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 production, scientific specialty Agrochemistry

Author of the dissertation: Ivan Dimitrov Velinov, full-time doctoral student at the Department of Agrochemistry and Soil Science at the Agricultural University, Plovdiv

Topic of the dissertation: Effect of nitrogen fertilization on yield and quality of grain sorghum

Reviewer: Assoc. Professor Dr. Galya Dimitrova Panayotova - Trakia University, Stara Zagora, field of higher education 6. Agricultural Sciences and Veterinary Medicine, professional direction 6.1. Crop production, scientific specialty Agrochemistry, appointed as a member of Scientific jury according to Order № RD -16-145/26.02.2021. of the Rector of the Agricultural University - Plovdiv.

1. Brief introduction of the candidate

Ivan Dimitrov Velinov was born in 1991 in the village of Markovo, Plovdiv region. He graduated in 2014 the Agricultural University of Plovdiv with a Bachelor's degree specialty "Agronomy of the tropics and subtropics" and professional qualification "Agronomist". During the period 2014-2016 he studied at the Master's Degree in "Ecology of Settlement Systems" at the University of Plovdiv. In 2015, under the Erasmus program, he studied and successfully completed one semester of the specialty "International Organic Agriculture" at the University of Kassel, Germany. According to the candidate, he is fluent in English and Russian at a good level and has competencies for using various computer programs.

He is enrolled in doctoral studies - full-time of education at the Agricultural University - Plovdiv under the doctoral program "Agrochemistry" with Order № RD-26-23 of 16.02.2017. He was dismissed with the right to defense from 04.02.2020. He has successfully passed all the necessary exams - for enrollment, doctoral minimum of discipline of Agrochemistry, as well as an exam in "Database".

2. Actuality of the problem

The current dissertation considers a problem related to the nitrogen nutrition of one of the main field crops in our country - sorghum for grain. This crop is characterized by high ecological plasticity, high drought resistance and its productive potential is more stable compared to crops such as maize and soybeans. For this main reason, in our country modern sorghum hybrids can be successfully grown in more areas and to replace other crops requiring higher moisture content.

The chosen topic and the tasks of the dissertation are current in scientific and

scientific-applied respect. The topic for study is relevant because nitrogen fertilization is the main agro-technical activity to achieve high and quality yields, but at the same time incorrect and unbalanced use leads to economic, environmental and social problems. Problems in the development of labor cooperation in modern requirements for sustainable production of high and quality results obtain, and to maintain or increasing soil fertility and obtaining optimal indicators. Solving the set tasks helps to develop and apply approaches and methods for optimizing the efficiency of fertilization.

3. Aim, tasks, hypotheses and research methods

PhD student has creatively evaluated the available information on the considered problem, as a result of which he formulated very well his aim and tasks and has selected the appropriate methods for their realization.

The aim of the dissertation was formulated correctly, namely to study the influence of nitrogen fertilization on the productivity, quality and efficiency of nitrogen use in sorghum for grain.

The five main tasks are specific, clearly and precisely formulated, related to establishing the influence of different levels of nitrogen nutrition on the formation of dry mass, export of nitrogen, phosphorus and potassium and their distribution in sorghum under conditions of pot experiments; to study the productivity and the main quality indicators of sorghum grain depending on nitrogen fertilization; to establish the influence of nitrogen fertilization on the accumulation, distribution and reuse of dry biomass, nitrogen and phosphorus in plants; to study the main indicators for agronomic, energy and economic efficiency of nitrogen fertilization in sorghum; to establish mathematical dependences of productivity, grain quality and basic parameters for nitrogen efficiency in order to optimize nitrogen fertilization in grain sorghum.

The sequence of carrying out the research, specified in the "Material and methods" is adequate to the set tasks. I think that the skillfully chosen objects and research methods are the basis for the successful realization of the set goals and objectives.

Two pot experiments were methodologically performed under the conditions of a cultivation facility with sorghum hybrid EC Alize. In the first experiment, the influence of nitrogen nutrition with five N levels on the formation and distribution of dry biomass, N, P and K in the organs of sorghum in stages 4-5 leaf was studied. In the second pot experiment the influence of eight levels of NPK nutrition on the formation of dry aerial biomass, the content of N, P, K and their distribution between the grain and the straw in maturity was analyzed.

In a field trial on alluvial meadow soil under non-irrigated conditions in 2017-2019 the influence of increasing N fertilization in norms from 0 to 30 kg N/da was studied. The plant material - a hybrid EC Alize is well characterized, carefully selected, bearing in mind that it is widespread in all regions of the country and gives a stable yield under non-irrigated conditions.

Field and pot experiments were conducted in a sufficient number of variants and replicates, over years with different climatic conditions, which guarantees high authenticity of the results obtained and analyzes. A large number of soil and plant analyzes, biometric, economic and chemical indicators were followed. The methods and ways of reporting the indicators are indicated. A description of the soil properties and assessment of the agrometeorological conditions for the region has been made. PhD student has successfully mastered and applied modern methods of analysis and appropriate programs for mathematical and statistical treatment of results, which is the reason to accept the results of the study as reliable.

