

REVIEW

by Prof. Georgi Georgiev Beev, PhD, Department of Biological Sciences, Faculty of Agriculture, Trakia University, Stara Zagora

of the PhD thesis for the award of the educational and scientific degree "Doctor" in the field of higher education 4. Natural Sciences, Mathematics, and Informatics; Professional direction: 4.3. Biological Sciences; Doctoral Program: Ecology and Ecosystem Protection

Author: Nikola Stamenov Angelov Topic: „Possibilities for sustainable management of urban soils through buffer green areas“

Scientific Supervisors: Prof. Iliana Velcheva†, PhD, PU "Paisii Hilendarski," Plovdiv
Assoc. Prof. Ekaterina Valcheva, PhD, Agricultural University, Plovdiv

□ General Description of the Procedure and Submitted Materials

By order No. RD-21-2267 dated 10.12.2024, from the Rector of Plovdiv University "Paisii Hilendarski" (PU), I was appointed as a member of the scientific jury for the defense of the PhD thesis titled „Possibilities for sustainable management of urban soils through buffer green areas“ The author of this PhD thesis is Nikola Stamenov Angelov, a part-time PhD student in the Department of Ecology and Environmental Protection, Faculty of Biology, PU "Paisii Hilendarski," Plovdiv. At the initial meeting of the scientific jury on 20.12.2024, I was assigned to review the thesis. I received all necessary materials electronically, which meet the requirements of Article 36 (1) of the Rules for the Development of the Academic Staff of PU, including:

- an application to the Rector of PU for initiating the defense procedure;
- a European format CV;
- a departmental council protocol indicating readiness for the defense procedure and preliminary discussion of the thesis;
- the PhD thesis;
- an abstract;
- a list of scientific publications on the topic of the thesis;
- copies of scientific publications;
- a declaration of the originality and authenticity of the submitted documents.

2. Brief Biographical Data

Nikola Stamenov Angelov completed his bachelor's degree in "Agronomy (Field Crops)" at the Agricultural University – Plovdiv in 2017 and obtained a master's degree in "Plant Protection" in 2018. He enrolled as a part-time PhD student in the doctoral program "Ecology and Ecosystem Protection" on 05.02.2020.

3. Relevance of the Topic and Feasibility of the Goals and Objectives

The PhD thesis addresses significant contemporary ecological issues related to urban soil pollution and its remediation through phytoremediation methods. The topic is highly relevant, especially given the rising challenges posed by urbanization and industrialization, which increase environmental pressures. The author convincingly highlights the importance of sustainable urban soil management and the impacts of anthropogenic factors on human health and ecosystems.

4. Understanding of the Problem

The PhD student introduces the problem through a comprehensive literature review on ecological factors affecting urban areas and the characteristic pollutants in these environments. Special attention is given to heavy metal pollution and its impact on human health and ecosystems. Various remediation methods are discussed, with a focus on phytoremediation and the potential of hyperaccumulator plants. The biological properties of different plants used in phytoremediation are analyzed, highlighting their capabilities in extracting and neutralizing pollutants and describing the mechanisms through which they contribute to the cleansing of contaminated soils. Including information on the role of soil microbiota in this context and concluding the review with a summary that connects the literature to the thesis's goals would help clarify the scientific significance and research directions.

5. Research Methodology

The methodology employed is well-suited to achieving the goals and addressing the tasks outlined in the PhD thesis. The selection of experimental sites across various areas in Plovdiv provides a solid foundation for studying the impact of anthropogenic factors on soil and plant ecosystems. The PhD student utilizes modern methods to analyze soil and plant samples, including ICP-OES and ICP-MS for precise chemical analysis. The physiological and biochemical analysis of grass species, such as measuring photosynthesis, transpiration, enzyme activity, and pigment content, is crucial for evaluating plant adaptation and efficiency in urban environments. Bioremediation capabilities are assessed through bioaccumulation and translocation factors, offering a reliable evaluation of the potential for soil remediation. Statistical data processing using Statistica and SPSS ensures the results' accuracy and reliability. However, more detailed descriptions of certain methods, such as the analysis of soil physico-chemical parameters and physiological parameters, would enhance clarity. Despite this, the overall methodology is well-structured and effective for meeting the research objectives.

