



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 Science, Scientific specialty Crop Science.

Author of the dissertation: Bojidar Frantsov Tanchev, PhD student (full-time) at the Department of Agronomy at the Agricultural University, Plovdiv.

Topic of the dissertation: Reactions to Bulgarian sunflower hybrids (*Helianthus annuus* L.) to contrasting agroecological conditions.

Reviewer: Prof. Dr. Nurettin Tahsin Tahsin, Agricultural University, Higher Education Department 6. Agricultural Sciences and Veterinary Medicine, professional field 6.1 Crop Science, Scientific specialty Crop Science.

Appointed as a member of the scientific jury by order No. RD-16-476/02.04.2026 by the Rector of the Agricultural University, Plovdiv. Elected as a reviewer at the first meeting of the scientific jury.

1. Brief presentation of the candidate.

Bojidar Frantsov Tanchev was born on 11.06.1998 in the city of Plovdiv. He graduated from secondary education at the "Antoine de Saint Exupery" High School - Plovdiv in 2017, with a major in English, after which he studied at the Agricultural University - Plovdiv as a bachelor's degree in Agronomy - Field Crop Production in the period 2017-2021 and as a master's degree in the pilot course in Digitalization and Management of Plant Production in the period 2021-2022. In 2023, he was enrolled as a full-time doctoral student at the Department of Crop Science at the Agricultural University, Plovdiv. Throughout the entire period of his studies, he also worked as an equestrian instructor developing mainly children and adolescents. In 2025, he participated in the Erasmus BIP " Plant Breeding For Extreme Environment " – Iceland.

2. Relevance of the problem .

Sunflower is the second largest agricultural crop in Bulgaria and the most widespread and important industrial and oil-producing plant, although sunflower has been grown in our country only since the beginning of the 20th century. The first experiments with sunflower in Bulgaria were carried out at the Experimental Station "Obraztsov Chiflik", near the city of Ruse in 1903. After the Balkan Wars, especially the Inter-Allied War, when the import of olive oil to Bulgaria stopped, there was an acute need for vegetable oil for the population. This led to a rapid expansion of the sunflower areas. For the first time, sunflower was grown on a large scale after 1917, when production has been continuously increasing to the present day, due to an increase in areas and also due to an increase in average yields. The rise in sunflower production increased sharply after the beginning of the 1980s, due to the introduction of hybrids, which, compared to the varieties grown until then, have high resistance to diseases and the Blue Kitta parasite, increased oil content in the seeds, as well as improved agricultural techniques - introduction of mechanization, use of fertilizers, pesticides and etc.

The main factors determining the productivity and quality of production in modern intensive sunflower production are the approach to the choice of hybrid, combined with the specific agro-ecological conditions. Over the past 20 years, a trend has emerged in Bulgaria towards the gradual elimination of Bulgarian sunflower hybrids in favor of foreign ones, and currently the sunflower varietal composition is represented entirely by imported hybrids. In Bulgaria, sunflower breeding has traditions and globally recognized successes, especially in the late 80s and early 90s. And now Bulgarian sunflower hybrids are offered and grown in neighboring European countries - Romania, Moldova and Ukraine.

Based on what has been said so far, it can be concluded that the importance of sunflower for Bulgarian agriculture has undoubtedly increased. Its position as the second most important field crop in terms of area and importance requires detailed research on the agronomic aspects of production, adequate to the selection achievements in this crop.

3. Purpose, tasks, hypotheses and research methods.

The aim of this dissertation is to establish the influence of different agroecological conditions on some biological and economic qualities of Bulgarian sunflower hybrids.

To achieve the goal, the following tasks have been set:

1. To study the phenological development of sunflower in order to establish the duration of the interphase periods depending on the agro-ecological region.
2. To study the productive indicators (seed, oil and meal yields) and plant structure of sunflower hybrids, depending on soil and climatic conditions.
3. To investigate the qualities of seeds, oil and meal of sunflower hybrids under contrasting agro-ecological conditions.
4. To establish the stability of sunflower hybrids in the genotype x environment interaction.
5. To establish the correlations between the studied quantitative and qualitative indicators of sunflower hybrids.

To achieve the goal and objectives of the study, two parallel three-year field trials were conducted during the period 2023-2025.

One experiment was conducted in the agroecological region of the city of Plovdiv - village of Zhitnitsa, Kaloyanovo municipality, and the other - in the agroecological region of the city of Dobrich - village of Petleshkovo, General Toshevo municipality. The experiments were set up using the block method in 4 replications with a size of the experimental area of 28 m².

Six sunflower hybrids were studied – P64LP170, used as a standard, a selection of the breeding company Corteva and five Bulgarian hybrids created in the only sunflower breeding center in Bulgaria – Dobrudzha Agricultural Institute – Gen. Toshevo – Dalena, Deveda, Enigma, Krasela and Sunny. The phenological development of sunflower in both regions was studied, as were biometric indicators – stem length, stem thickness, stem mass, stem density, leaf mass, panicle diameter, number of seeds in a panicle, panicle mass, mass of seeds in a panicle and panicle density.

The productive indicators seed yield, harvest index of the plant, the kernel and the seeds, as well as the yield of oil and meal were studied. The quality of the seeds includes the oil content in the seeds, the mass of 1000 seeds and the hectoliter mass, and the quality of the oil - the ratio of saturated-unsaturated fatty acids and the fatty acid

composition of the oil. The quality of the meal is determined by the content of crude protein and the amino acid composition of the protein.

