REVIEW

on a dissertation for obtaining the educational and scientific degree **"Doctor"** in: field of higher education 6. Agricultural sciences and veterinary medicine, professional field 6. 1 Crop science, scientific specialty: Crop science.

Author of the dissertation: SVETLANA YORDANOVA MANHART
part-time PhD student at the Department of Crop Science at the Agricultural University, Plovdiv.

Dissertation topic:" "Varietal reaction of coriander (Coriandrum sativum L.) depending on the application of some foliar treatment products"

Reviewer: Assoc. Prof. Dr. Yovko Kirilov Dyulgerski, TTPI, Agricultural Academy, Prof. direction 6. 1. Plant growing, Scientific specialty: Selection and seed production,
designated for a member of the scientific jury by order № RD-16-515/04. 05. 2023. by the Rector of AU.

1. Brief introduction of the candidate.

Svetlana Yordanova Manhart was born on June 16, 1982. In 2008, she graduated with a master's degree in economics and production organization at the Humboldt University in Berlin. In 2018, she graduated with a master's degree in plant protection at the Agrarian University in Plovdiv. Since 2019, Svetlana Manhart is part-time PhD student at the Department of Crop science at the same university. Since 2018, he has been working as the Secretary of evaluation committees at the "Local Initiative Group - Maritsa Municipality". At the same time, he is the manager and partner of Agro Impuls OOD, which is active in the field of agriculture. Since 2022, she is a part-time lecturer in the Department of Crop science, and since February 2023, she is an assistant in the same department. Svetlana Manhart has diverse interests and skills in a variety of fields. She has many specializations at home and abroad. She speaks perfect German and very good English language.

2. Relevance of the problem.

In recent years, all over the world and especially in Europe intensifies the interest in essential oil, medicinal and flavor plants. They are used in the cosmetic, pharmaceutical and food industry, and the areas of these crops are rapidly expanding. In Bulgaria, the soil and climatic conditions are favorable for the cultivation of medicinal and aromatic crops, and there are long-lasting traditions in the production of essential oils. The export orientation of the sector has made it emblematic for the country. Areas with essential oil and medicinal plants are about 1.1% of all harvested in Bulgaria. The largest share is occupied by the areas with coriander, distributed in almost all regions of the country.

Coriander is one of the most valuable essential oil crops in the world. Although coriander is the leader among essential oil crops in Bulgaria, it is the subject of limited research. To increase the yield of coriander seeds, the content of essential oil, as well as the ability of the culture to overcome some abiotic stress factors, there is a decisive importanc the wider implementation of agrotechnical and agrochemical measures, in which the use of foliar treatment products (growth regulators – biostimulators, retardants, bacterial preparations, vitamins, organic substances and anti-stress products). These products stimulate the biological potential of plants and influence the rate of growth and development. Therefore, it is extremely important for the practice to study other domestic and foreign products that are suitable for coriander and to introduce them into production, which will allow to successfully realize high productivity and quality of seeds.

3. Purpose, tasks, hypotheses and research methods.

The main goal of the present study is to study the reaction of coriander varieties depending on the applied foliar treatment products and to determine their influence on the productivity, content and composition of essential oil in the seeds. To achieve this goal, the four tasks are set, whose decision detailed in the experimental part of the dissertation. These tasks include, respectively: tracking the phenological development of coriander, establishing the duration of the interphase periods depending on the variety and applied foliar treatment products; establishing the yield of seeds and its structural elements, as well as the yield of essential oil in coriander varieties depending on the products used; examination of the physical qualities of the seeds, the content of essential and ordinary oil depending on the variety and applied foliar treatment products; determining the influence of the products used on the chemical composition of the essential oil in coriander varieties.

To achieve the goal and to the tasks, a number of three-year field experiments with a huge number of phenological, biometric, productive, quality and chemical indicators are applied and a wide range of chemical analyzes, mathematical methods and software products are used, which are described in detail.

