

SCIENTIFIC REVIEW

from the member of the Scientific Review Commission, Assoc. Prof., PhD
Milka Dimitrova-Doneva – Institute of Agronomy – town of Karnobat, Scientific
Division *Crop Production 6.1*, scientific specialty *Crop Production*

Subject: dissertation for educational and scientific degree "Doctor";
Doctoral student (candidate): Dimitrinka Stoilova Krusheva - Scientific Center
for Agronomy – town of Sredets, according to the doctorate procedure opened by
the University of Agribusiness and Rural Development – city of Plovdiv

1. General information:

- this scientific review has been made pursuant to Order No. 417 / 18.12.2021
of the Rector of University of Agribusiness and Rural Development - prof. PhD
Mariana Ivanova - for the appointment of Scientific Review Commission and
assignment of writing a review.

- Author of the dissertation work under review: Dimitrinka Stoilova
Krusheva, doctoral student, carrying out open doctoral study at the University of
Agribusiness and Rural Development – city of Plovdiv.

- Topic of the dissertational work: THE IMPACT OF CERTAIN
TECHNOLOGICAL FACTORS ON THE YIELD POTENTIAL WHEN
GROWING TRITICALE IN THE ENVIRONMENTAL CONDITIONS OF
STRANDZHA MOUNTAIN.

2. Brief biographical data of the PhD candidate.

Dimitrinka Stoilova Krusheva was born on 25 September 1977 in the town of
Sliven. She was awarded master's degree with major in Agronomy at the Burgas
Free University. From 2005 to 2009, she has worked in Big Bulgarian Flour Mills
AD, town of Sredets as laboratory analyst. In 2009, she took the job position of
Agronomist at the Sredets Field Experimental Center. In the same year, after

winning a contest, she was appointed as a scientific research associate at Sredets Field Experimental Center. In 2012, she was appointed as a scientific assistant in Sredets Field Experimental Center (now Scientific Center for Agriculture - Sredets), where she is still working. In 2020, she was enrolled as a doctoral student with an independent form of study in the scientific field *Crop Production* at the University of Agribusiness and Rural Development – city of Plovdiv. Dimitrinka Krusheva has completed the tasks included in her individual curriculum. She has also successfully passed the relevant doctoral exams. She has medium-level command of the English language as well as good computer skills.

3. General presentation of the Dissertation

Triticale is the first man-made crop in the cereal group and in terms of phylogenetics, it is the youngest among them. At present, it occupies about 4 million hectares, out of which over 70% are in Europe. Over the last ten years, triticale fields have increased by 26.8%, which clearly indicates that the species is becoming increasingly important. In Bulgaria, the cultivation of triticale commenced in the early 80s of the 20th century, when the first recognized Bulgarian varieties were created.

Designed to combine the high yield rate of wheat with the unique tolerance of rye to abiotic stress, triticale is a plant to which the modern selection technologies have given completely different characteristics than what the original idea pursued. Current varieties of hexaploid triticale are characterized by high yield, high grain quality and high resistance to many economically important diseases. The new varieties of triticale are equal or even superior to the other grain species in terms of grain, fodder and biomass yield and are used for human or animal food as well as in industrial applications. Along with all these advantages, the crop is less demanding regarding soil and weather conditions. It is often considered an alternative to wheat and other cereals, especially in regions with unfavourable environmental factors. Contemporary triticale varieties show higher yields and better adaptation to poorer and more acidic soils than wheat.

The path for optimal manifestation of the biological advantages as well as adaptation to production conditions passes through improving the technology of growing the crop. This imposes the need for testing individual varieties and study of the cultivation technology in soil and climatic conditions prevalent in the various geographical regions.

The studies on the possibilities for growing triticale in the region of Strandzha Mountain are by far not sufficiently complete and comprehensive. Analyzing the reaction of the crop to the soil-climatic matrix of the region and to the main technological elements (sowing period, seed rate, fertilization rate) will clarify the problem of establishing the optimal level of agronomic parameters enabling the full manifestation of triticale's productive potential. In this sense, the chosen topic and tasks of the reviewed dissertation are relevant and current both in scientific as well as in practical application terms.

