OPINION

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

<u>Author of the dissertation:</u> Nguyen Cao Nguyen is a part-time doctoral student at the Department of Chemistry and Phytopharmacy at the Agricultural University, Plovdiv

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

Reviewer: Prof. Dr. Panteley Denev from the University of Food Technology, professional field "Chemical Sciences", scientific specialty "Organic Chemistry", <u>https://ras.nacid.bg/dissertation-preview/23412</u> appointed a member of the scientific jury with order № RD-16-1089 / 26.11.2020 by the Rector of AU.

1. Relevance of the problem.

The topicality and significance of the dissertation work of Nguyen Kao Nguyen, carried out under the supervision of Prof. D.Sc. Krassimir Ivanov, can be judged by the fact that so far there are no similar studies in Bulgarian and Vietnamese agri-environmental science. The dissertation develops purely chemical methods for controlled synthesis of environmentally friendly zinc-containing compounds that stimulate the growth of selected biocultures, as well as their physiological impact at different stages of development of these crops. Synthesized nanoscale materials such as foliar fertilizers have been used in crops in Bulgaria and Vietnam.

2. Purpose, tasks, hypotheses and research methods.

The goals set in this dissertation are in two main directions:

1. controlled synthesis of zinc containing hydroxy nitrates and their

physicochemical characterization; 2. assessment of the potential of the synthesized nanoscale materials as foliar fertilizers for main agricultural crops.

A large set of organizational, laboratory and technological methods has been used to perform the set tasks. The main crops for Bulgaria (corn) and Vietnam (Curcuma Longa and Phyllanthus amarus) were used as test crops to assess the potential of the synthesized nanoscale materials as foliar fertilizers. The influence of the synthesized Zn-containing leaf nanotor on the physiological status of Zndeficient maize plants grown under both controlled and field conditions was studied. The influence of: zinc nanotore feeding on the physiological and mineral status of plants was studied; the composition of the suspension on the productivity and quality of maize grains (moisture, protein, fat and protein content; of the genotype on the efficiency of foliar fertilization with zinc-containing nano-fertilizers).

3. Visualization and presentation of the obtained results.

The set research tasks are specific, feasible and correctly arranged and solving them builds the experimental part of the dissertation. A good knowledge of the state of the problem is presented in the literature review, developed on the basis of 138 sources, mostly in Latin and published in the last 10 years. Although the adopted approach for structuring the dissertation is not typical for Bulgaria, Nguyen Kao Nguyen has creatively conceived and interpreted the existing scientific data, problems and literature, which she presented briefly and clearly in the review. A contribution to the educational part of the doctoral program is the demonstrated ability to evaluate, discuss and summarize the correctly cited scientific facts and to identify problems that justify the clearly formulated main goal. The literature review enables the doctoral student to orientate correctly in the subject and to highlight the significant problems, both in scientific and in scientific-applied aspect.

The section "Materials and methods" describes precisely the main methods that are applied in the implementation of the tasks in the dissertation. There is a detailed and accurate description of the methods used - scanning electron microscopy (SEM), high resolution electron microscopy (HRTEM), thermal analysis (TG, DTG, DTA), X-ray diffraction analysis (XRD), atomic emission elemental analysis (ICP-AES), statistical analysis.

4. Discussion of the results and used literature.

The reference is well structured and related to the subject of the dissertation. It is divided into five sections related to the components of the dissertation. A sufficient number of literature sources are cited - 163 from 1952 to 2020. The above testifies to a good theoretical preparation of the doctoral student.

5. Contributions to the dissertation.

In the current dissertation of Nguyen Kao Nguyen the main idea of the research is fulfilled - obtaining new scientific information and new knowledge that will allow controlled synthesis of zinc-containing nanotors and assessment of their potential to increase yields and quality of production of major crops.

Scientific and applied contributions

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As more important scientific contributions of an applied nature, I would point out:

- A method has been developed for control preparation of mixed Cu-Zn hydroxy nitrates using concentrated solutions of Cu(NO₃)₂.3H₂O and Zn(NO₃)₂.6H₂O.

- It has been shown that foliar zinc fertilizers can completely restore the physiological parameters of plants grown in conditions of zinc deficiency, as zinc hydroxide nitrate is better than commercial ZnO. Influence of foliar fertilization with nanosized zinc hydroxide nitrate on maize yield and qualitative field experiments.

- Synthesized zinc hydroxide nitrate has been found to have undoubted potential as a successful long-term foliar fertilizer. A significant positive effect on grain yield of up to 25.0% has been demonstrated for variants compared to controls. The best effect can be obtained by double spraying on 4 - 5 fully sprouted leaves and 8 - 9 fully developed leaves.

- Hybrids from the early maturity group FAO 400 have been shown to be the most sensitive to foliar fertilization with zinc. No direct link has been established between foliar fertilization with zinc and the content of proteins, fats and starch in maize grains. The critical factor for determining yield and yield components is the mature season of hybrids.

- It is stated that the application of foliar zinc during the first stage of growth has a significant (p <0.05) effect on the accumulation of Zn in maize

6. Critical remarks and questions.

During the development of the dissertation the doctoral student has acquired knowledge and skills, to interpret and analyze the existing literature sources and to independently formulate research hypotheses, and to develop an experimental program for their implementation.

I have no recommendations or remarks from Nguyen Cao Nguyen

7. Published articles and citations.

The dissertation presents five learned publications, three of which are indexed in WOS, participation in three international and one national conference, seven citations, which cover the minimum national requirements.

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

CONCLUSION:

The presented dissertation and the accompanying materials FULLY MEET THE REQUIREMENTS of the Law on the Development of the Academic Staff in the Republic of Bulgaria, the Ordinance for the implementation of the Law, and the specific criteria for awarding the educational and scientific degree "PhD" at the Agricultural University Plovdiv. Given the above and my general impression that the achieved scientific contributions are real and represent a reliable basis for future research with a practical focus,

Based on the analysis, I give a **POSITIVE** evaluation of the dissertation and propose that the scientific jury award Nguyen Cao Nguyen educational and scientific degree "PhD" in scientific field 4. "Natural Sciences, Mathematics and Informatics", professional field 4.4 "Earth Sciences "Under the doctoral program" Ecology and Ecosystem Protection ".

Date: 22.02.21 PREPARED THE OPINION:

Plovdiv city