6. Characteristics and Evaluation of the PhD Thesis

The thesis comprises 132 pages, 20 tables, 46 figures, and 188 references. The introduction outlines the main research question concerning the influence of buffer grass strips on soil characteristics and microbiological activity in urban settings. The author effectively argues the need for this research, citing current ecological concerns and the importance of

biodiversity in urban environments. The introduction is well-organized and sets the stage for the research goals and hypotheses.

The literature review systematically presents existing research on buffer grass strips, their impact on soil, and their ecological functions. The author covers extensive literature, including studies on bioremediation, soil microbiomes, and the effectiveness of plants in improving soil quality and reducing pollutants in urban areas. The review is thorough and provides a solid theoretical foundation for the experimental phase.

The "Materials and Methods" section details the methods for data collection and analysis, combining classical laboratory techniques with innovative approaches for assessing biological activity and soil pollution. This ensures the results' reliability and makes the research reproducible.

The experimental results indicate a significant impact of buffer grass strips on soil physicochemical parameters such as pH, organic content, and nutrient levels. Additionally, an increase in microbiological activity and heterotrophic microorganism populations is observed in areas with grass strips. The results are clearly presented through tables and graphs that illustrate changes in various indicators, allowing readers to track the processes' dynamics in the experimental areas. In the results summary, the author relates the findings to the literature review, offering a detailed discussion of their ecological and practical implications. The discussion highlights how buffer grass strips can improve soil quality and reduce pollutants in urban environments, emphasizing their bioremediation potential. Recommendations for future research and practical applications of grass species in urban ecosystems are also provided. The conclusion synthesizes the main findings, emphasizing the importance of buffer grass strips in enhancing the ecological condition of urban areas. It highlights their role in improving soil quality and microbiological activity, forming the basis for future urban ecosystem restoration efforts. The conclusion also suggests directions for further research and practical applications of the studied methods. The bibliography includes 188 sources, with 30 in Cyrillic, covering both classical and contemporary research in ecology, botany, bioremediation, and microbiology. The sources are diverse and up-to-date, ensuring the research's depth.

7. Contributions and Significance of the Research for Science and Practice

The PhD thesis offers significant scientific and applied contributions with broad potential applications in ecology and sustainable urban management. The main contributions include:

- **Original Scientific Contributions:**

- Novel data on the elemental composition of urban soils and biomass of buffer green strips: For the first time in Plovdiv, data on the elemental composition of soils and biomass have been collected and analyzed, providing new insights into the effectiveness of bioremediation through specific grass species.
- Establishment of buffer green areas with perennial crops: Buffer grass strips have been created around transport arteries with selected perennial leguminous and

cereal crops known for their high bioaccumulation capabilities and adaptability to urban environments, contributing to soil quality improvement.

- **Applied Scientific Contributions:**

- Validated technology for creating buffer green areas: A technology for establishing buffer green areas with bioremediation functions in urban settings has been developed. This technology, including an assessment of the plants' physiological state, has been successfully applied in Plovdiv, leading to long-term soil quality improvements.
- A tested model for sustainable urban soil management: A model for managing urban soils through buffer green areas has been developed and successfully tested, demonstrating how buffer grass strips can sustainably enhance soil quality and the ecological condition of urban areas.

- **Significance of the Research for Science and Practice**

The significance of the PhD thesis lies in its contribution to the understanding and application of sustainable urban soil management. The research provides new data on the elemental composition of urban soils and the role of buffer grass strips in bioremediation. The validated technology for creating buffer green areas with bioremediation functions offers a practical solution for improving urban soil quality and can be implemented in other cities facing similar challenges. The developed model for sustainable urban soil management demonstrates how ecological interventions can enhance urban ecosystems resilience and health, benefiting both the environment and public health.

8. Assessment of the Publications Related to the PhD Thesis

The PhD thesis is based on two scientific articles, both published in international journals indexed in databases such as WoS and/or Scopus. In these articles, the PhD student is listed as the fourth author. The interest in these works is evident, as, despite being published in the last two years, they have been cited 15 times in peer-reviewed publications indexed in international databases (Web of Science and Scopus).