The literature review is based on 242 sources, 107 of which are in Latin alphabet languages and 135 in Cyrillic alphabet languages. They cover an 89-year period (from 1930 to 2019) where a fair fraction of them (28%) were published after 2000. The literature review is well structured in four subsections, respectively: 1. Origin of triticale crop and selection and improvement work in the world and in Bulgaria 2. Factors influencing grain productivity and quality. 3. Reaction of triticale to adverse factors 4. Use of triticale.

The studies on selection and improvement work in the world and in Bulgaria are well covered in the dissertation. The results of existing research by Bulgarian and foreign authors on the influence of sowing time, seed rate and fertilization on the biological and economic qualities of the grain have been duly analyzed and compared. The scientific works studying the influence and interactions of environmental conditions on the productivity, structural elements and the tolerance of the species towards different types of stress are properly discussed. The nutritional characteristics of the grain and the possibilities for its broader use are analyzed as well.

The doctoral student demonstrates very good knowledgebase in the field of the dissertation topic. Positive aspect of the review is that it is systematized in sections and the relationship between the individual studies is logical and consistent. This facilitates quite a lot the allocation of unexplained scientific problems and the development of a concept for the solution of such.

The conclusions and the summaries of the literature review have enabled the doctoral candidate to formulate clearly and precisely the **target of the study**, that is:

Study of the complex interaction of the factors (sowing period, seed rate, fertilizer rate) in triticale cultivation under the specific Strandzha Mountain conditions and their influence on grain yield and quality.

To achieve this, three **main objectives** have been outlined, related to the study of growth and development of triticale varieties at different sowing periods in the Strandzha region, establishing the influence of various agronomic factors - sowing time, seed rate and nitrogen fertilization rate on the structure of the crop and the yield components, followed by evaluation and analysis of average yields broken down by said agrotechnical factors in the studied triticale varieties.

The methods and methodological approaches through which the targeted goal and the objectives of the dissertation have been accomplished are appropriately and correctly applied and the analysis of the obtained results has served to confirm the scientific hypothesis which refers to the most optimal choice of combination of agrotechnical factors for obtaining high productivity and grain quality of the tested varieties of triticale, grown in the specific conditions of Strandzha.

The experimental part of the dissertation research was conducted in the experimental field of the Scientific Center for Agriculture – town of Sredets during the period 2011-2013. Subject of study were two varieties of triticale - *Vihren* and *Rozhen TS210B*. On leached cinnamon forest soil, after predecessor crop coriander, a multifactorial field experiment with 72 variants was conducted using the block method. The factors and their levels were studied respectively: Factor D - Sowing

time: D1 - 1-5 October; D2 - 15-20 October; D3 - 1-5 November; Factor B - Seed rate: B1 - 450 germinatable seeds/m²; B2 - 560 germinatable seeds/m²; B3 - 700 germinatable seeds/m²; Factor C - Nitrogen fertilization (against the background P8K6): C1 - N0; C2 - N6; C3 - N10; C4 - N14.

Field and laboratory tests were performed in a sufficient number of replicates over years with varying weather conditions. A large number of biometric, economic and chemical characteristics were monitored - biological (plant growth and development, crop structure, morphological characteristics, yield components); environmental (air temperature, precipitation); laboratory (biochemical and technological). The methods and terms of reporting the values of the characteristics have been described. A presentation of the soil properties and description of the agrometeorological conditions in the region of Sredets have been made. The mathematical and statistical processing of the data derived from the conducted field experiments and laboratory analyzes was done with the SPSS 20 software as well as in EXCEL. All this gives good grounds to accept the results obtained in the research experiments as reliable.

In order to achieve the targeted goal of the doctoral dissertation and solve the respective tasks, the methodical part has been well planned.

The **Results and Discussion** section includes six interrelated subsections, corresponding to the goals and the objectives. In each one of them, the experimental material is well presented. The findings in the individual subsections as well as the conclusions therein are consistent with the obtained experimental data.

The results connected to the first task are well analyzed by the doctoral candidate and provide valuable insight about the specifics in the phenological development and growth of the tested triticales varieties depending on the conditions in the region as well as subject to sowing timing.

