

REVIEW

on a dissertation thesis for obtaining the educational and scientific degree "doctor" in the field of higher education 6. Agricultural sciences and veterinary medicine, professional direction 6.1 Crop production scientific specialty Field crops.

Author of the dissertation: Svetlana Yordanova Manhart, PhD student (part-time) at the Department of Plant Breeding at the Agricultural University, Plovdiv.

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

Rewever: Prof. Dr. Hristofor Kirchev Kirchev, Agricultural University, area of higher education 6. Agricultural sciences and veterinary medicine, professional direction 6.1 Plant production scientific specialty Field crops, appointed as a member of the scientific jury by order No. RD-16-515/04.05.2023 year from the AU Rector.

1. Brief introduction of the candidate.

Svetlana Yordanova Manhart was born on 16.06.1982 in the city of Plovdiv. Secondary education was completed at the Mathematical High School "Acad. Kiril Popov" - Plovdiv. During the period 2001-2008, she studied at the Humboldt-Universität zu Berlin and obtained a master's degree in Economics and Production Organization. In 2016, she graduated with a master's degree in Plant Medicine at the Agricultural University - Plovdiv. In 2019, after successfully winning a competition, she was enrolled as a part-time PhD student at the Department of Field Crops at the Agricultural University - Plovdiv, and from the beginning of 2023, she was appointed as an assistant in the same department. Work and internship began in 2007 as a credit security intern at Readybank AG - Germany and passed through junior specialist, credit inspector, accountant and manager in various structures in Germany and Bulgaria. During her doctoral studies, she participated in three conferences and three research projects.

2. Relevance of the problem.

Essential oil crops are raw materials, irreplaceable in many industries (perfume, cosmetics, pharmacy, food industry, etc.) regardless of the created artificial flavours and flavourings. The specific soil and climatic conditions in Bulgaria and the long-standing traditions in the cultivation of aromatic and medicinal plants make this section of crop production increasingly relevant and preferred by several farmers, especially in the context of the search for alternative crops within the field crop rotation. Such an alternative is coriander, which is successfully included in the production along with other field crops. Coriander essential oil is valuable because it is used as a flavouring agent in several foods, beverages, confectionery and sauces. A relatively new field of technology is the application of foliar treatment products, which seeks to increase seed yield, essential oil content, and the ability of the crop to overcome certain stress factors during the growing season.

3. Purpose, tasks, hypotheses and research methods.

The present study was conducted to investigate the response of coriander cultivars 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 fulfil the objective, four tasks are set as follows:

1. To follow the phenological development of coriander and to establish the duration of the interphase periods depending on the variety and applied foliar treatment products.

2. To determine the yield of seeds and their structural elements, as well as the yield of essential oil in coriander varieties depending on the products used.

3. To examine the physical qualities of the seeds, and the content of essential and simple oil depending on the variety and applied foliar treatment products.

4. To determine the influence of the products used on the chemical composition of the essential oil in coriander varieties.

To achieve the goal and tasks of the study, three annual field trials were carried out in the period 2020-2022 in the village of Vojvodinovo, Plovdiv region.

The experiment is two-factorial, laid out by the method of split-plots in 4 repetitions with the size of the experimental area of 15 m².

Factor A – Variety

A₁ – „Jantar“

A₂ – „Marokan“

A₃ – „Local small-fruited“

A₄ – „Thüringer“

A₅ – „Marino“

Factor B – Foliar treatment products, applied once at the end of a budding phase.

B₁ – Control (untreated)

B₂ – Mineral gel fertilizer – Grow energy

B₃ – Fulvin

B₄ – Isabion

The following biological indicators were studied: Phenological development - the occurrence of the main phenological phases - sprouting, rosette, stem formation, budding, flowering, fruit formation, and ripening. Duration of the interphase periods and the growing season.

Biometric parameters - determined from representative samples of 10 plants as follows: Plant height, number of umbels per plant, number of seeds per umbel, number of seeds per plant and mass of seeds per plant.

Productive parameters: seed yield, essential oil content, essential oil yield and simple oil content.

Seed quality indicators: mass per 1000 seeds, hectoliter mass and essential oil composition.

Chemical analyses:

Soil agrochemical analysis - annually before sowing from the 0-20, 20-40 cm layer, to determine pH, the content of mobile nitrogen, mobile phosphorus and mobile potassium.

Seed analysis - Essential oil content, crude fat content and determination of essential oil composition.

Mathematical data processing includes:

The variation analysis, through which various indicators characterizing the respective samples are determined utilizing a module Descriptive statistics.

To establish the influence of the product on the coriander variety, two-factor analysis of variance (ANOVA) was performed. Using the model of the two-factor dispersion analysis, the influence of the different products on the considered five varieties of coriander was investigated. With the one-factor variance analysis model and Duncan's multi-rank test, the dependence of the individual chemical parameters in the different varieties was investigated.