4. Visualization and presentation of the obtained results.

The presented dissertation contains 190 pages and contains sequentially: introduction, literature review, purpose and tasks, material and methods, soil-climatic characteristics, results and discussion, conclusions, contributions and list of used literature. The content of the dissertation is well structured and very well balanced in terms of its sections. The introduction briefly but very well presents the state of the problem. The literature review is 30 pages long - very rich and comprehensive, but without unnecessary details. Several aspects are represented in it. The influence of soil nutrition on the growth and productivity of coriander, the content and chemical composition of essential oil from coriander fruits and the previous studies on the influence of biostimulators and foliar treatment products on biometric indicators, yield and essential oil content of the fruits of coriander are described in detail. In the Material and methods section, which consists of 12 pages, the methodology and the way of

conducting the field experiments, the studied factors, the tested varieties, the indicators represented in the study, the agrotechnics carried out, soil-climatic characteristics and brief information about the mathematical processing of the data are presented. The varieties with which the doctoral student works are five in number, precisely described and presented in photographic material. They are very well chosen, with origins from different countries, as one of the used varieties is the work of Bulgarian selection. The detailed soil-climatic characteristics of the village of Vojvodinovo in the Plovdiv Region, where it is part of the study area, are given. Information is presented on the three foliar treatment products used in the study. For visualization are used 31 tables, 36 figures and six photos. A high scientific style is used, and at the same time the dissertation is written in an accessible language, which allows it to be used in the future by a wide range of specialists.

5. Discussion of the results and used literature.

Discussion of the results is the main and largest section of this paper. It covers a total of 100 pages and consists of several subsections. In the first subsection, which includes phenological development of the studied varieties, it is determined that the length of the vegetative period is from 113 to 118 days. Applied foliar treatments (mostly Isabion) extend flowering to 4-5 days. The doctoral student found that it is the longer flowering that is the main reason for the increase in the duration of the vegetative period as a result of the treatment with foliar products.

The second subsection presents the results of applying the foliar treatment products to multiple biometrics. It is established that the treatment with leaf products positively affects all the quantitative signs of the tested varieties: the height of the plants increases; the number of umbels per plant increases; positively affects the number of seeds per umbel, increases the number of seeds per plant depending on the variety. It is statistically proven that the mass of seeds per plant in all treated variants is higher than that of the controls, and the tested foliar treatment products helped to increase the seed yield up to 13.4% compared to the control depending on the climatic factors of the year and the variety.

In the third subsection, the influence of foliar treatment products on the productive indicators of the studied varieties is examined. The tested foliar treatment products help to increase the seed yield of coriander varieties. Two-factor analysis of variance showed a strong statistical effect on seed yield of both cultivars and foliar products. On average over the study period, all treated variants are found to exceed controls by 2.9 to 11.8%. It is statistically proven that the use of the product Energy 20-8-60 has the greatest effect on the indicator of essential oil content. The increase in these values ranges from 8.3% in the Thuringian variety to 11.8% in the Moroccan and Marino varieties. Application of Isabion and Fulvin 40-22 products to coriander plants increased the essential oil content from 2.9% (Marino variety) to 6.5% (Amber variety). The interaction of the factors on the characteristic essential oil content is not proven during the experimental years.

On average over the study period (2020–2022), the foliar treatment products used had a positive effect on the crude fat content of the seeds in all studied cultivars. They help to increase the values of this indicator from 1.7% to 10.0% compared to the

controls. It is established that in the case of the Marino variety, the application of the preparation Energy 20-8-60 significantly increases the crude fat content. From the two-factor variance analysis, it can be seen that the "Variety" factor has a statistically significant influence on the "crude fat content" indicator. The factor "Products for leaf treatment" in the 2021 has an insignificant influence on the values of this indicator, while in the 2020 and 2022, that factor has a statistically proven effect on the investigated indicator.

The next sub-section includes the influence of foliar treatment products on the quality parameters of the varieties. On average for the study period (2020–2022), the highest mass per 1000 seeds in the control varieties is recorded for Marino variety - 6.19 g, followed by Moroccan variety - 5.99 g and Thuringian and Amber varieties - 5.54 and 5 .31 g, and the smallest absolute mass is recorded for the Local small-fruited variety - 4.75 g. The applied foliar products Fulvin 40-22 and Energy 20-8-60 is proven to increase the values of this indicator compared to the control from 3.4% to 7.6% and from 3.1% to 11.5%. The greatest positive impact is reported for the Isabion product, which increased the mass of 1000 seeds by 16.4% in Mesten drebnoploden variety; with 13.6% for the Marino variety; with 12.0% for the Amber variety and with 10.7% and 7.0% for the Moroccan and Thuringian varieties.