The analysis of the agrometeorological conditions during the studied period has allowed the doctoral student to determine the duration of the vegetation period as

well as the specific development of the tested triticale varieties in the interphase periods. She found that the meteorological conditions are the ones to have the strongest impact on the growth and development of the crop. In the three studied sowing periods, the duration of the interphase periods from sowing to germination and from germination to tillering is being limited by the average air temperature. Under identical development conditions, Rozhen has a shorter interphase period from germination to tillering. The interphase tillering-stem elongation period in both varieties, regardless of the sowing period, is shorter, especially in a year of late tillering. Entering the sunlight stage and the impact of the longer daytime explains the shortening of this interphase period. Spring drought appears as an abiotic stress to which the two varieties respond by accelerating their development. Vihren variety enters the ear formation phase 2 to 10 days later than Rozhen. Furthermore, Vihren variety, despite the later entry into the previous phenological periods, ripens 3 - 6 days earlier than the Rozhen variety. Full ripening during the research period occurs between 18 and 26 June for Vihren and between 21 and 30 June for Rozhen.

The conducted research and analysis on the impact of the agro-technical factors on the seed elements, the yield components and on the chemical composition of the grain provide a large database of results and accordingly, possibilities for interpretation. The doctoral student emphasizes on the final results of the impact/interaction of the studied factors. The respective levels have been determined at which the studied characteristics have the highest values. She discovered that the number of germinated Vihren seeds was determined by the seed rate and the fertilization rate, with most plants formed at a seed rate of 700 germinatable seeds/m² and fertilization with 10 kg of nitrogen - 641.25 pcs/m², whilst in the case of Rozhen variety, statistical significance can be attributed to both the seed rate (B) as well as the three-factor interaction between sowing period, seed rate and fertilization rate (D*B*C). It is concluded therefore that the values of this parameter do not depend on the sowing timing.

The plant height and the productivity of the tillering process are characteristics that are predetermined mainly by the hereditary features of the respective genotype. However, they are also influenced to an extent by environmental conditions and the applied agronomic factors. The doctoral student proved by her research that Vihren forms taller plants at the earlier sowing times but Rozhen does so at the later sowing times. The most number of productive tillers in both varieties were formed in D2 but the differences in comparison with the other two scenarios are small. The gradual increase of the seed rate leads to an increase of the values of the plant height in Vihren, while the Rozhen plants are the highest upon the lower seed rate applied. Low seed rates have a positive effect on the number of productive tillers. As far as the singled-out influence of the factors is concerned, the most significant impact on the formation of the both parameters has fertilization. Increase in the nitrogen fertilizations rate results in increase in the plant height and the number of productive tillers in both varieties was the highest at the C3 (N10) fertilization rate. In terms of the height of the Rozhen plants, the interaction of the fertilization with the seed rate was stronger while for Vihren - the fertilization with the sowing timing. It has also been established that the Vihren variety has superior values of the studied sowing characteristics than Rozhen.

It has been pointed out that the studied factors in their single and combined effect affect to varying degrees the formation of the structural elements of the yield. In the case of the Vihren variety, earlier sowing and lower seed rate ensure the greatest ear length, while in the case of the Rozhen variety, the ear length is not significantly influenced by the sowing time and seed rate. In both varieties, the single effect of nitrogen fertilization is clearly expressed. For Vihren, the independent influence of the sowing period and the interaction of the latter with nitrogen fertilization is also significant as well as the interaction between fertilization and the seed rate. Comparing the data, the doctoral candidate revealed that Vihren has formed longer ears, regardless of the action and interaction of the studied factors. The largest average length of the ear for the Vihren variety was

obtained at the combination D1B2C4 - 14.3 cm, and for Rozhen - at the combination D3B3C4 -12.3 cm

Regarding the characteristics *number of grains in a ear* and *weight of the grains in a ear*, the dissertation author has proven that for both varieties the influence of the fertilization factor was statistically significant. The differences in the values of the above two characteristics when analyzed by the factors sowing time and seed rate are small and negligible. It has been stated that despite the smaller number of grains in a ear, the weight of the grains in a ear in the Rozhen variety is greater than that of Vihren.

