

REVIEW

Лесотехнически университет
Агрономически факултет
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on a dissertation for obtaining the educational and scientific degree "Doctor" in: field of higher education **Agricultural Sciences and Veterinary Medicine**, professional field 6.1. **Plant Growing**, the scientific specialty **Agrochemistry**

Author of the dissertation: Wissam Hourani, PhD student in absentia at the Department of Agronomy at the University of Forestry, Sofia

Dissertation: "New Approaches for Saffron (*Crocus Sarivus* L.) Fertilization in Lebanon"

Member of the scientific jury: Assoc. Prof. Dr. Margarita Todorova Nikolova, pensioner, University of Forestry, Sofia, professional field: 6.1. **Plant breeding**, scientific specialty: **Agrochemistry**, appointed as a member of the scientific jury by Order No PS- 641/05.12.2022 by the Rector of the University of Forestry.

Brief presentation of the candidate.

Wissam Hourani was born in 1994 in Lebanon, where he completed his higher education with a master's degree in plant breeding. Immediately afterwards he continued his education with a Master's degree in Mediterranean Organic Agriculture in Bari, Italy and a PhD in Agrochemistry at the University of Forestry in Sofia. He works as a coordinator of a farm network in which he develops various activities – farm visits and consultations, collecting data and analyzing them, identifying problems and proposals for their solution, organizing events with farmers, introducing innovations and good agricultural practices in growing fruits and vegetables, market research and analysis, etc. In previous works in public and private institutions he has also been engaged in market research and introduction of new products for agricultural production in different areas of Lebanon, research, and training in plant protection of various crops, organizing seminars with farmers.

The very good education and the accumulated multifaceted experience (agrotechnics, agrochemistry, organic farming, plant protection, statistics, trade and marketing, mapping, advisory activities with farmers) enable Hurrani to choose a topical topic, formulate clear goals and choose an appropriate methodical approach to achieve them. During the doctoral studies he has acquired knowledge and skills related to research activities – research and summarization of literature on the scientific problem; conducting field trials; he has mastered methods for monitoring and for taking specific samples for saffron quality analysis, laboratory tests, data collection and statistical processing. He has good digital training, fluent in English and Arabic.

2. Actuality of the problem.

The object of the study is saffron, a plant of great importance for culinary, pharmacy, industry, cosmetics and whose unit price is from the highest in the world. The study was prompted by the idea of saffron replacing the illegal cultivation of cannabis and poppy in underdeveloped areas of Lebanon. In connection with the introduction of this non-traditional for Lebanon crop, the dissertation studies climatic factors and elements of the technology of growing saffron with emphasis on the influence of the size of mother bulbs, soil fertility management, balanced nutrition, application of new technological solutions for more efficient and environmentally friendly use of nutrients and water (use of bio- and nano-fertilizers and soil superabsorbent). The study was conducted simultaneously and using the same methodology in Iran, where there is a tradition of growing saffron, to compare the results in both countries. The complex assessment of a number of

indicators made in the dissertation makes the development relevant, of scientific and practical importance not only for the conditions of Lebanon, given the growing interest in saffron cultivation in Southern Europe and other parts of the world.

3. Degree of knowledge of the problem and creative interpretation of the literary review.

The topic of the dissertation is complex, requiring knowledge of the achievements in various scientific fields – genetics, molecular research, management of saffron nutrition in order to effectively produce high-quality organic production; use of a new generation of fertilizers (organic and nanofertilizers suitable for organic farming); irrigation and efficient use of water by application of soil superabsorbents – polymers; quality of production and others. The PhD student has covered a large number of titles (226) whose chronology reflects the growing worldwide interest in saffron and with a dozen exceptions, the publications are from the last 20 years. The literature review covers all aspects developed in the dissertation and relevant to the effective production of saffron – botanical characteristic, taxonomy, genetics, distribution, climate requirements, characterization and application of nanofertilizers and soil superabsorbents. The vast amount of information is appropriately structured, written in good language and easily perceived. The author makes an analysis and targeted comments on the presented literary results, which shows a competent understanding of the problems and from which a well-grounded formulation of the objectives of the dissertation results.

Literary sources are described accurately and according to a uniform standard.

4. Purpose, tasks, hypotheses and research methods. Compliance of the chosen methodology of research with the aim and tasks of the dissertation.

The main objective of the dissertation is to evaluate and optimize the cultivation of saffron under the climatic conditions of Lebanon with a view to expanding its cultivation in new areas of the country. This includes characterization of the conditions of the area, comparative study of phenological phases, quantitative and qualitative indicators of Lebanese and Iranian saffron, genetic identification of Lebanese saffron, as well as the study of new elements in saffron cultivation technology as an influence of the size of mother bulbs, individual or combined application of organic and nanofertilizers by fertigation and of soil superabsorbent polymers (SAP) with a view to making more efficient use of nutrients and water.

