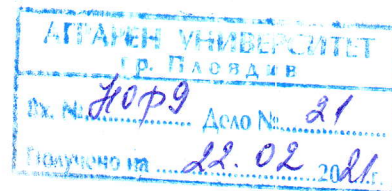


OPINION



On a dissertation for obtaining the educational and scientific degree "Doctor" in: field of higher education 4. "Natural Sciences, Mathematics and Informatics", professional field 4.4. "Earth Sciences", scientific specialty "Ecology and Environmental Protection"

Author of the dissertation: Nguyen Cao Nguyen, a part-time Ph.D. student at the Department of Chemistry and Phytopharmacy at the Agricultural University, Plovdiv

Topic of the dissertation: Study of the technological processes of zinc hydroxide nitrate nanocrystals production applying for foliar fertilizer for important agricultural plants

Member of the scientific jury: Prof. Dr. Eng. Violina Angelova Rizova, Agricultural University - Plovdiv, field of higher education "Natural Sciences, Mathematics and Informatics", professional field 4.4. "Earth Sciences", scientific specialty "Agrochemistry", appointed a member of the scientific jury by order № RD-16-1089 / 26.11.2020

1. The relevance of the problem.

The topic of the dissertation is extremely relevant, as it concerns a significant problem related to the zinc status of major crops. Maintaining the optimal amount of zinc in plants is of extreme importance in achieving increases in yields and product quality.

2. Purpose, tasks, hypotheses and research methods.

The dissertation's primary goal is related to the assessment of the potential of new zinc-containing foliar nano fertilizers in increasing the yields and the quality of the production of main agricultural crops for Bulgaria (corn) and Vietnam (Curcuma Longa and Phyllanthus amarus). To achieve this goal, four tasks were set and the sequential solution of each is presented in the experimental part of the dissertation. The conditions for the synthesis of zinc hydroxy nitrate and mixed zinc-copper hydroxy nitrates were studied in detail. Modern instrumental methods were used in the physicochemical characterization of the samples: X-ray diffraction analysis, scanning electron microscopy, high-resolution transmission electron microscopy, thermal analysis and chemical analysis. Maize, Curcuma Longa and Phyllanthus amarus were used as test crops to assess the potential of the synthesized nanoscale materials as foliar fertilizers.

3. Visualization and presentation of the obtained results.

The dissertation is developed on 172 typewritten pages. The dissertation is well-structured and balanced and contains all the necessary sections. The results of the research are very well illustrated and presented in 63 figures and 52 tables. The cited literature includes a total of 163 sources. The literature review corresponds to the topic and the main directions of the dissertation. Nguyen Cao Nguyen shows good awareness of the achievements of the problem treated in the dissertation, and has developed skills for the purposeful use of previous scientific achievements in their work. The dissertation is written in a highly scientific style and reflects the author's

ability to analyze and summarize results independently.

4. Discussion of the results and used literature.

The results of the research, their analysis and discussion occupy an essential part of the dissertation. They are presented in a well-structured logical sequence. The results' analysis is performed in-depth, in a logical sequence and a highly scientific style. The doctoral student shows good theoretical training and mastery of modern methods of analysis. The literature used is well-selected and gives an idea of the degree of knowledge the doctoral student possesses on the issues under consideration. The comparison of the data received from him with those of other authors show his personal contribution to the development. All literature sources are correctly cited and described bibliographically.

The research is conducted in two main directions: (i) controlled synthesis of zinc-containing hydroxy nitrates and their physicochemical characterization, and (ii) evaluation of the potential of the use of synthesized nanosized materials as foliar fertilizers for major crops. Zinc-containing nano fertilizers were synthesized and their potential for increasing yields and quality of maize and *Curcuma Longa* products was evaluated. The agronomic response of Zn-deficient maize plants to foliar fertilization with nanosized zinc-containing foliar fertilizers was studied. Observations were made on the physiological status of plants and the dynamics of the concentration of zinc and micro- and macro-elements in plant organs. The influence of foliar fertilization with zinc on the yields and structural components of the grain in maize and the content of curcuminoids in the rhizome of *Curcuma Longa* was determined.

The conclusions correspond to the experimental results.

5. Contributions to the dissertation.

The dissertation contains scientific and scientific-applied contributions which, in terms of content, significance and usefulness for science and practice, are completely sufficient to obtain an educational and scientific degree "Doctor". Among them, the most important are:

1. A method has been developed for the control preparation of mixed Cu-Zn hydroxy nitrates using concentrated solutions of $\text{Cu}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O}$ and $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$.

2. Zinc fertilization throughout the initial growth stages plays a decisive role in the formation of the reproductive organs of maize plants.

2. The influence of foliar fertilization with nanosized zinc hydroxide nitrate on maize yield has been established. The application of leaf zinc during the first stage of growth has a significant ($p < 0.05$) effect on the accumulation of Zn in maize stems and leaves. The accumulation of zinc is followed by its remobilization from the stems to other plant organs during the second stage of growth.

3. The influence of foliar application of zinc on the distribution of micro- and macro-elements in *Phyllanthus amarus* has been established. The Zn, Cu, Mn and macronutrients content of plant roots varies narrowly, with no significant impact of ZnHN fertilization.

4. The influence of foliar application of zinc on the distribution of micro- and macro-elements in *Curcuma Longa* has been established, as well as on the content of curcuminoids in the rhizome of *Curcuma Longa*. Treatment with zinc-containing foliar fertilizer increases the curcumin content in the productive parts of the plant. The other ingredients forming the quality of turmeric remain unaffected. The interaction of zinc with micro and macronutrients is much more pronounced in the soil solution and the roots of the plants than in their above-ground parts after using zinc-containing leaf fertilizers.

I accept all of contributions made by the doctoral student. They are his personal work and proof that he can conduct experimental work on his own and correctly

interpret the results obtained.

6. Critical remarks and questions.

I have no significant critical remarks on the presented dissertation.

7. Published articles and citations.

In connection with the developed dissertation, 5 scientific publications have been published, 2 of which the doctoral student is the first author. Three of the publications have been published in journals with impact factor. Some of the results obtained in the dissertation have been presented at four conferences, three of which are international and one national.

The publications presented by doctoral students cover the required 30 points for the acquisition of ONS "Doctor", according to the new Law for the Development of Academic Staff in Bulgaria.

A reference for 7 citations of two publications is presented. This is proof of the relevance of the problem in the dissertation for maintaining the optimal amount of zinc in plants.

The presented abstract objectively reflects the structure and content of the dissertation.

Conclusion:

Based on the learned and applied by the doctoral student, different research methods utilized, correctly performed experiments, the summaries and conclusions, I believe that the presented dissertation meets the requirements of the Law for the Development of Academic Staff in Bulgaria and the Agricultural University Regulations. It gives me a reason to rate it POSITIVE.

I allow myself to suggest to the esteemed Scientific Jury to also vote positively and to award Nguyen Cao Nguyen the educational and scientific degree "Doctor" in the scientific specialty "Ecology and Environmental Protection".

Date: 3.02.2021
Plovdiv

MANUFACTURED

OPINION:

(Prof. Dr. Eng. Violina Rizova)