Dependent on the sowing period, the values of the weight of 1000 Vihren grains are highest in the early period and for Rozhen - in the late sowing period. When combined with the lower (560 germinatable seeds/m²) seed rates, the highest values of said parameter were reported. The significant influence of the fertilization factor and the interaction between the three factors was underscored for both varieties. Of all studied variations, the highest weight per 1000 Vihren grains was reported in the triple combination D1B2C4 -37.00 g, and for the Rozhen variety – in the combination D3B2C4 - 47.525 g.

Regarding the influence of meteorological conditions and agro-technical factors on the quality and chemical composition of the grain, higher percentage of crude protein was reported in 2012 which was characterized by higher temperatures during the vegetation season. In 2011, higher content of phosphorus, lysine, starch, fat and fiber was noted in the Rozhen variety. Regardless of the sowing time and seed rate, the least crude protein content in the grain is observed in the unfertilized scenarios. With increase in the fertilization rate, increased protein content was also reported. In early and late sowing, regardless of fertilization levels, Vihren accumulates more crude protein than Rozhen.

The interaction of the factors in the combination D2B2C3 provides high content of lysine in the grain. For the Vihren variety it is 3.88% and for the Rozhen variety - 3.60%.

The late sowing of both varieties leads to increase of the percentage of phosphorus while no correlation was found due to the factors studied in terms of the potassium content variation.

The percentage of starch and ash decreases with the increase of the fertilizer rate for both varieties. For Rozhen, it was found that the increase of the nitrogen fertilization results in increase of the content of the fats and decrease of the content of the fibers. For Vihren, the correlation is the other way around.

In the analysis of the grain yield formation under the impact of the factors tested, as well as in the evaluation of the differences between the separate variants, the doctoral candidate summarizes that for both varieties the tested factors, both independently and in combinations, have a statistically significant impact on the yield formation. In the different combinations (a total of 36) between the factors studied, the increase varies. The evaluation of the differences based on the criterion (t) of Student and the limit differences (GD) as per Fischer give an answer in terms of their reliability and level of proof.

The author has found that, depending on the sowing time, approximately the same average yields are obtained for Vihren and for the Rozhen variety the yield is higher upon 15-20 October sowing. It is proved to be higher than the one reported during the first sowing time even at the lowest level of reliability. Depending on the seed rate for the two varieties, a higher proved yield is obtained with B2 and B3 as compared to B1 and the difference between the second and the third degree of the seed rate factor, notwithstanding the sowing time, is statistically unreliable. The increase of the level of nitrogen fertilization (C) increases the yield and its differences between the degrees of that factor are statistically reliable. From the combinations of the sowing time factor (D) and fertilization for the Vihren variety, the highest yield obtained is with D2C4. The differences in the yield reported at fertilization rates N10 and N14 (C3 C4) and with the three sowing times are statistically unreliable. That means that the lower fertilization rate also has approximately the same effect on the yield formation. From the combination of the

seed rate (B) and fertilization (C) factors for the Vihren variety, the highest grain yield is reported with B2C4 variant and for the Rozhen variety – with B3C4 variant. Higher yields are reported at the highest fertilization rate (N14)- C4, notwithstanding the seed rate. The differences for the two varieties are statistically significant.

For the two varieties, the highest yield is obtained with D2B2C4 and D3B2C4 combination. For the Vihren variety it is 562.25kg/da and 563.25kg/da and for Rozhen -552.00 kg/da and 544.50 kg/da, respectively.

Based on the experimental work performed and the results obtained, the doctoral candidate Dimitrinka Krusheva has formulated four summarized conclusions which I accept.

4. Assessment of the structure and contents of the dissertation paper and opinion on the correctness of the author's summary of the dissertation paper.

The structure of the dissertation work under review is with a classical heading and arrangement of the sections, i.e.: Introduction - 2 pages; Literary Review – 22 pages; Target and Objectives – 1 page; Material and Methods – 7 pages; Soil and Climate and Agrotechnical Characteristics of the Region – 17 pages; Results and Discussion – 84 pages; Conclusions – 2 pages; Contributions – 1 page; Literature – 28 pages.