On average, for the period of the experiment, the hectoliter mass indicator changes depending on the variety and applied leaf products. The Moroccan variety stands out with the largest mass of seeds per 100 l - 32.3 kg, followed by the Marino, Thuringian and Mesten drebnoploden varieties - 30.5 kg, 30.4 kg and 30.0 kg, and the smallest hectoliter mass is registered for Yantar variety – 29.0 kg. The control variants in all tested varieties have lower values than the treated ones, and the studied leaf products have a positive influence on the growth of the hectoliter mass. The increase in the mass of seeds per 100 l when treating coriander plants with the product Energy 20-8-60 compared to the control is 13.2%; 10.8%; 7.2% and 5.5% in Thuringian, Moroccan, Marino and Mesten drebnoploden varieties, respectively. The increase in the hectoliter mass in the Amber variety is from 6.3% when this product was applied, to 12.3% and 13.0% when treated with Isabion and Fulvin 40-22 compared to the control. These two products in the remaining Thuringian, Moroccan, Mesten drebnoploden and Marino varieties exceed the control by 10.7%; 7.2%; 6.0% and 5.5%.

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In the fifth subsection, an interpretation of the numerous chemical analyzes performed in the study is made. The biostimulant Isabion is found to increase the linalool content of the essential oil of Moroccan (by 9.05%) and Mesten drebnoploden (by 5.26%) varieties compared to the control. In the Amber and Thuringian varieties, the products Energy 20-8-60, Fulvin 40-22 and Isabion did not affect the linalool content of the essential oil. Mineral gel fertilizer Energy 20-8-60 leads to a decrease in the content of linalool in the essential oil of the Marino variety by an average of 4.03%. Based on the obtained results from a hierarchical cluster analysis, the chemical parameters are assessed comprehensively and grouped into clusters. Three main clusters are distinguished for Amber and Marino varieties, and for Mesten drebnoploden, Thuringian and Moroccan varieties, the chemical indicators are presented in two main clusters. The promising varieties identified in the regression and cluster analyzes are the Local Small-fruited and Thuringian cultivars. They are distinguished by high values in basic chemical parameters.

In the last sixth subsection, the established correlations between quantitative and qualitative indicators of coriander varieties are given. The most significant are: seed yield with vegetative period (r = 0.977), seed yield and number of seeds per plant (r = 0.964), mass of seeds per plant (r = 0.954), number of seeds per plant and number of seeds per umbel (r = 0.911), number of seeds per plant and essential oil yield (r = 0.877), number of seeds per plant with plant height (r = 0.848) and number of umbels per plant (r = 0.828). Significant interrelationships are also established for the qualitative indicators: hectoliter mass with γ-terpinene (r = 0.993), hectoliter mass with geraniol with correlation coefficients (r = 0.987).

Averaged over the three-year study period, the positive influence of the applied leaf products on the essential oil yield of the tested cultivars is confirmed. The highest values of this indicator are obtained when applying the products Energy 20-8-60 and Isabion from the local small-fruited varieties - 13.2 kg/ha, Moroccan - 12.8 and 12.9 kg/ha, followed by the Amber variety - 10.4 and 10.1 kg/ha; Thurigen – 9.0 kg/ha, and the lowest for the Marino variety – 6.6 and 6.3 kg/ha. The increase in essential oil yield in the treated compared to the control variants was greatest in Moroccan variety followed by Marino variety from 10.7 to 17.9%; Mesten drebnoploden from 11.4 to 15.8% and Amber from 11.1 to 15.6%, and the least in the Thuringian variety from 8.6 to 11.1%. Regarding the mean values of the essential oil yield indicator, the tested coriander cultivars were ranked in the following descending order: Mesten drebnoploden> Moroccan > Amber > Thuringian > Marino.

At the end of each section and subsection, the doctoral student sums up the obtained results. The analysis of all results is presented thoroughly and in depth. The interpretation of the obtained data is accurate and correct, as they are compared with those of other authors who worked in the same direction. The conclusions are 14 in number and represent a synthesis of the numerous data obtained and analyzed by the doctoral student. They are correct, very precisely formulated and fully consistent with the obtained results. The literature review includes 238 titles, showing very good theoretical preparation. Of these, 52% are published in the last ten years, and over 16% even in the last three, which demonstrates the relevance of the literature review.

6. Contributions to the dissertation.

As a result of the properly prepared and precisely performed experimental work and the objective analysis of the obtained results, the doctoral student has presented 9 contributions showing her personal scientific achievements, which can be broadly divided into scientific and scientific and applied.