In conclusion, I note that in order to achieve the set goal and tasks, the methodological part is very well planned.

4. Visualization and presentation of the obtained results.

The work on volume, structure and balance between the separate parts fully meets the requirements for dissertation of "Doctor" and is in accordance with Law for Development of Academic Staff and the Regulations for its implementation in AU-Plovdiv. The dissertation is written on 208 pages and contains obligatory parts.

The main section "Results and discussion" is written on 122 pages (58% of the total volume). I can note the great use of statistical methods, which leads to a precise assessment of the data. Based on the results of study, after each part specific conclusions are identified, and at the end of the thesis a summary with 9 conclusions is formulated and scientific and applied contributions are outlined. Four recommendations for the practice are given.

The literature review covers 29 pages and is well structured. It shows a current level of problems and very good information of the doctoral student about previous research in the scientific field of the work. In the literature review, the studies are summarized within three headings, related to the influence of N fertilization on grain productivity and quality, efficiency of reuse of assimilates and basic indices of efficiency in N fertilization of sorghum.

The bibliography includes 278 sources, of which 31 are in Cyrillic and 247 in Latin. The majority part of the bibliographic reference - 212 copies (76.2%) was published after 2000, and 78 sources (28%) were printed after 2010 and contain up-to-date information. The presented literature was used very skillfully to support and explain the data obtained, which helped the doctoral student to outline important theoretical and practical trends in the study area. This enriches the dissertation. The literature review indicates that the Ivan Velinov has acquired a very good awareness of the problem, has enriched his knowledge of what has been achieved so far in this field and is able to creatively analyze and interpret the literature data.

The visualization of the dissertation is very good. The obtained results are correctly described and illustrated with informative, well-formed 10 high-quality figures and well-structured 108 tables. The discussion of the obtained data is done in a convincing style of expression. The factual material is written in concise scientific language, in an analytical and professional style. In general, the presentation of the

results, their illustration, the design of the dissertation is precisely done.

5. Discussion of the results and used literature.

The "Results and Discussion" section includes six interrelated subsections, corresponding to the set aim and objectives. In each of them the rich experimental material is well presented and consistently and analytically discussed. The findings in the individual sections and the conclusions are in good scientific style, in accordance with the obtained data. Emphasis is placed on comparing the results with similar studies by other authors from the country and abroad. Each section ends with a well-formed summary.

The effect of the level of nitrogen nutrition on the dry mass and the content of N, P and K was very well studied in two pot experiments and it was found that the young plants accumulate a larger amount of dry biomass and nutrients at N_{600} and the high level N_{800} significantly reduces the absorbed nitrogen in plant organs. Regarding the influence of the level of mineral nutrition on the yield and content of N, P, K it was found that fertilization $N_{600}P_{200}K_{200}$ most strongly increases productivity, and N concentration in the grain increases at fertilization with high norms of the three elements.

The doctoral student thoroughly examines the formation of grain yield and protein yield in grain depending on nitrogen fertilization under the conditions of field trial and points out that the increase of N norm to 18 and 24 kg N/da has a strong positive effect. Attention is paid to the study of the harvest index of yield, as well as the main quality indicators – test weight and weight of 1000 grains, in which fertilization N_{12} has the best effect.

The content of N, P, K, the export with the grain and straw and the expense of the elements at nitrogen fertilization have been thoroughly studied. The significant influence of nitrogen on the uptake of the three elements can be seen from the fact that at fertilizing with N_{24} and N_{30} the control values are exceeded by 84% for nitrogen, 50% for phosphorus and by 67% for potassium.

Quality indicators such as crude protein, crude fiber, crude fat, ash and nitrogen-free extracts have been identified as relevant in sorghum for determining the energy and nutritional value of grain. The author points out that nitrogen fertilization is a determining factor for the yield of protein in the grain, and at norms N_{18} and N_{24} the highest values for gross energy are obtained.

The author examines in depth the agrochemical efficiency of nitrogen fertilization in sorghum with indicators such as partial productivity, agronomic efficiency, partial nutritional balance, return efficiency, physiological efficiency and internal efficiency of nitrogen use. It is emphasized that the reutilization of N, P and dry biomass has higher values up to norms N_{12} and N_{18}, after which it decreases.

The economic evaluation of nitrogen fertilization in sorghum and the mineral balance of nitrogen, phosphorus and potassium have been developed precisely and thoroughly.