The content of the dissertation is well balanced and facilitates the comprehension and understanding of the text. The dissertation paper is written on 162 pages with a clear prevalence of the sections on the results and their analysis presented in 36 tables, 26 figures. The tables are informative, well structured, with clear and precise headings, with the required statistical and mathematical processing, the figures are presented in an aesthetic manner, they illustrate and supplement the analyses made.

The dissertation work is written in a good scientific style.

In terms of volume and structure, it meets the requirements of the Act on Academic Staff Development in the Republic of Bulgaria.

The author's summary of the dissertation paper presented consists of 48 pages. It reflects objectively the structure and contents of the dissertation paper. The author's summary of the dissertation paper ends with a short summary in English language which is very valuable and an obligatory requirement for such type of papers.

5. Determination and evaluation of the scientific and applied-science contributions in the dissertation paper

- The contributions reflect objectively the results obtained, the new elements, they are based on the established conclusions. I accept and positively evaluate the three summarized practical application contributions formulated by the doctoral candidate:

- The interaction of the main agrotechnical factors (sowing time, seed rate and fertilization rate) of the triticale Vihren and Rozhen varieties under the conditions of Strandzha Region has been comprehensively studied.

- A complex evaluation of the impact of the main agrotechnical factors and their effect on the yield of triticale from the Vihren variety and the Rozhen variety was made. The results can be used for optimization of the technologies for triticale cultivation in Strandzha Region.

- The study found that for the two varieties, when grown in the Strandzha Mountain Region, the most appropriate sowing timing is in the period 15-20 October, at a seed rate of 560 germinatable seeds/m² and fertilization with N14 kg/da.

6. Publications and participation in scientific forums.

The reference provided to me on publications with regard to the dissertation paper contains information about five written scientific articles – two independent (certificates are presented that the articles are accepted for print by the editorial board of The New Knowledge Magazine which is an academic publication of University of Agribusiness and Rural Development (UARD)), two in co-authorship and one of them with the doctoral candidate as the first author. The total

number of points (31.67 points) meets the minimum scientometric requirements for obtaining of an academic doctoral degree, as per Act on Academic Staff Development in the Republic of Bulgaria, Rules for Application of Act on Academic Staff Development in the Republic of Bulgaria and the Rules of UARD - Plovdiv.

7. Critical notes and recommendations

A few recommendations can be made to the dissertation paper:

- Besides stating the results obtained, it will be advisable for the doctoral candidate to pay more attention in her next papers to the discussion of the obtained results and their comparison with results obtained by other authors in similar research projects.

- In my opinion, more contributions could be derived and they can be summarized in the following groups: contributions of scientific nature: contributions of applied-science nature and contributions of applied nature.

- My recommendation to the doctoral candidate is to continue her research on different elements of the cultivation technology with new triticale varieties and to deepen her work in search of relations between the different parameters and their mathematical and statistical processing.

8. Questions

What approaches would the doctoral candidate apply in order for the information and the optimization recommendations contained in the dissertation paper to reach farmers as soon as possible?

The recommendations (notes) made by me hereinabove should not undermine the significance of the dissertation work and do not affect my general positive evaluation of the scientific research made by Dimitrinka Krusheva. They could be taken into consideration in her future research.

9. Conclusion

The dissertation work reviewed herein fully meets the requirements of Act on Academic Staff Development in the Republic of Bulgaria, Rules for Application of

Act on Academic Staff Development in the Republic of Bulgaria and the Rules of UARD for obtaining of an academic doctoral degree. The research methods learned and applied by the candidate, the properly conducted experiments, the summaries, conclusions made and the formulated contributions give me all good reasons to evaluate the dissertation POSITIVELY. Accordingly, I would like to respectfully propose to the Scientific Review Commission to also vote positively and award Dimitrinka Stoilova Krusheva the academic degree ***Doctor of Science*** in the scientific division *Crop Production 6.1*, scientific specialty *Crop Production*.

03.02.2021

town of Karnobat
Doneva)

SCIENTIFIC REVIEWER:

(Associate Professor Milka Dimitrova-