



REVIEW

on a dissertation work 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: **Crop Production**

Author of the dissertation: Bozhidar Frantsov Tanchev enrolled in the PhD program, full-time study form, at the Department of 'Crop Science' at the Agricultural University, Plovdiv

Dissertation topic: 'Reactions of Bulgarian sunflower hybrids (*Helianthus annuus* L.) to contrasting agroecological conditions'

Reviewer: Assoc. Prof. Dr. Daniela Valkova Yaneva, Dobrudzha Agricultural Institute, Agricultural Academy, field of higher education: 6. Agricultural Sciences and Veterinary Medicine, professional field: 6.1 Crop Production, scientific specialty: Selection and Seed Production of Cultivated Plants, appointed as a member of the scientific jury by order № РД 16-476/02.04.2026г. from the Rector of AU-Plovdiv.

1. Brief presentation of the candidate.

Bozhidar Frantsov Tanchev was born on 11.06.1998 in the city of Plovdiv. Graduated from secondary education at FEG "Antoine de Saint-Exupéry" – Plovdiv in 2017, with a profile in English language, after which he studied at the Agricultural University – Plovdiv as a bachelor's degree in Agronomy – Crop Production during the period 2017-2021 and was awarded as an honors graduate of the class and as a master's degree in the pilot course in Digitalization and Crop Management during the period 2021-2022. In 2023, he was enrolled as a regular doctoral student at the Department of Crop Science at the Agricultural University, Plovdiv. Throughout his entire period of study, he worked as an equestrian sports instructor, mainly developing children and adolescents. In 2025, he participated in the Erasmus BIP project 'Plant Breeding For Extreme Environment' – Iceland.

2. Relevance of the problem.

For countries with a temperate climate, including Bulgaria, sunflower is the most important oilseed crop. This is mainly due to the high nutritional and biological value and the very good taste qualities of sunflower oil. The economic significance and wide distribution of sunflower are due to the complex qualities of sunflower seeds, whose main components are oil and protein content. Without diminishing the protein content of the seed and its nutritional value, it should be noted that sunflower is mainly used as a source of oil. Its particular value is determined by the unsaturated fatty acids it contains – linoleic C /18:2/ and oleic C /18:1/, and the saturated fatty acids stearic C /18:0/ and palmitic C /16:0/. The share of the first two reaches 90% of the sum of all fatty acids. As a result of numerous studies, it has been found that oils containing 65-75% linoleic acid are more valuable for technical purposes and less suitable for food, since they are not stable in storage and oxidize during food preparation.

For culinary purposes, it is desirable for oils to contain a moderate amount of linoleic acid and an increased content of oleic acid, so that their quality does not deteriorate when heated. Due to the fact that it is a trench crop, sunflower helps in the correct crop rotation, being the main predecessor for cereal crops. Sunflower is widely used in the food and pharmaceutical industries. It is used as a technical and fodder crop, as an ornamental plant in the floriculture industry. Its economic importance is also enhanced by the fact that it is an extremely attractive plant for honey bees. In recent years, the use of sunflower as a source for obtaining biodiesel - a promising and environmentally friendly fuel that is obtained from annually renewable sources and does not pollute the environment - has gained importance. Sunflower producers are striving to use high-yielding hybrids that have the ability to overcome constantly changing stress factors, such as changes in environmental and meteorological conditions, and attacks by sunflower pests. Changes in the dynamics of the sunflower seed market show that farmers are actively moving towards sunflower hybrids that are best adapted to the local soil and climatic features of the environment, which maintain stable yields during drought and temperature stress, and irregular and unevenly distributed precipitation. The wide application of sunflower justifies the need for expanding improvement work and determines the diverse directions in its cultivation.

The importance of this economically important crop for our country requires detailed research on the agronomic aspects of its production. Correct agroclimatic zoning is necessary to determine the factors limiting the growth and development of sunflower and to identify measures to reduce their negative impact.

The correct selection of hybrids for individual regions of the country could be an effective strategy for adapting to climate change and lead to higher productivity and stability of sunflower seed production.

All this gives me sufficient reason to note that the topic of the developed dissertation is relevant and useful.

3. Purpose, tasks, hypotheses and research methods.

The aim is formulated correctly, specifically and precisely. The specified and developed tasks are in connection with the set goal and concern:

- study of the phenological development of sunflower in order to establish the duration of the interphase periods depending on the agroecological growing regions;
- study of indicators related to the productivity of sunflower hybrids depending on soil and climatic conditions;
- determination of the qualities of their seeds, oil and meal under contrasting environmental conditions;
- determining the productive stability in characterizing the genotype x environment interaction;
- establishing correlations between the studied quantitative and qualitative indicators in the studied sunflower hybrids.

The study was conducted in two agroecological regions - the village of Zhitnitsa, Kaloyanovo municipality, Plovdiv region and the village of Petleshkovo, General Toshevo municipality, Dobrich region in the period 2023-2025. The two parallel field trials included Bulgarian sunflower hybrids created at DAI: Dalena CLP, Sunny IMI CLP, Enigma CLP, Deveda and Krasela, as well as one foreign hybrid P64LP170.

Methodologically, the experiments were set up and conducted correctly under field conditions, in compliance with the specified agrotechnical measures that create a favorable

environment for plant development. The selection of studied indicators was precisely specified correctly. Ten biometric traits were determined, six characters concerning productivity, seven characters characterizing the quality of seeds, oil and meal. Soil agrochemical analyses and seed analyses were conducted annually according to standard methodology.

To establish statistically significant influences of the studied factors, a two-way analysis of variance (ANOVA) was applied. To determine the stability of the studied hybrids, Wricke's ecovalence (W_i^2), Shukla's stability variation (σ^2_i) and Plaisted and Peterson's stability parameter (θ_i) were used. Stability analysis was also performed using the AMMI (Additive Main Effects and Multiplicative Interaction) model and GGE Biplot (Genotype main effect + Genotype-by-Environment interaction) analysis. Correlation analysis was used to calculate the relationships between the studied traits.

4. Visualization and presentation of the results obtained.

The dissertation submitted for review is 162 pages long, including 26 tables and 27 figures. The literature sources are 167, of which 14 are in Cyrillic. The dissertation is well balanced and structured, covering all sections.

The literature review is comprehensive, presented on 27 pages and includes 6 subsections: From the American steppes, through botanical gardens to industrial processing; Beginning of scientific research with sunflower. Breeding methods; Sunflower hybridization; Sunflower breeding in Bulgaria; Main directions in sunflower cultivation; Sunflower response to different agroecological conditions.

A detailed soil and climatic characteristic of the Plovdiv and Dobrich regions has been made, presented on 12 pages. Based on the data, it is indicated that the climatic conditions in the two regions are very different from the average multi-year ones. The information presented is systematized and well-illustrated. The results from the two test regions are presented and interpreted correctly.

The statistical software products used contribute to the reliability of the data obtained and the good visualization of the presented results.

5. Discussion of the results and used literature.

The obtained results are presented in six main areas: Phenological development; Plant structure; Productive indicators - yield of seeds, oil, meal; Qualitative indicators - quality of seeds, oil and meal; Stability of sunflower hybrids in the interaction genotype x environment; Correlation dependencies between the quantitative and qualitative indicators of sunflower hybrids.

Based on the conducted research, data from statistical analyses and competent interpretation of the results, the doctoral student formulates reliable conclusions. They are presented in a logical sequence.

1. The growing season of sunflower in the Plovdiv region is about 120 days, and in the Dobrich region – 135 days. The first year of the study is an exception due to the sharp cold snap after sowing and prolonged germination, which extended the growing season in the Plovdiv region.
2. On average for all hybrids in the Plovdiv region, plants are formed from 36% stems, 19% leaves, 18% pistil and 27% seeds. In the Dobrich region, the stem occupies 33%, the leaves – 20%, the pistil – 16% and the seeds 31%.
3. Seed yield from the hybrids P64LP170, Deveda, and Enigma is higher in the Dobrich region, and from Dalena, Krasela and Sunny - in the Plovdiv region. In the region of Southern Bulgaria the highest yield was recorded for the Sunny hybrid – 180.3 kg/da, and in Dobrudzha from the

P64LP170 standard – 187 kg/da.

4. The oil yield is higher in the conditions of Dobrich, with the exception of the Sunny hybrid, which forms a higher oil yield in Plovdiv. In the Dobrich region, the most oil per unit area was obtained from the Deveda hybrid.

5. The harvest index of the plants is higher in the Dobrich region, with the exception of the Sunny hybrid. In the Plovdiv region, the share of seeds in the cob is highest in the Sunny hybrid, and in Dobrich in the P64LP170 standard. In both regions, the highest harvest index of seeds was recorded in the Krasela hybrid.

6. In the P64LP170, Dalena, Enigma and Krasela hybrids, the oil content in the seeds is higher in the Plovdiv region compared to that in Dobrich. The Sunny hybrid is the highest-oil in both regions.

7. The character weight of 1000 seeds for the hybrids P64LP170, Dalena, Krasela and Sunny is higher in the Plovdiv region compared to that in Dobrich, and for Deveda and Enigma – the opposite. In both regions, the weight of 1000 seeds is the highest for the hybrid Sunny IMI. The hectoliter weight is highest in both regions for hybrid Krasela.

8. The content of saturated fatty acids in all hybrids is higher in the Plovdiv region and of unsaturated fatty acids – in the conditions of Dobrudzha. The content of saturated fatty acids is highest in both regions in the Deveda hybrid, and of unsaturated fatty acids in the Sunny hybrid.

9. All hybrids accumulate more linoleic acid in the Dobrich region. The highest content of linoleic acid in both regions is observed in the Deveda hybrid. The lowest content of linoleic acid in both regions is observed in the Sunny hybrid, which is also the highest oleic.

10. The content of crude protein in the seeds is higher in the Plovdiv region in all studied hybrids. In both regions, the most protein accumulates in the P64LP170 standard, which also has the highest content of the three limiting amino acids (lysine, methionine and cystine).

11. With the lowest values of the ecovalence, variation and stability parameter is the hybrid Enigma, which can be defined as the most stable. The second in rank is the hybrid Dalena, the third - Sunny, the fourth Deveda and in the last places as the most unstable in terms of yield are the hybrids P64LP170 and Krasela. This is largely confirmed by the grouping of the hybrids using the AMMI and GGE Biplot models.

12. Strong positive correlations of seed yield have been reported with oil yield, and of the structural elements of the plant, the weight and number of seeds per head have the strongest influence on yield. The absolute values of these traits also have a very low correlation variance, which further proves the strong effect of the traits on seed yield.

13. A positive and proven relationship of oil content was reported only with hectoliter weight. The remaining reliable correlations are negative – with the content of crude protein and the content of saturated fatty acids, which is mainly related to stearic acid, for which the correlation variance is the lowest.

6. Contributions of the dissertation work.

The contributions formulated by the PhD student fully correspond to the presented and analyzed results.

Four scientific-theoretical and four scientific-applied contributions have been defined.

Scientific contributions

1. It has been established that the growing season of sunflower in the Plovdiv region is shorter than that in Dobrich by an average of 15 days, except in cases where there is a cold snap after sowing and prolonged germination, which prolongs the growing season.

2. The proportion of plant organs has been established. The proportion of stems and pistils

is greater in the Plovdiv region, and in the Dobrich region – leaves and seeds.

3. The study distinguished the Enigma hybrid as the most stable. The Dalena hybrid ranks second, the Sunny hybrid third, the Deveda hybrid fourth, and the P64LP170 and Krasela hybrids in last place as the most unstable in terms of yield.

4. A positive correlation was found between seed yield and oil yield, mass and number of seeds in the kernel. A positive correlation was found between oil content and hectoliter weight, and a negative correlation was found between oil content and crude protein content.

Scientific and applied contributions

1. The combination of climatic conditions in the individual regions is specific and allows for differentiation of the tested hybrids at different levels of abiotic stress during the individual phenological phases. The accumulated information is suitable for refining the cultivation technology under the conditions of Southern and Northern Bulgaria in a risky environment.

2. It has been studied that in the region of Southern Bulgaria the highest seed yields were recorded for the Sunny hybrid, and in Dobrudzha for the P64LP170 standard. In the region of Dobrich the most oil was obtained from the Deveda hybrid, and in Plovdiv – from the Sunny hybrid. In both regions the highest meal yield was obtained from the P64PL170 standard.

3. It has been established that the Sunny hybrid is the highest oil yield in both regions, with the highest mass per 1000 seeds. For all hybrids, the mass of seeds in 100 l volume is greater in the Dobrich region. The hectoliter weight is the highest in both regions for the Krasela hybrid.

4. It has been studied that in both regions the highest linoleic is the hybrid Deveda, and the highest oleic is the hybrid Sunny, and the crude protein content in the seeds is higher in the Plovdiv region. In both regions the highest protein, lysine, methionine and cystine accumulate in the P64LP170 standard.

7. Critical notes and questions.

The information presented in the literature review about the collection created at the Dobrudzha Agricultural Institute could be enriched with more data. It is the only stationary collection of wild sunflower species in Bulgaria, which includes 175 accessions of annual and 215 accessions of perennial wild species. It was created in the period 1970-1980 and is enriched periodically.

Bulgaria often ranks first in the EU in sunflower seed production, and in 2022 it was in first place. What recommendations would you give for the wider implementation of Bulgarian sunflower hybrids?

I recommend that the PhD student continue his research in this scientific field, expanding and deepening his research.

8. Published articles and citations.

The main results of the dissertation work are presented in two articles published in the journal Research Journal of Agricultural Science. In them, the doctoral student is the lead author, which clearly defines his personal contribution in writing them. The publications have the necessary scientific value. The journal is referenced and indexed in Web of science (All databases).

The presented abstract objectively reflects the structure and content of the

dissertation.

Conclusion:

Based on the various research methods learned and applied by the doctoral student, the correctly conducted experiments, the generalizations and conclusions made, I believe that the presented dissertation meets the requirements of the Law on the Protection of Scientific and Technological Research of the Republic of Bulgaria and the Regulations of the Agricultural University for its application, which gives me reason to evaluate it **POSITIVELY**.

I would like to propose to the esteemed Scientific Jury to also vote positively and award Bozhidar Frantsov Tanchev the educational and scientific degree of "**Doctor**" in the scientific specialty "Plant Science".

Date: 05.05.2026
city of Plovdiv

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