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**Review**  
**of the doctoral dissertation of MSc Eng. Xianzong Xia entitled**  
**“The effect of low frequency magnetic field (LFMF) on the quality of radish (*Raphanus sativus* L.) seeds**

The influence of the magnetic field on living organisms was already known in the 19th century. Initially, the focus was on demonstrating changes in the life processes of animals and humans, and from the second half of the 20th century, interest in the use of the magnetic field for plant biostimulation began to emerge, including as a supplement to chemical methods of seed protection in conventional and integrated agriculture. Previous studies have shown that the magnetic field can affect the sowing value of seeds and the yield of crops, and the effects of pre-sowing seed stimulation depend on the parameters used and the quality of seeds. Since the issues of the impact of the magnetic field on seed germination and plant growth are still not fully recognized, the research undertaken as part of the presented doctoral thesis is the next step towards developing effective technologies for its practical application and refers to global trends.

The doctoral dissertation submitted for review was carried out at the Department of Phytopathology, Seed Science and Technology, Faculty of Agriculture, Horticulture and Biotechnology, Poznań University of Life Sciences, as part of the English-language Doctoral Studies, under the supervision of prof. dr hab. Roman Hołubowicz. This dissertation was presented in the form of three monothematic publications, one published in 2020 in *Notulae Botanicae Horti Agrobotanici Cluj-Napoca* (IF: 1.444) and two in 2024 in *Folia Horticulturae* (IF 2.0) and a 53-page Doctoral Thesis, in which the Author presented and summarized the entire scope of research included in the above-mentioned manuscripts. In the three publications assessed, the PhD student was the first and at the same time the corresponding author. According to the statement on page 52 of the Doctoral Thesis, His contribution consisted in collecting literature data and formulating the research problem together with the supervisor, Prof. R. Hołubowicz, and in preparing research methods, conducting experiments, as well as developing the results in the form of a publication and performing editing work related to their printing in the mentioned journals. The participation of the other co-authors mainly concerned providing specialist medical equipment for conducting research and assistance in editing manuscripts for their publication.



The three manuscripts that are the subject of the assessed dissertation were published in the typical layout of the journals *Notulae Botanicae Horti Agrobotanici Cluj-Napoca* and *Folia Horticulturae*. The aim of the first publication published in 2020 in *Notulae Botanicae Horti Agrobotanici Cluj-Napoca* (48(3), 1458-1464) was to demonstrate the effect of low-frequency magnetic field (LFMF) on the quality of dry radish (*Raphanus sativus* L.) seeds. The second monograph, a continuation of the first one, published in 2024 in *Folia Horticulturae* (36(3), 1-10) concerned the effect of low-frequency magnetic field (LFMF) on the germination and vigor of radish seeds previously subjected to the process of accelerated aging, which resulted in their lower sowing value. In the third paper, published in review form in 2024 in *Folia Horticulturae* (36(1), 1-14), which closely refers to the two previous ones, the PhD student and his co-authors presented the possibilities of using a magnetic field for biostimulation of plant material based on their own and previous research around the world.

In the Doctoral Thesis presented in English, the Author skillfully combined into one whole all the aspects shown in the three monothematic publications mentioned. The Doctoral Thesis, with a slightly different structure than the publications, consists of well-composed, eleven chapters: List of publications constituting the Dissertation, Abstract, Introduction, Literature Review, Hypothesis and Research Objectives, Materials and Methods, Summary of the attached research publications including the results and their discussion, Conclusions, Bibliography, Declaration of the authors' participation in the preparation of the mentioned publications and Summary in Polish.

In the English-language "**Abstract**" (p. 5) and Polish-language "**Polish summary**" (p. 53 of the doctoral thesis), the PhD student correctly presented the research theses. He skillfully presented the methodologies of treating radish seeds, untreated and previously subjected to the ageing process, with a magnetic field and presented the obtained results. He stated that magnetic field treatment has great potential in commercial seed refinement.

The chapters "**Introduction**" and "**Literature review**" in the doctoral thesis are very well developed and are largely identical to the review publication in *Folia Horticulturae*. They are closely related to the scope of the doctoral thesis and constitute a compendium of current knowledge in the field of seed refinement and the use of magnetic fields in seed production. The doctoral student has demonstrated in a good style significant problems in seed production and the possibilities of using magnetic fields for seed biostimulation. He has also indicated the prospect of increasing the tolerance to stress and vigour of cultivated plants in unfavourable environmental conditions by treating with a magnetic field and the need to undertake research on its mechanisms and practical application. The professional presentation of methods of



treating plant material with a magnetic field and the possibilities of improving seed germination, the size and quality of plant yields and increasing enzymatic activity is worth noting. The doctoral student has also indicated molecular mechanisms related to the response of plants to magnetic field treatment, problems in using this field in seed production, as well as issues related to the study of ultra-weak photon emissions. The author has presented his previous research properly, using his own work and well-selected numerous literature items that have recently appeared in the world. The scope of the issues presented and the way they are discussed testify to his broad knowledge. It is a pity that among the numerous cited literature items, a larger number of publications published by Polish researchers have not been included, which could promote Polish science more.