Scientific contributions

In scientific terms, the most significant contributions of the doctoral student are expressed in:

- The vegetative period of varieties coriander of different origin, grown under the soil-climatic conditions of the Plovdiv region, is determined. For the first time is proven, foliar treatment products to prolong the flowering of plants coriander and increase the length of the vegetative period

.- The influence of the treatment with leaf products on the structural elements of the yield in the tested varieties is monitored and an increase is found compared to the control of the indicators - number of umbels per plant, number of seeds per umbel, number of seeds per plant and mass of seeds per plant.

- The biostimulant Isabion to increase the linalool content of the essential oil of the Moroccan variety and Mesten drebnoploden variety compared to the control is found, and the products Energy 20-8-60, Fulvin 40-22 and Isabion did not affect the linalool content of the essential oil of the Amber and Thuringian varieties, while the mineral gel fertilizer Energy leads to a decrease in the content of linalool in the essential oil in the Marino variety.

-The presence of the aldehyde 2E-Tridecenen-1-al under the influence of the treatment with foliar preparations is found in all tested varieties, which is absent in untreated variants. It is established that the content of aldehydes in the essential oil of the Amber and Marino varieties is significantly affected by treatment with the preparation Isabion.

- Correlation relationships are established between qualitative and quantitative indicators in coriander varieties. Regression models are built and the influence of the Isabion preparation on the chemical parameters of Mesten drebnoploden variety with the highest coefficient of determination is proven.

Scientific and applied contributions

Some of the PhD student's contributions are of a scientifically applied nature, the most important of which are:

-The positive effect of the foliar treatment products Energy 20-8-60, Isabion and Fulvin 40-22 on the yield of seeds and essential oil has been proven. It is found that the Isabion product increased the seed yield up to 9.9% and the Energy 20-8-60 and Isabion products increased the essential oil yield up to 18.3% compared to the control depending on the variety.

- It is been studied and found that foliar treatment products increase the essential oil content of the studied varieties (up to 11.8%), with the product Energy 20-8-60 being the most effective. The foliar treatment products used increased the crude fat content of the seeds in all investigated cultivars up to 10.0%. The strongest effect is reported when

applying the product Energy 20-8-60 for the Marino variety - 14.68% compared to the control.

- It is established that the studied leaf products have a positive influence on the physical qualities of the seeds. The Isabion product has the strongest influence on the mass of 1000 seeds, with the increase being the highest in Mesten drebnoploden variety up to 16.4%. The increase in seed mass per 100 l volume compared to untreated variants varied from 5.5 to 13.2% depending on the variety.
- The results of the conducted research make it possible to apply the foliar treatment products Energy 20-8-60, Isabion and Fulvin 40-22 in the coriander cultivation technology.

7. Critical remarks and questions.

With regard to the presented dissertation and abstract I have no significant critical remarks. The use of a wide range of methods of work and the large number of results obtained and valuable for science and practice personal contributions are an indicator of the great and precision work done by the PhD student developing the dissertation, and as well as that Svetlana Manhart is a qualified scientist and specialist in the field of agrarian sciences.

My only remark about the presented dissertation is that the doctoral student failed to take into account one more important contribution although it is not directly related to the purpose of the present work, namely the complete, accurate and comprehensive characterization of the five investigated varieties coriander. In connection with this, I have the following question for the doctoral student: Who or which of the studied varieties coriander are most suitable for cultivation in the Plovdiv region and why?

8. Published articles and citations.

In connection with the dissertation, two article are published. On one of the articles, the doctoral student sole author, and on the other she is the first author. Both articles are published in scientific publications, referenced and indexed in a global database with scientific information (Web of Science). The publications are related to the topic of the dissertation work.The articles presented by the PhD student covers the minimum 30 points required for the acquisition of educational and Scientific Degree "Doctor" according to the requirements of Law on the Development of the Academic Staff in Republic of Bulgaria. Probably because both articles are published less than a year ago, their citations have not yet been noticed.

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, correctly performed experiments, summaries and conclusions, I believe that the presented dissertation meets the requirements of Law on the Development of the Academic Staff in Republic of Bulgaria and the Regulations of the Agricultural University for its application, which gives me reason to rate it **POSITIVE**.

I allow myself to suggest to the esteemed Scientific Jury also to vote positively and to award Svetlana Yordanova Manhart educational and scientific degree **"Doctor"** in the scientific specialty Plant Breeding.

Date: 16. 05. 2023

Пловдив

REVIEWER: .....

(Assoc. Prof. Dr. Y. Dyulgerski)