direction of regulating better growth conditions of young red oak seedlings and the potential for controlling further growth dynamics.

As stated in the manufacturer booklet, Slavol® is a biofertilizer for field crops, vegetables, and some horticultural species, as well as *Thuja* sp., *Cypress* sp., *Juniper* sp., and *Taxus* sp. It demonstrated the capability to promote growth and efficiency in earlier studies (Đorđević and Babović 2012; Djukic et al., 2012; Miskoska-Milevska et al., 2018; Miskoska-Milevska et al., 2020). Slavol® contains a mixture of plant-growth-promoting bacteria with the ability to produce auxin, solubilize phosphate, and fix nitrogen, hence naturally promoting plant growth. These pathways influence plant crucial metabolic processes, and the obtained results presented in this paper are therefore expected and consistent with literature data.

Mechanisms of action of plant-growth-promoting bacteria are well described in the literature (Olanrewaju et al. 2017) and in the situation where different legislations limit the utilization of chemical fertilizers and pesticides, these natural substituents present a potentive tool in seedling production.

Plant growth parameters measured in this paper are one of the most used morphological traits in forest seedling monitoring and quality estimation (Grossnickle and MacDonald, 2018b). Plant height is important for photosynthesis and competition with other vegetation in the field for sunlight, while root collar diameter gives insight into root growth, volume, and development. Roots play a crucial role in the acquisition of nutrients, deposition, and anchoring and are of great importance for plant well-being.

Conclusion

The biofertilizer potential of application is large and should be utilized for sustainable plant production both in agriculture and forestry. In this paper, we investigated the potential of Slavol® to enhance the northern red oak seedling growth, by measuring seedling height and root collar diameter. The results confirmed positive impact of the biofertilizer, and statistical analysis showed a significant difference in seedlings height and root collar diameter among the treated seedlings group at the beginning and the end of the experiment. In future research Slavol® effect should also be inspected in various environmental conditions and different application patterns.

Acknowledgment

This study was carried out under the Agreement on realization and funding of scientific research activity of scientific research organizations in 2024 funded by the Ministry of Science, Technological Development and Innovation. No. 451-03-66/2024-03/200027.

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