I believe that as a result of the author's in-depth research, a large amount of research work has been carried out, including pot and field experiments, precisely conducted laboratory studies and analysis, the results of which are the basis of the dissertation. The conducted analyzes are interconnected and as a whole reveal the effect of the applied influences. The data are analyzed in a good scientific style with well-selected statistical analyzes and software products. These results enrich the knowledge of sorghum and can serve as a basis for future research. The interpretation of the results is objective and analytical and corresponds to the obtained facts, and their comparison with those of other authors highlights the personal contributions of the author. The conclusions at the end of the sections allow a more accurate formulation of the generalized conclusions. The large volume of research, the skillful presentation of the results and their correct interpretation show a high level of competence of the I. Velinov. The correct Bulgarian language and the missing spelling mistakes make a good impression.

Recommendations for the practice are made in accordance with the obtained results.

6. Contributions to the dissertation.

I support the submitted statement of contributions. They reflect the positive aspects of the dissertation, point out the novelties, are based on specifically established results and conclusions.

I think that in the dissertation there are **scientific-theoretical contributions**. It can be pointed out that the test of a modern sorghum variety in terms of alone and combined nitrogen fertilization for the region of Plovdiv as a whole is a valuable contribution from an agronomic point of view. The obtained new information on the impact of fertilization with increasing norms on the concentration and uptake of N, P, K can serve to justify various scientific tasks in order to optimize economically optimal levels of sorghum nutrition, to develop programs and guidelines to ensure plants with nutrients by appropriate fertilization. Scientific contribution to agrochemical science are the established indicators for the efficiency of nitrogen fertilization. Based on the established regression dependences, grain yield can be prognosticate depending on the level of nitrogen nutrition.

The dissertation has indisputable **scientific-applied contributions** that are useful for agronomic activity. The variety EC Alize stands out as promising in terms of grain and protein yields and has a high harvest index despite years with varying hydrothermal conditions. New data have been obtained on the influence of deficient, optimal and high nitrogen fertilization in different weather conditions on the productivity and quality of sorghum grain. The obtained data on the complex influence of environmental factors on the formation of biomass, yield and quality of sorghum grain can be used in the development of quantitative assessments of the impact of current and expected agrometeorological conditions on plant condition and productivity. The new information on the expense of N, P, K for the formation of 100

kg of grain with a corresponding accumulation of biomass can be used in compiling models for fertilization and process control in the cultivation of sorghum for grain. The research gives an opportunity to improve the technology for growing the sorghum variety. Effective fertilization rates for grain sorghum to increase the profitability of production have been substantiated through economic analysis. The data that the optimal balance in the cultivation of sorghum for grain is created by the applied of moderate nitrogen rate of 18 kg N/da and a phosphorus rate above 5 kg/da is useful for producers.

7. Critical remarks and questions.

I have no critical remarks and questions on the structure and scientific value of a well-developed dissertation. As insignificant remarks I can note:

1. Question to the PhD student: How do you think the proven negative dependence (r = - 0.535 *) between N fertilization and the concentration of nitrogen in the leaves of young sorghum plants would be explained?

2. I consider that the indicators of weight of 1000 grains and test weight are better considered in section 5.4. Basic quality indicators of sorghum, not in section 5.3. Productivity.

3. The standards for weight of 1000 grains and test weight at the present moment have been replaced by newer ones (respectively BGS ISO 520: 2010 and BGS ISO 7971).

4. When designing the work, the text should be before the respective table or figure (For example, tables 8, 9, 16, 26, 30, 31, etc.).

5. Publications should be presented as an imprint of the respective edition.

8. Published articles and citations.

The dissertation is accompanied by three scientific publications related to the study, prepared in a very good scientific style according to the requirements for printing.

One alone article is published in a collection of the International Symposium "Agrosym 2019", and two co-authored were published in the International Journal "Scientific Papers. Series A. Agronomy", Romania. The three publications are printed in English and cover the scientometric requirements for the scientific degree "Doctor" in the amount of 30 points. I have no information and no citations are reflected.

The presented abstract objectively reflects the structure and content of the dissertation, the obtained results and conclusions.

CONCLUSION:

The dissertation shows that the Ivan Velinov has good theoretical training and ability to conduct independent field and laboratory experimental work, has received basic knowledge and skills for research in the field of agrochemistry, can correctly summarize and interpret the results and is built researcher. The dissertation and contributions are the personal work of the author and are the result of three years of

research, including the use of various methods and techniques, derivation of field and pot experiments and the application of modern mathematical and statistical processing of experimental data.

Based on the different research methods learned and applied by the doctoral student, the correctly performed experiments, the summaries and conclusions made, I believe that the presented dissertation is in accordance with the requirements of Law for Development of Academic Staff in Bulgaria and the Regulations of the Agricultural University for its application, which gives me reason to evaluate it **POSITIVE**.

I allow myself to suggest to the esteemed Scientific Jury also to vote positively and to award **Ivan Dimitrov Velinov** the educational and scientific degree "**Doctor**" in the scientific specialty **Agrochemistry** in the professional direction 6.1. Crop production.

Дата: 19.04.2021 г.
Plovdiv

REVIEWER: .....
(Assoc. prof. Galya Panayotova, PhD)