Correlation analysis was applied to analyze statistical dependencies between strength and direction signs. Its indicator is the correlation coefficient. Correlation analysis establishes a relationship with a relatively high correlation coefficient between basic biometric and chemical indicators.

Cluster analysis is a term from mathematical modelling that refers to the grouping of multiple objects from the same group (called a cluster) that are most similar to each other. Cluster analysis involves many different methods. It allows the researcher to classify a huge amount of "primary" information into groups called clusters.

Factor analysis was conducted using the principal components method (PCA), with the number of principal components (factors) being determined by the number of eigenvalues of the correlation table that are greater than one. Eigenvalues indicate the contribution of the respective component in explaining the total variance in the observed variables. The factor model is mostly determined by the factor weights, which represent the correlation coefficients between the respective factors and indicators. The assessment of the adequacy of the factor analysis was carried out using the Kaiser-Meyer-Olkin (KMO-test) and Bartlett tests.

The main software product used to process and analyze the experimental data in the dissertation is IBM SPSS 26 (a suite of programs for data processing, analysis and presentation) and MS Excel.

4. Visibility and presentation of the results obtained.

The scientific work submitted for review contains 191 pages, 37 tables, 36 figures and 5 photographs. The list of cited literature contains a total of 238 literary sources, of which 11 are in Cyrillic and the rest are in Latin.

The dissertation contains all sections generally accepted for this type of presentation, namely: content - 2 pages; introduction - 3 pages; literary review - 28 pages; purpose and tasks of the research - 1 page; material and methods - 13 pages; soil and climate characteristics - 6 pages; results and discussion - 101 pages; conclusions - 4 pages; contributions - 3 pages and literature - 29 pages.

The literature review is divided into subsections describing the effect of soil nutrient regime on plant growth and productivity, essential oil content and chemical composition of coriander fruits, and the effect of biostimulants and foliar treatment products on biometrics, yield and essential oil content in coriander seeds.

The results of the literature review carried out in this way show that coriander reacts positively to the used growth regulators, biostimulators and foliar fertilizers, which gives reason to continue the studies with this crop, especially since in the "List of authorized plant protection products" of the country they are not included ones that can be used with cilantro.

5. Discussion of results and references.

As a consequence of the precisely performed experimental activity, the obtained data are described and discussed in the Results and Discussion section. The section is divided into 6 subsections.

In the first subsection, the phenological development of coriander is described, taking into account the dates of occurrence of the phenophases. The average duration of the growing season for coriander varieties for the period is between 113 and 118 days. The Moroccan variety has the shortest growing season, followed by the local small-fruited and Jantar varieties, while the Marino and Thuringian varieties have the longest growing season. Applied foliar treatment products affect the duration of flowering in plants and extend it by 1 to 5 days depending on the year and variety.

The next subsection describes the influence of year, cultivar and foliar treatment products on plant biometrics. Averaged over the study period, all tested foliar products helped to increase plant height relative to the control in Moroccan, Local small-fruited and Marino cultivars. Applied foliar products increased the number of umbrells per plant compared to the control. These products have the best effect on the Jantar variety. Averaged over the trial period, the number of seeds per umbrel in all variants varied between 9.6 and 15.6. The Isabion biostimulator had a positive effect on the

indicator in all tested varieties, with the number of seeds per umbrel increasing by an average of 12% in the Moroccan variety, followed by the Marino variety - at 9%, the Thuringian variety - 8.3%, the Local small-fruited variety - 7.4 % and lastly the Jantar variety with 5.2%. In general, for the entire period, a positive effect of the biostimulators on the number of seeds per plant was observed in all tested varieties, with an average increase of 6 (for the Marino variety) to 46 (for the Moroccan variety) compared to the control values. Seed mass per plant in all treated variants was higher than that of the respective controls. The highest values of the indicator were reported for the Moroccan variety treated with Isabion.

In the sub-section 'productive parameters', it was found that the tested foliar treatments helped to increase seed yield in all coriander cultivars. Two-factor analysis of variance showed a strong statistical effect on the seed yield of both cultivars and foliar products. It has been statistically proven that the use of the Energy product has the greatest effect on the indicator of essential oil content. Application of Isabion and Fulvin products increases the essential oil content from 2.9% (Marino variety) to 6.5% (Jantar variety). Regarding the mean values of the essential oil yield indicator, the tested coriander cultivars can be arranged in the following descending order: Local small-fruited > Moroccan > Jantar > Thuringian > Marino. The foliar treatment products used had a positive effect on the crude fat content of the seeds in all studied varieties.