In connection with the main objective, questions are formulated that need clarification and respectively tasks that allow for a complex assessment of the possibilities for optimizing the cultivation of the crop. To achieve the main objective, the research program is organized in three phases: a) study of the influence of the climatic conditions of Northern Lebanon on the yield and quality of saffron, b) identification of saffron species suitable for the new growing areas, c) study the influence of bulb size, nano-fertilizers and SAP on the efficiency of saffron production in Lebanon. An appropriate approach is the simultaneous study using the same methodology of the test point (Douma) chosen for the conditions of Lebanon and of a site typical for the cultivation of saffron in Iran (Mahallat), which allows for a comparative assessment of the conditions in the studied areas of Lebanon and Iran.

In the section "Material and Methods" the soil and climatic conditions, the design of the experience and technology of growing saffron, the methods of taking saffron-specific samples for quantitative and qualitative analyses, the methods of analysis and statistical treatment are competently described. The composition of the tested organic and nano-fertilizer products - *Seaumic*, *Super plus ZFM++*, and *LITHOvit FORTE* and of the soil polymer superabsorbent used. From the tables characterizing the fertilizers studied, a difference can be seen in both their composition and the content of nutrients. There is no comment on what amounts of nutrients are imported with the applied norms from the individual fertilizers and whether there are significant differences in some of them.

The complex methodical approach to achieving the objectives of the dissertation requires the inclusion in the research program of a large number of indicators, for the processing and analysis of which modern and adequate methods and equipment for measurements and analysis have been applied, as well as a suitable mathematical apparatus for establishing statistically proven relationships between the studied indicators.

5. Visualization and presentation of the results obtained.

The dissertation paper is presented on 127 pages, structured adequately and contains all the necessary sections. The huge volume of data obtained in the study were processed by appropriate modern statistical analyses and are presented in 28 figures and 14 tables, supplemented by 5 annexes at the end of the dissertation. Part of the figures are colour photographs and PCR test results, suitably illustrating the methodology used and results obtained. The headings of the figures and tables are described at the beginning of the dissertation after the content which assists their search in the text. The results are presented informative enough and are aesthetically well formed.

6. Discussion of results and literature used.

The results of the conducted study are presented by the phases of the conducted research, after which the discussion is made in a separate chapter. In general, in the first phase, the focus is on a comparative assessment of climatic and soil conditions, as well as of the applied agricultural practices at the two experimental sites in Lebanon and Iran. Important soil characteristics for the cultivation of saffron are selected – texture, pH, content of organic matter and nutrients, electrical conductivity, as well as climatic factors – altitude, precipitation, temperature conditions and their influence on the occurrence of phenophases in the development of saffron. It is estimated that the conditions of the study area in Lebanon are suitable for growing saffron. The information obtained in this part of the study is important for agriculture in Lebanon and is also valid for other countries and areas with similar soil-climatic conditions. In the second phase, by using DNA and other appropriate genetic analyses, the genotype of Lebanese saffron and its suitability for successful cultivation in the area was identified. Large number of biometric indicators, yield elements and important quality ingredients (picrocrocin, crocin and safranal) were determined.

In the third phase, the envisaged innovative approaches to increasing the efficiency of saffron production are tested in field experiments. The assessment of the effects of the studied factors – weight of bulbs, organic and nano - fertilizers and soil superabsorbent polymer (SAP) is made on the basis of data from a multifactorial ANOVA analysis investigating their relationship with all traced indicators. During the growing season, the dates of occurrence of phenophases and a number of biometric indicators are taken into account, which allows a more detailed explanation of the action and interaction of the studied factors. A positive effect of single application of tested fertilizers on the yield and quality of stigmas, and as more effective is outlined Seamic – an 84% increase in stigma yield, followed by ZFM++ with 64%. SAP alone increases yields by up to 36% thanks to the retention of more moisture in the soil and, as a consequence, better use of nutrients. The results also show, that the application of the organic fertilizers tested in conjunction with a soil superabsorbent gives a better effect on the yield stigmas, but the quality of the production, especially the content of picrockin, is better when the fertilizers are applied alone. The author concludes that these results are grounds for the co-application of fertilizers with SAP to be recommended in arid areas with low soil fertility. This would reduce the use of industrial chemical fertilizers and therefore the negative impact on the environment. An important conclusion is that by appropriately combining certain fertilizer formulations and superabsorbent, the efficiency of smaller bulbs can also be improved. The results obtained in this section are of great practical importance and require further study.

