



REVIEW

On PhD Thesis for obtaining the scientific degree "Doctor" in: Professional field 4.4. Earth Sciences, Scientific specialty "Ecology and Ecosystem Conservation"

Author of the PhD Thesis: Ivelina Dimitrova Neykova, full-time PhD student at the Department of Microbiology and Ecological Biotechnology at the Agricultural University, Plovdiv

Title of the PhD Thesis: „PHYTOREMEDIATION OF HEAVY METAL CONTAMINATED SOIL THROUGH COMPOST AND BENEFICIAL MICROORGANISMS IN VEGETABLE CROPS“

Reviewer: Assoc. Prof., PhD, DSc Dilian Georgiev Georgiev. Scientific specialty: Associate Professor and PhD in the field of higher education 4. Natural sciences, mathematics and informatics in professional field 4.3. Biological sciences (Ecology and ecosystem conservation); DSc in professional field 4. Natural sciences, mathematics and informatics in professional field 4.3. Biological Sciences (Zoology)

appointed a member of the scientific jury by order № РД-16-611/31.05.2022 of the Rector of AU.

1. Brief introduction of the candidate

Born on June 26, 1988. Education and experience: Bachelor's degree in Plant Protection (10.2007-10.2011, Agricultural University - Plovdiv). Master's degree in Business Communications and Public Relations (11.2011-06.2013, University of Plovdiv "P. Hilendarski" - Plovdiv). Full-time PhD student at the Agricultural University - Plovdiv, Department of Microbiology and Environmental Biotechnology on the topic: "Phytoremediation of heavy metal contaminated soil through compost and beneficial microorganisms in vegetable crops" (March 1, 2014-01.09.2017). During the period 2015-2017 he conducted exercises in the disciplines "Microbiology" and "Ecology of Microorganisms" under a civil contract at the Agricultural University, Department of "Microbiology and Environmental Biotechnology". From 30.09.2021 until now he works as a medical representative at Sevox Pharma Ltd.

2. Relevance of the topic

With the rapid development of industry and the increase in the number of people on the planet, significant amounts of waste of all types are generated in the environment. Improper management of this waste poses real risks to both the environment and public health. Various methods are used in practice to limit these risks. One of them is phytoremediation of contaminated soils, which is widely used and current in the world. The topic of the dissertation is in line with the overall policy of the European Union and its strategy for sustainable use of the environment. It is up-to-date and helps to expand knowledge in the field of environmental protection by providing new information on real practical actions to combat pollution.

3. Aim, tasks, hypotheses and research methods

The dissertation is written on 200 pages and contains 29 tables and 61 figures. The list of cited literature lists 508 sources, of which 2 are in Cyrillic and 506 in Latin.

The aim of the dissertation is in line with the environmental policy of the European Union and its strategy for sustainable development.

The tasks (six in number) set for the implementation of this goal are correctly selected and chronologically arranged.

The labor hypothesis is correctly formulated and then developed in the chapter presenting the results of the study. The doctoral student is familiar with the issue and has selected adequate research methods.

The methodology is applied accurately and is in accordance with the set tasks. Microorganisms that stimulate the growth of vegetable plants were isolated and their tolerance to heavy metals was studied, and three vascular experiments were performed. A large amount of raw data has been accumulated, which are adequately and accurately analyzed by mathematical and statistical methods.

4. Presentation of the obtained results

The results are properly structured and presented in the paper, as illustrated with numerous figures and tables (29 tables and 61 figures). A table is presented at the end of the dissertation in Appendix 1. The quantity and quality is sufficient for this type of dissertation.

I consider the results as completely satisfactory and excellent which agree with the requirements for a dissertation in a professional field 4.4. Earth Sciences, Scientific Specialty "Ecology and Ecosystem Conservation".

5. Discussion of the results obtained and references

The results are in the following several aspects: isolation of microorganisms that stimulate the growth of vegetable plants; study of plant development on soils contaminated with heavy metals; study of microbial communities in the rhizosphere and non-rhizosphere of vegetable plants. There are data and on the use of compost in the process of phytoremediation of soils.

The discussion of the obtained results is standard, in two main aspects - comparison with already known, published facts and upgrading with new, original information. The differences and similarities between the obtained results and those in the literature are discussed.

In conclusion, a total of 14 conclusions are summarized, summarizing the main contributions of the dissertation.

Chapter "References" includes 508 sources, of which 2 in Cyrillic and 506 in Latin. This is a significant amount of information that the PhD student has worked with and analyzed. This shows her excellent knowledge on this topic.

6. Contributions of the dissertation

I consider the contributions of the dissertation to be significant. They are original and are in the field of environmental protection and human health. The contributions of the dissertation are eight in number: two scientific, four scientific-applicable and two applicable. Based on these conclusions, I believe that the dissertation has a number of contributions that can be derived and this makes it even more important and valuable.

Scientific contributions

The influence of compost enriched with beneficial bacteria on the development and accumulation of heavy metals in commercial plant species was studied. For the first time in the country, soil microbial communities and their connection with soils contaminated with heavy metals have been studied.

Scientific- Applicable contributions

The four contributions listed in the dissertation indicate the proof of the benefits of compost in phytoremediation of soils and its importance for environmentally friendly agriculture and sustainable use of natural resources.

Applicable contributions

Two contributions of an applicable nature are indicated. It has been proven that spinach can be successfully used as a test crop to detect heavy metal contamination of agricultural soils and that the use of quality organic additives in conjunction with

populations of beneficial bacteria is an appropriate approach to phytostabilization of soils contaminated with heavy metals.

7. Critical notes and questions

I have no any critical notes, remarks or questions to the PhD student.

8. Published papers

The publications are sufficient in number (4) and are in accordance with the requirements of the respective law of the Republic of Bulgaria. They have been published in prestigious periodical scientific journals (1 paper) and collections (3 papers, one published by Springer). They clearly show the personal contribution of the doctoral student and her work on the issue:

1. Бабрикова Ив., Ст. Шилев, Т. Бабриков. 2016. Намаляване натрупването на тежки метали в спанак отглеждан върху замърсена почва с използване на компост и полезни бактерии. Сборник с доклади от „Екология и здраве“ 09-10 юни 2016 г., стр. 435-440, ISSN 2367-9530, <http://hst.bg/bulgarian/conference.htm>

2. Babrikova I., S. Shilev, T. Babrikov. 2016. Compost and PGPR decrease heavy metal availability and toxicity to vegetables. In: (Filcheva, Stefanova, Ilieva eds.). 4th Nat. conf. of BHSS with Int. Participation. 8-10 September, 2016, Sofia, ISBN 978-619-90189-2-7, 285-294.

3. Shilev, S., Azaizeh, H., Vassilev, N., Georgiev, D., Babrikova I. 2019. Interactions in soil-microbe-plant system: adaptation to stressed agriculture. pp.131-171. In: Singh, D.P., Gupta, V.K., Prabha, R. (Eds.) Microbial Interventions in Agriculture and Environment, Volume 1: Research Trends, Priorities and Prospects. Springer Singapore. doi: 10.1007/978-981-13-8391-5.

4. Shilev S, Babrikova I, Babrikov T. 2020. Consortium of plant growth-promoting bacteria improves spinach (*Spinacea oleracea* L.) growth under heavy metal stress conditions. Journal of chemical technology and biotechnology, 96(4), pp. 932-939 <https://doi.org/10.1002/jctb.6077>

The presented abstract objectively reflects the structure and content of the dissertation. It is arranged according to the requirements.

CONCLUSION:

Based on the different research methods learned and applied by the PhD student, the correctly performed experiments, the summaries and conclusions made, I believe that the presented dissertation meets the requirements of the law for development of the academic staff of the Republic of Bulgaria and the Regulations of the Agricultural University for its application, which gives me reason to evaluate it POSITIVE.

I allow myself to propose to the esteemed Scientific Jury to vote positively and to award Ivelina Dimitrova Neykova the scientific degree "Doctor" in professional field 4.4. Earth Sciences, specialty "Ecology and Ecosystem Conservation".

Date: 17.06.2022
Plovdiv

Подписите в този документ са заличени във връзка с чл.4, т.1

от Регламент (ЕС) 2016/679 (Общ Регламент относно защитата на данни).