The following subsection describes the quality indicators of the seeds. The largest mass per 1000 seeds was reported for Marino - 6.19 g, and the smallest absolute mass was recorded for the Local small-fruited variety - 4.75 g. The applied foliar products Fulvin and Energy have been proven to increase the values of this indicator compared to the control. The hectoliter mass varies depending on the variety and the 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 Local small-fruited varieties, and the smallest hectoliter mass is registered with the Jantar variety. The studied leaf products have a positive influence on the growth of the hectoliter mass. The linalool content varies between 63.25% and 73.25%. The influence of the Isabion product is most pronounced in the Moroccan, Local small-fruited and Marino varieties. The influence of the preparation Fulvin in the Jantar, Moroccan and Marino varieties is also positive.

In the last section, correlations were made between quantitative and qualitative indicators of coriander. Seed yield is directly related to all other quantitative indicators, with the values of the correlation coefficients varying within narrow limits. Strong positive correlations with seed yield were reported with the growing season, and of the structural elements of the plant, the indicators number of seeds per plant, a mass of seeds per plant and number of seeds per umbrel exerted the strongest influence on seed yield. The correlation between the parameters hectoliter mass and the chemical components γ -terpinene and geraniol was the highest, followed by the parameters γ -terpinene and geraniol and fat content. The correlation between hectoliter mass and crude fat content is strong and statistically significant.

Based on the obtained and analyzed results, the PhD student formulates 14 conclusions, which summarize the research in abbreviated form.

The cited literature shows the excellent theoretical preparation of the PhD student and the high level of awareness of the fundamental and latest scientific achievements on the researched problems both at home and abroad.

6. Contributions of the dissertation.

The excellent theoretical and practical training of the doctoral student, as well as the precisely performed experiments and data analysis from them, enable her to form a total of 9 contributions as follows:

Scientific-theoretical contributions

1. The vegetation period of coriander varieties of different origins, grown under the soil and climatic conditions of the Plovdiv region, has been determined. For the first time, foliar treatment products have been shown to prolong the flowering of coriander plants and increase the length of the growing season.

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

3. It was found that the Isabion biostimulator increased the content of linalool in the essential oil of the varieties Moroccan (by 9.05%) and Local small-fruited (by 5.26%) compared to the control, and the products Energy 20-8-60, Fulvin 40-22 and Isabion did not affect the content of linalool in the essential oil in the varieties Jantar and Thüringen, while the mineral gel fertilizer Energy led to a decrease in the content of linalool in the essential oil (on average by 4.03%) in the variety Marino.

4. The presence of the aldehyde 2E-Tridecenen-1-al was reported under the influence of the treatment with foliar preparations in all tested varieties (concentrations from 0.038% to 0.674%), which was absent in the untreated variants. It was found that the content of aldehydes in the essential oil of the varieties Jantar and Marino was significantly affected by treatment with the Isabion product, with a significant increase compared to the controls.

5. The use of various mathematical and statistical methods provides rich information on all aspects of the influence of the products on the studied varieties. Correlation relationships were established between qualitative and quantitative indicators in coriander varieties. Regression models were built and the influence of the Isabion product on the chemical parameters of the local small-fruited variety with the highest coefficient of determination was proven.

Scientific and applied contributions

1. 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 was found that the Isabion product increased the seed yield by up to 9.9% and the Energy 20-8-60 and Isabion products increased the essential oil yield by up to 18.3% compared to the control depending on the variety.

2. It has been studied and found that foliar treatment products increase the essential oil content of the varieties studied (up to 11.8%), with the product Energy 20-8-60 being the most effective. The foliar treatments used increased the crude oil content of the seeds in all tested cultivars up to 10.0% compared to the controls. Crude fat content was highest when using the product Fulvin 40-22 in Jantar, Moroccan, Local Small-fruited and Thuringian varieties - from 6.4% to 9.8% compared to the control. The strongest effect was reported when applying the product Energy 20-8-60 in the Marino variety - 14.68% compared to the control.

3. It was 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 the local small-fruited 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.

4. 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 notes and questions.

The dissertation submitted for review fully meets the requirements of the Law on the Development of the Academic Staff and the Rules for its Application. The dissertation was written with a lot of effort, effort was put in by both the PhD student and the supervisors.

8. Published articles and citations.

According to the minimum scientometric requirements specified in the Regulations for the Application of the Law on the Development of the Academic Staff, 2 publications related to the dissertation are indicated, which fully cover and even exceed the required number of points. The presented abstract reflects objectively the structure and content of the dissertation work.

CONCLUSION:

Based on the different research methods learned and applied by the PhD student, the correctly performed experiments, and the generalizations and conclusions made, I consider that the presented dissertation meets the requirements of the Law and the Rules of the Agricultural University for its application, which gives me the reason to evaluate it POSITIVELY.

I take the liberty of proposing to the honourable Scientific Jury to also vote positively and award SVETLANA YORDANOVA MANHART the educational and scientific degree "Doctor" in the scientific specialty of Field crops.

22.05.2023
Plovdiv

REVIEWER:
(Prof. Dr. H. Kirchev)