In the process of discussion, the information obtained in the experiments was analyzed adequately while presenting and commenting on results in publications of other authors. This helps to provide a more reasoned justification for the conclusions and conclusions drawn. A more thorough analysis

of the action of individual formulations of commercial organic fertilizers would be useful, as there are differences in their composition.

An important element of the dissertation is that as a result of the discussion, the author outlines the directions for future research with a view to expanding the range and increasing the efficiency of saffron cultivation.

7. Contributions of the dissertation.

As a result of the research, the PhD student formulated a total of five contributions, which I accept. I believe that there are both scientific and practical contributions to the development, all of an original nature:

Scientific contributions

- For the first time with detailed studies of climatic, soil and genetic characteristics, as well as with experiments in real conditions, in which the influence of saffron bulb size, fertilization and soil superabsorbents on yield and quality has been shown that the area of Douma (Northern Lebanon) is suitable for efficient saffron cultivation. This contribution has great economic and social importance for one of the less developed areas of Lebanon. The validity of the information obtained might be also referred to other areas in the world where there is a similar combination of the factors studied.
- Using modern DNA analyses, the Spanish species *Crocus* grown in northern Lebanon has been shown to be *Crocus oreoreticus*.

Scientific and applied contributions

- It has been shown that by applying the tested nanofertilizers or the organic product Seaumic can increase the yield and increase the quality of saffron production. This technology of crop nutrition management shows the possibility of bio-production of saffron.
- It has been found that the effect of tested fertilizers can be significantly improved by co-application with polymers – superabsorbents into the soil, which, by water retention, improve the water and nutrient status of saffron. This technological solution allows growing the crop in arid areas and on soils with low fertility.
- For the first time, the possibility of increasing the quantity and quality of production has been shown when using bulbs of smaller size by appropriate combination of fertilizers and soil superabsorbents.

The information obtained in the research can serve to develop a strategy for adapting saffron cultivation in northern Lebanon. Along with the proposed technological solutions, a significant contribution of the development is the outlining of the directions for further research related to overcoming potential negative climatic phenomena, optimizing nutrition by jointly applying appropriate formulations and norms organic and nanofertilizers in combination with soil superabsorbents.

8. Assessment of the extent of the dissertant's personal involvement in contributions.

For the realization of the research program a huge amount of exploratory, experimental and analytical work has been carried out. I have no personal observations on the doctoral student's activity, but the way of presenting and commenting on the results of the study shows that Wissam Hourani has acquired skills to work with modern scientific methods and approaches, analyze data and formulate scientific conclusions and conclusions.

9. Critical remarks and questions

In the discussion of the results for the performance of the tested fertilizers, the emphasis is mainly on the effect of trace elements in general and the organic substances in them. In my opinion, there is a lack of more in-depth comment on the imported differences in diet, because the fertilizers used differ in composition and content of the applied nutrients. For example, LITHOvit FORTE also inputs silicon that is not contained in other fertilizers. This note is rather a recommendation for the future scientific activity of the PhD student, especially since the soils studied are alkaline, with a high content of organic matter, total nitrogen, absorbable forms of phosphorus and potassium. In distinguishing the effect of individual nutrients more clearly, the results of the study may be applied to other fertilizer formulations.

10. Published articles and citations.

The main results of the dissertation are presented in 3 scientific publications, two of which are under print. One of the publications is single and in one of the collective is the first author.

The citation reference presents three publications reflecting results from the PhD student's published article.

In conclusion, I believe that the scientifiemetric requirements for acquiring a Ph.D. are met.

11. Evaluation of publications on the dissertation: issue, nature of the publications in which they are printed. Reflections in science - use and citation by other authors.

The publications are in specialized and authoritative scientific journals such as *Agronomy Research* and the *Bulgarian Journal of Agricultural Science* and present a large part of the results in the dissertation. Citations are in authoritative international journals.

The presented summary is well structured and illustrated and objectively reflects the content and achievements of the dissertation.

CONCLUSION:

Based on the various research methods learned and applied by the doctoral student, the correctly derived experiments, the generalizations and conclusions made, I believe that the dissertation presented meets the requirements of the Law on Forestry and the Rules of the University of Forestry for its application, which gives me reason to evaluate it **POSITIVELY**.

I would like to propose to the honorable Scientific Jury also to vote positive/negative and award to Wissam Hourani the educational and scientific degree "Doctor" in the scientific specialty **Agrochemistry**.

Date: 12.12.2022.
G. Sofia (Assoc. Prof. Margarita Nikolova, PhD)

REVIEWER:

