



## REVIEW

of the dissertation thesis for awarding the educational and scientific degree "Doctor",  
in the field of higher education 5. Technical sciences,  
professional field 5.13. General engineering,  
doctoral program Mechanization and electrification of crop production.

**Author of the dissertation:** M.Sc. Eng. Iliyan Bozhidarov Bozhkov, doctoral student of independent training at the "Agricultural Mechanization" department at the Agricultural University, Plovdiv

**Dissertation topic:** „Stepless adjustment of the sowing rate for the Saxonia A200 row drill”

**Jury member:** Prof. Georgi Dimitrov Kostadinov, PhD - Institute of Soil Science, Agrotechnology and Plant Protection "N. Pushkarov", the scientific specialty "Mechanization and electrification of crop production", designated as a member of the scientific jury order No. RD-16-366/12.03.2024 of the Rector of AU-Plovdiv.

### 1. Brief presentation of the PhD student

Engineer Iliyan Bozhidarov Bozhkov was born in the village of Malo Konare, Plovdiv region on 28.04.1980. He received a Bachelor's degree at the Agricultural University - Plovdiv in 2007, majoring in "Agronomy", professional qualification "Agronomist". The following year, he received a Master's degree in the same specialty and in 2011 a semi-master's degree in the specialty "Agricultural Technology", professional qualification "Agroengineer". He worked as the chair of the committee at the Annual Technical Inspection Point and since 2013 he has been the Chief Inspector at the ODZ in Pazardzhik, with responsibility for Control and registration of agricultural machinery. By Order RD-2643/30.05.2022 of the Rector of AU, he was enrolled as a doctoral student of independent training on 15.04.2022. He was dismissed with the right of defense by Order RD-2624/13.03.2023 on 28.02.2023

Uses Russian and French languages, Microsoft Office, CorelDRAW, Internet, etc.

### 2. General characteristics of the dissertation and abstract - volume and structure

The dissertation contains: List of used abbreviations and symbols, Introduction, four chapters (Analysis of the state of the problem, General methodology, Theoretical justification of stepless management of the sowing rate, Experimental studies) Conclusions, General

conclusions, Used literature and Appendices. The content of the dissertation is presented on 114 pages, and the note is illustrated with 22 figures and 16 tables. The used literary sources are 112 items, of which 81 items. are in Cyrillic, 18 pcs. in Latin and 13 pcs. from electronic sites. The appendices include 6 specifications of the electronic components used.

### **3. Relevance of the problem**

Grain production is a complex process that requires careful planning, management and investment to ensure maximum yield under specific conditions. Grain production is continuously improved through the application of newer technological solutions and innovations. This includes the use of more efficient varieties, the use of modern agricultural machinery, advanced irrigation systems and precision farming, which uses data on regional conditions and allows optimization of the production process.

One of the main technological processes in grain production is sowing. The yield and quality of the obtained grain depend to a significant extent on its quality. Sowing is carried out by the sowing apparatus, which is one of the most important organs in the seeders. It plays a major role in the dosing, distribution and delivery of the seed material.

After a thorough analysis of the different types of seed drills, their advantages and disadvantages, the author defines the main problems with the widely used gear and chute type seed drills. Clarifies the causes of uneven feeding, seed trauma and problems with the transmission and regulation systems used in row drills.

On this basis, the purpose of the research and the tasks that must be solved for its achievement are defined.

### **4. Purpose, tasks, hypotheses and research methods**

The aim of the research is to develop a system for stepless adjustment of the seeding rate in planters for crops with a "fused surface".

Its achievement is ensured by solving the six tasks set:

1. Determination of the theoretical prerequisites for stepless regulation and maintenance of the sowing rate for wheat under variable working conditions;
2. Determining the necessary power to drive the sowing devices of the Saxonia A200 seeder;
3. Determination of the sown quantity of wheat seeds for one revolution of a toothed (pin) sowing device;
4. Determination of the functional relationship between the transmission number in the transmission mechanism, the density of the seeds and the quantity of sown seeds;

5. Development of a version of an electronic system for managing the sowing rate for the Saxonia A200 row drill;

6. Determining the reduced operating costs depending on the transmission mechanism (mechanical or electronic) used in the row drill when sowing cereals with a "fused surface".

#### OBJECT OF THE RESEARCH

Sowers, their technological indicators, transmission and regulation mechanisms in row drills.

#### SUBJECT OF RESEARCH

The parameters and modes of operation of the seeders, the influence of the physical and mechanical parameters of the seeds (in particular, their density) on the sown quantity, the parameters of components for building an electronic system for monitoring and controlling the sowing rate in the operation of row drills and their economic indicators.

The author logically moves from the analysis of the state of the problem to its theoretical statements. The main parameters of the sowing machines were analyzed. The power required to drive them is determined. The correspondence of the technological processes with the biological characteristics of the seeds was analyzed. Defined are the reduced operating costs depending on the transmission mechanism used in the row drill when sowing cereals with a "fused top". A stepless control of the seeding rate is theoretically justified using a mechatronic system with a direct current and an alternating current motor for driving the shaft of the seeders.