According to the criteria outlined in the Regulation for the Application of the Law on the Development of the Academic Staff in the Republic of Bulgaria (ZRASRB), the PhD student fully meets the required 30 points from publications, with the published articles related to the thesis accumulating a total of 40 points:

1. Petrova, S., Nikolov, B., Velcheva, I., Angelov, N., Valcheva, E., Katova, A., Golubinova, I., Marinov-Serafimov, P. 2022. Buffer Green Patches around Urban Road Network as a Tool for Sustainable Soil Management. *Land*, 11, 343, 1-23. Q2, IF=3.906 – 20 points.
2. Petrova, S., Velcheva, I., Nikolov, B., Angelov, N., Hristozova, G., Zaprianova, P., Valcheva, E., Golubinova, I., Marinov-Serafimov, P., Petrov, P., Stefanova, V., Varbanova, E., Georgieva, D., Stefanova, V., Marhova, M., Tsankova, M., Iliev, I. 2022.

Nature-Based Solutions for the Sustainable Management of Urban Soils and Quality of Life Improvements. *Land*, 11, 569, 1-22. Q2, IF=3.905 – 20 points.

The results presented in the PhD thesis have been shared with the scientific community not only through publication in high-ranking journals but also through presentations at four scientific forums, two of which were international.

8. Personal Contribution of the PhD Student

As an external reviewer, I do not have direct observations and, therefore, cannot adequately assess the personal contribution of the PhD student to the conducted research or the extent to which the formulated contributions and obtained results are his own. This is due to most of the research being carried out by large multidisciplinary teams. Indirect conclusions can be drawn from the published articles, where each author's contribution is described. Specifically, it is stated that PhD student Nikolay Angelov contributed to the validation of results and data processing, which undoubtedly enhanced his professional growth and development.

I believe that the thesis is the author's original work and that there is no plagiarism of data or texts from other authors' publications.

10. Abstract

The abstract comprises 36 pages and offers a concise but comprehensive overview of the PhD thesis content. It includes a significant portion of the figures that support the conclusions and key contributions of the research. A bibliographic reference of the publications related to the thesis is also provided.

11. Critical Notes and Recommendations for Future Use of the Thesis Contributions and Results

The PhD thesis is written in clear scientific language, following the logical sequence of experiments and their interpretation, making it convincing. It impresses with the variety of methods used and the significant amount of data, graphically represented in 46 figures and 20 tables.

My remarks on the thesis content do not affect my overall positive evaluation but could be beneficial for the PhD student's future research and publication activities:

- The introduction includes citations of authors, which is uncommon in scientific dissertations. Citations in this section should be avoided to maintain focus on presenting the topic and significance of the research.
- The literature review lacks sufficient information on the role of soil microbiota, despite it constituting a significant part (50%) of the results. This omission limits the context and significance of the study.
- A limited number of sources are cited in the literature review from pages 14 to 19, referencing only three authors. This limitation could undermine the diversity and depth of the analysis and reduce the objectivity of the review.

- The analyses of soil moisture, pH, and electrical conductivity are discussed too superficially. There is a lack of detailed connection between these parameters and other studied factors, which could provide a more comprehensive understanding of interactions in the soil environment.

Conclusion

According to ZRASRB, the "Doctor" degree is both an educational and scientific degree. The content of the PhD thesis convincingly demonstrates that PhD student Nikolay Angelov has not only built upon the knowledge acquired during his Master's degree but has also fulfilled the educational component of the "Doctor" degree and mastered various instrumental methods. He is capable of critically discussing the obtained results and presenting them in written form. The submitted PhD thesis meets the scientific value requirements of ZRASRB, the Regulation for the Application of ZRASRB, and the corresponding Regulation of PU "Paisii Hilendarski."

Based on the analysis of the significance of the conducted research, the developed PhD thesis, and the presented publications, I give my positive evaluation and recommend that the esteemed members of the scientific jury award the educational and scientific degree "Doctor" to Nikola Stamenov Angelov in the scientific field of Natural Sciences, Mathematics, and Informatics, professional direction Biological Sciences, PhD program "Ecology and Ecosystem Protection."

January 20, 2025

Stara Zagora

Reviewer:.....

/Prof. Georgi Beev/