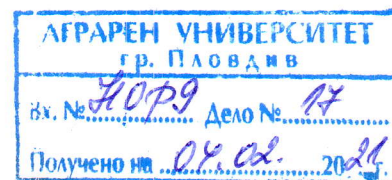


STATEMENT OF OPINION



By Assoc. Prof. Maria Kostadinova Stoyanova, Ph.D.,
The Paisii Hilendarski Plovdiv University

on a dissertation for awarding the educational and scientific degree "Doctor" in Area 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 General Chemistry 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”

Scientific supervisor: Prof. Dr. Krasimir Ivanov, DSc

1. Brief Biographical Information about the candidate

The candidate was awarded a master degree in higher education from the University of Agriculture and Forestry, Vietnam in 2010. He has extensive professional experience as a researcher in the field of development and testing of new fertilizers in Vietnam, which is directly related to the topic of his dissertation. In 2015 Nguyen Nguyen has been enrolled, as a part-time Ph.D. student, at the Department of General Chemistry at the Agricultural University, Plovdiv for the period of 4 years.

2. Relevance of the problem developed in the dissertation

Global agricultural policy is aimed at the efficiency and the sustainability of agriculture, which will not only ensure the production of high quality products in line with the growing demand and the higher societal demands for greater quality and healthier foods, but also to reduce the environmental pollution. It is essential for increasing the yields and quality of the agricultural products, the nutrition of crops, closely associated with the use of mineral fertilizers in order to absorb sufficient amounts of macro-and micronutrients.

Recently, nanotechnologies have been rapidly entering the agricultural science and the practice. The use of nanomaterials in agriculture as foliar fertilizers would provide effective concentration and controlled release of nutrients, increased target activity and less ecotoxicity, easy delivery and absorption by the plants. Related to this is the topic of the dissertation, which determines the scientific significance and relevance of the research and its practical focus.

3. Knowledge of the problem

The literature survey is meaningful and reflects the current state of research on the topic of dissertation. It is based on 163 sources, all in Latin letters, 45% of which have been published since 2010. The literature review is structured in five parts, covering research on the physiological role of zinc for plant growth and reproduction; the consequences of Zn deficiency in plants for their development; recent trends in the synthesis of nanocomposites and their use as fertilizers with an emphasis on zinc-containing materials as foliar fertilizers for basic crops for Bulgaria and Vietnam. The literature survey shows a very good theoretical awareness of the Ph.D. student, its ability to analyze and interpret creatively different scientific literature.

4. Purpose, tasks, hypotheses, and research methods

The aim of the study is clearly defined: a controlled synthesis of zinc containing nanofertilizers and an assessment of their potential for enhancing the yields and quality of production from basic crops. To achieve the goal of the dissertation work, four research tasks have been planned in a logical sequence, solving which allows for a complex assessment of the possibilities for use and efficiency of the synthesized nanosized zinc-containing composites as foliar fertilizers.

In methodological aspect the research work on the dissertation is properly planned, with logically following all stages of synthesis of nanosized zinc-containing composites, their complex characterization with a set of physicochemical methods and as a final stage conducting experiments under controlled conditions and field experiments. The conditions for conducting the experiments and the methods and techniques used, have been described in detail and, in addition to predetermining the receipt of reliable scientific results, show that the doctoral student has acquired the necessary methodological experience for conducting a scientific experiment.

5. Results visualization and presentation

The dissertation is written on 172 pages and includes introduction, literature review, experimental part (materials and methods), experimental results and discussion, main results and conclusions, and references. Section 3. Experimental results - consists 8 parts, each of which has been structured as a scientific publication. Therefore, there is some repetition of texts (from the literature review and from methods and the equipment outline), but this approach of structuring the section facilitate acquaintance with the dissertation. The obtained results are systematized in 51 tables and illustrated with 61 appropriate figures, which clearly represent the established relationships. In terms of volume and comprehensiveness, the conducted research meets all the requirements for dissertation work.

6. Discussion of the results

Due to the significant volume of experimental work, including synthetic part – preparation of nanoscale zinc-containing composites under variable conditions (temperature, concentration, ratio of starting components, etc.), using a large number of well-selected physicochemical techniques for chemical and structural analysis of synthesized samples (X-ray diffraction analysis, scanning electron microscopy, high-resolution transmission electron microscopy, thermal analysis (TG, DTG, DTA) and chemical analysis (ICP-AES), conducting laboratory and field experiments with the synthesized Zn-containing foliar fertilizer and subsequent analysis of plant samples to determine the distribution of micro- and microelements in their vegetative and reproductive organs, the section *Experimental results* occupies the largest volume of the dissertation.

The results of the research are analyzed in depth and interpreted correctly, taking into account the achievements of other scientists in the same field. The conclusions are a logical consequence of the set tasks and correspond to the experimental results.

7. Contributions to the dissertation

The results of the research have a scientific and emphasized scientific-applied character. In scientific aspect, the contributions of the dissertation are expressed in:

- Original results for the stability of the synthesized hydroxy nitrates and the conditions for the formation of solid solutions in mixed Zn-Cu hydroxy nitrates;
- Obtaining a new knowledge about the equilibrium of $\text{Zn}_5(\text{OH})_8(\text{NO}_3)_2 \cdot 2\text{H}_2\text{O}$ - ZnO and the conditions for controlled synthesis of a product with predetermined properties;
- Enrichment the knowledge in the field of inorganic synthesis by development of a method for controlled synthesis of nanosized Zn-Cu hydroxy nitrates;

- Establishment of the crucial role of zinc feeding throughout the initial growth stages for the formation of the reproductive organs of maize plants;
- Establishment the dependence of the foliar fertilization efficiency with zinc containing fertilizer on the genotype of maize plants.

The following can be indicated as scientific and applied contributions:

- Controlled synthesis of nanosized zinc containing hydroxy nitrates, which can be successfully applied as long-acting foliar fertilizers for major crops;
- Possibility for entirely recovery the physiological parameters of Zn-deficient maize plants by feeding with Zn-containing leaf fertilizer;
- Feeding of *Curcuma Longa* with zinc-containing foliar fertilizer increases the curcumin content in the productive parts of the plant.

8. Assessment of the publications and personal participation of the Ph.D. student

The scientific results have been published in 4 articles (in English) and have been reported in 4 scientific forums (three of which are international). Two of the publications are published in journals with impact factor (IF 0.921 and 0.242). The list includes also another article which is under review. In two of the articles the Ph.D. student is the first author, which undoubtedly confirms his active role and personal contribution to the research. So far, 7 citations have been noticed, which demonstrates the relevance and significance of the conducted research.

The extended abstract of the thesis is of total volume of 51 pages, correctly represents the content of the dissertation, and summarizes the main results of the study.

CONCLUSION

The presented dissertation meets all the requirements of the Law on Development of Academic Staff in the Republic of Bulgaria and the Regulations of Agricultural University for the implementation of this Law.

Ph.D. student Nguyen Nguyen has been successfully coped with the set goal and related tasks of the dissertation, has acquired new theoretical knowledge and experimental skills, correctly interprets the results of the research, which confirms that the educational and scientific goals of doctoral studies have been achieved.

Based on the above mentioned, I am highly convinced to give a **positive assessment** of the dissertation work and to recommend to the esteemed scientific jury also to vote positively to award **Nguyen Kao Nguyen** the educational and scientific degree "Doctor (Ph.D.)" in the scientific specialty "*Ecology and Environmental Protection*".

Date: 04.02.2021 r.

Plovdiv

Statement of opinion prepared by:



/Assoc. Prof. Ph.D. Maria Stoyanova/