### **5. Significance and persuasiveness of the obtained results, interpretations and conclusions**

In the fifth chapter of the dissertation, the doctoral student presented the results of the planned research. He determined the power required to drive the sowing devices of the Saxonia A200 planter and the amount of wheat seeds sown in one revolution of a toothed (pin) sowing device depending on the gear of the reducer. He determined the functional relationship between the transmission ratio in the transmission mechanism, seed density and the amount of seed sown. On the basis of the selected seed drill, Saxonia A200 has determined the reduced operating costs depending on the used transmission mechanism (mechanical or electronic) when carrying out sowing of cereals with a "fused surface".

The main approach that the doctoral student uses is the cybernetic one - it has long been in vogue and has been imposed in experimental research in all fields. For this purpose, he creates a suitable experimental setup that allows the main kinematic, structural and technological parameters (factors) to be managed, and to be easily and accurately measured. The multifactorial experiments were conducted on the 2nd-order designs of type  $B_2$ , which are among the best quasi-D-optimal designs. Data processing was performed with one of the most common software packages, Statistica.



## **6. Contributions**

I essentially accept the scientific-theoretical and scientific-applied contributions formulated by the author. They confirm the fulfillment of the set goal and reflect the results obtained. From my point of view, some of the contributions could be better edited, because in this form with specifying values, they are closer to defining conclusions.

Taking into account the results achieved and interpreted by the author, from my point of view, the contributions can be attributed to:

### **PROVING SIGNIFICANT NEW SIDES OF ALREADY EXISTING THEORIES AND HYPOTHESES BY NEW MEANS**

The transmission function in a mechatronic system, which controls and supports the process of sowing seeds in the Saxonía A200 planter, has been theoretically determined.

The functional relationship between the density of the seeds, the transmission ratio and the quantity of sown seeds was established.

The gear ratio was found to have a stronger effect on the variation in the amount of seed sown compared to the seed density.

It has been proven that the type of drive system (mechanical or electric) of the seeder's sowing devices does not have a significant impact on the reduced operating costs.

### **CREATION OF NEW CLASSIFICATIONS, METHODS, CONSTRUCTIONS, TECHNOLOGIES**

Two versions of the mechatronic system for controlling the seeding rate for the Saxonía A200 seeder have been developed - with a DC and an AC motor.

A methodology has been developed for determining the main parameters of the electric drive of the sowing devices of the Saxonía A200 planter.

### **OBTAINING AND PROVING NEW AND CONFIRMATIVE FACTS**

The amount of wheat seeds sown in 1 revolution of the toothed (pin) sowing device of the Saxonía A200 seeder is determined.

## **7. Evaluation of the quality of scientific publications reflecting the results in the dissertation**

The main results of the dissertation work of mag. Eng. Iliyan Bozhidarov Bozhkov are reflected in 5 of his publications, all in English. The published materials reflect the main part of the conducted research. All published publications are co-authored, with two of them being the first author, two others being the second author, and one being the third author. Three of the publications are indexed in Scopus. According to the scientometric indicators, it scores 50 points, thereby exceeding the minimum requirements of the Law and the Regulations for its application. I have no citation information for the publications.

## **8. Evaluation of the abstract**

The author's abstract presented by the doctoral student has a volume of 37 pages and objectively reflects the structure of the dissertation work, the obtained results and conclusions. It is presented in Bulgarian and English. The author's views on the contributions achieved are also presented. A list of publications related to the dissertation work is attached.

## **9. Personal contribution of the author**

From the approval of the materials related to the dissertation, it is clear that the development is exclusively the work of the doctoral student, but under the expert and exacting control and assistance of his supervisor.

## **10. Questions, critical remarks and recommendations to the candidate**

Is there a difference, and what, between the variance and the mean-square deviation?

Controlling or controlled factors is the correct expression?!

What is meant by the term "Seed Amount"? Quantity as number, as mass or as volume?!!

What does the author mean by using the term «speed of rotation (n)»?

The author on page 87 of the Dissertation claims "It can be seen that with an increase in density, the amount of seeds sown increases linearly" - it is not clear where this is seen from?!

Fig. 2 there is no explanatory text in the Abstract. At the same time, the markings in fig. 2 differ from those in the formula proposed on the basis of the graph.

Fig. 8 is illegible.

In a scientific text, the SI system should be used. Mass instead of weight, hectare instead of acre, rotational frequency instead of revolutions, etc.

It is inappropriate to use expressions such as «unprecedented opportunity» in a scientific text.

The interpretation of discrete variables as continuous is incorrect - Abstract fig. 7 (Dissertation fig. 4.2.).

No «With the averaged data from table 12, a regression analysis was carried out using the program product Statistica v.7.» and with the data from Table 12.

The proposed regression model is not written correctly.

## Conclusion

The notes and recommendations made do not detract from the knowledge and skills demonstrated by the doctoral student. The presented work, in terms of its research volume, content and contribution, fully meets the requirements of ZRASRB and the Regulations of the AU for its application, and I give it an overall **positive assessment**. The basis for this assessment is the achieved goal, the demonstrated knowledge, the use of a modern methodical approach, technical and software tools and the results obtained.

I offer the doctoral student a M.Sc. Eng. Iliyan Bozhidarov Bozhkov to be awarded the educational and scientific degree "Doctor" in the scientific specialty / doctoral program "Mechanization and Electrification of Crop Production" in the professional direction 5.13. General engineering.

07.05.2024

Jury member:

  
/Prof. G. Kostadinov/