In the chapter "**Hypothesis and research objectives**", the PhD student briefly demonstrated three hypotheses that he established in the presented research. The aim of the dissertation was to check the usefulness of using a magnetic field to improve the germination of radish seeds with typical and reduced sowing value under the influence of accelerated aging and to determine the growth of the obtained seedlings.

In the chapter "**Materials and methods**", the PhD student correctly discussed the methods used for treating typical and aged radish seeds with a magnetic field and the methods for assessing the effects of these treatments, using, among others, seed assessment tests recommended by ISTA and photon emission studies. The applied research methods require high precision of execution, predispositions and appropriate scientific preparation. The way in which the research methodology is discussed in the reviewed work shows that the PhD student well understands the essence of the methods used and the processes taking place and has the appropriate knowledge in the discussed area.

The presented research results and their interpretation in the chapter "**Summary of the attached research publications**" are in accordance with the relevant publications and have been properly presented and documented with clear tables, photos and drawings. It is difficult to present all the results important for science and practice in a short review. The most important ones include, among others, the demonstration of the positive effect of the magnetic field on the quality of seeds of the radish varieties studied and the growth of seedlings obtained from them. It is also important, from a theoretical and practical point of view, to specify the exact parameters of this field for the treatment of dry seeds (MF 20 mT for 60 minutes) and the possibility of improving the sowing value of seeds previously subjected to accelerated aging, which resulted in a decrease in their germination capacity. In this case, the PhD student demonstrated the need to differentiate the parameters of the applied magnetic field depending



on the variety: 20  $\mu$ T for 120 minutes or 20  $\mu$ T for 60 minutes. This result is particularly important and indicates the need to develop these parameters for seeds of individual varieties, with different sowing value and aging at different rates, including those stored for a longer period in warehouses under production conditions. It is also interesting to demonstrate changes in the activity of metabolic processes related to the germination of radish seeds under the influence of the tested magnetic field, which did not have a negative effect on the growth of seedlings. Based on his results and literature data, the PhD student indicated that magnetic field treatment has great potential in improving the sowing value of seeds, but the development of effective technologies in this area requires further research. The obtained results were discussed in detail in reference to numerous literature data, most of which have been recently published in renowned scientific journals.

In the "**Conclusions**" chapter, the Author skillfully formulated 6 conclusions resulting from the conducted research, and in "References" he listed 132 cited publications closely related to the discussed issue and largely published in recent years. The included list of literature and the fact that three publications included in the presented doctoral dissertation were published in 2020 and 2024 prove that the Doctoral Student is familiar with the latest scientific achievements in the discussed field, which he is able to use in his own research.

In summary, it should be emphasized that the three publications presented as part of the assessed doctoral dissertation are closely linked in terms of content, and the English-language doctoral dissertation is a well-composed summary of all the problems discussed in them. The entirety of knowledge on the discussed issues, related to the topic of the doctoral dissertation, was presented in an interesting and good style, using well-selected scientific reports published around the world. The insightful presentation of the issues discussed demonstrates a great knowledge of the problems discussed and the ability to synthetically convey the acquired knowledge. The doctoral student demonstrated a good knowledge of the issues being developed and the ability to interpret the obtained results. The conducted research expands knowledge in the field of possibilities of improving the sowing value of seeds using a magnetic field, the application of which in practice on a larger scale still encounters many difficulties. The presented research closely refers to work carried out around the world, as evidenced by the increasing number of scientific publications in this field and the pressure of the seed industry to develop effective and economic methods of seed refinement. Correct language, scope of conducted research and the ability to discuss and explain obtained results based on well-selected items of world literature testify to the broad knowledge of the PhD student in the scope of conducted experiments and preparation for conducting scientific research. I have verbally



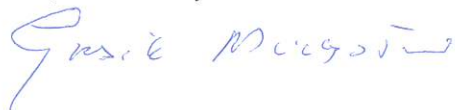


communicated to the PhD student any minor defects found in the presented PhD Thesis, which do not reduce its value.

Taking into account the scope of the research conducted, the results obtained, the manner of their presentation and interpretation, and their cognitive and practical values, I state that the presented doctoral dissertation in the form of three monothematic publications and the Doctoral Thesis, constituting their extensive summary, fully meets the requirements for doctoral dissertations in the Act on Academic Degrees and Titles and specified in Article 179 of the Act of July 3, 2018, the Law on Higher Education and Science. Hence, I request that MSc. Eng. Xianzong Xia be admitted to further stages of the doctoral procedure.

Skierniewice 28.11.2024

*Prof. dr. Mieczysław Grzesik*

A handwritten signature in blue ink, appearing to read "Grzesik Mieczysław".