Chemical analyses include soil agrochemical analyses – annually before sowing to determine: pH, content of mobile nitrogen, mobile phosphorus, mobile potassium and humus. Seed analyses include determination of crude fat, crude protein and fatty acid composition of the oil – by gas chromatography .

To establish statistically significant influences of the studied factors, a two-way analysis of variance (ANOVA) was applied.

Wricke 's ecovalence (W_i^2), Shukla 's stability variation (σ^2_i) and Plaisted 's stability parameter (θ_i) were used and Peterson. Stability analysis using the AMMI (Additive Multivariate Model) model was also used. Main Effects and Multiplicative Interaction and GGE Biplot (Genotype main effect + Genotype by Environment interaction) analysis.

To calculate the relationships between the studied traits, correlation analysis (Pearson correlation coefficient ($r_{x,y}$)). In addition to the correlation coefficient (r), the relationships between variables are also expressed graphically through correlation scatter.

The statistical processing of the results was performed with the products MS Excel – Data analysis (ANOVA) and the application XLSTAT 2016.02.

The online program Stabilitysoft was used to calculate parametric and nonparametric stability statistics.

For stability analysis using the AMMI model and GGE Biplot analysis, the PBTtools software was used.

4. Visualization and presentation of the results obtained.

The scientific paper submitted for review contains 162 pages, 26 tables, 27 figures and 1 appendix. The list of cited literature contains a total of 167 literary sources, of which 14 are in Cyrillic.

The dissertation contains all the sections generally accepted for this type of presentation, namely: Table of Contents – 2 pages; Introduction – 2 pages; Literature Review – 26 pages; Aim and Objectives – 1 page; Material and Methods – 9 pages; Soil and Climate Characteristics – 2 pages; Results and Discussion – 85 pages; Conclusions – 3 pages; Contributions – 2 pages and References – 18 pages.

The literature review is divided into subsections describing studies on the origin of the sunflower - from the American steppes, through botanical gardens to industrial processing. Beginning of scientific research with sunflower. Selection methods. Sunflower hybridization . Sunflower selection in Bulgaria. Main directions in sunflower cultivation. Sunflower response to different agro-ecological conditions.

The agroclimatic characteristics include the general climatic characteristics of the two regions of the experiment – Dobrudzha Agricultural Institute – town of Gen. Toshevo and village of Zhitnitsa, Kaloyanovo municipality, hereinafter referred to as Plovdiv region and Dobrich region for short. The soil characteristics are described, as well as an analysis of the agrometeorological conditions during the study period in the two agroclimatic regions.

5. Discussion of the results and literature used.

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

The first subsection describes the phenological development of sunflower. To track the phenological development of sunflower, the dates of occurrence of the phenophases according to the Schneiter and Miller scale are first described - sowing (V0), germination (VE), 2nd pair of true leaves (V2), 4th pair of true leaves (V4), budding (R1), beginning of flowering (R5), end of flowering (R6) and ripening (R9). The data are presented in tabular form.

Each of the phenological phases occurs to a different extent earlier in the Plovdiv region than in the Dobrich region, which is completely understandable, as a result of the later warming of the weather in Northern Bulgaria than in Southern Bulgaria. The exception is the first year of the study, during which there was delayed germination in Plovdiv. The reason for the large differences in germination in the Plovdiv region are the sharp temperature fluctuations in March, when sowing was carried out in suitable temperature conditions, but the subsequent sharp cooling after sowing also led to a reaction of the hybrids in terms of germination speed. In addition to the dates, the duration of the interphase periods are also illustrated in graphic form.

The formation and share distribution of plant organs are described in the second subsection. This is of key importance for the main economic indicators of the crop – yields and quality of production. Interphase development in sunflower is divided into two stages – vegetative (formation of the two vegetative organs – stem and leaves) and reproductive – formation of the two reproductive organs – inflorescence and seeds. Quantitative biometric measurements of plant organs allow to calculate the distribution of each organ relative to the total biomass of the plant. On average for all hybrids in the Plovdiv region, plants are formed by 36% stems, 19% leaves, 18% pistil and 27% seeds. In the Dobrich region, the stem occupies 33%, leaves – 20%, pistil – 16% and seeds 31%.

The third subsection presents the productive indicators of sunflower - the yields of seeds, oil and meal, as well as the harvest indices of plants, hulls and seeds. The yield of seeds 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. The yield of oil is higher in the conditions of Dobrich, with the exception of the Sunny hybrid, which forms a higher yield of oil in Plovdiv. In the Dobrich region, the most oil per unit area was obtained from the Deveda hybrid. In both regions, the highest yield of meal is with the P64LP170 standard. The harvest index of the plants is higher in the Dobrich region, with the exception of the Sunny hybrid. In the Plovdiv region, the highest share of seeds in the cotyledon is for the Sunny hybrid, and in Dobrich for the P64LP170 standard. In both regions, the highest harvest index of seeds is recorded for the Krasela hybrid.

The fourth subsection includes the main quality indicators of sunflower - oil content in seeds, ratio of saturated and unsaturated fatty acids, fatty acid composition of the oil, crude protein content and amino acid composition of the protein. Both main physical indicators of the seeds are described - mass of 1000 seeds and hectoliter weight. It has been established that in the hybrids P64LP170, Dalena, Enigma and Krasela the oil content in the seeds is higher in the Plovdiv region than in Dobrich. The highest oil content in both regions is the hybrid Sunny. In both regions the mass of 1000 seeds is the highest in the hybrid Sunny. The hectoliter weight is highest in both regions for the Krasela hybrid. The content of saturated fatty acids in all hybrids is higher in the Plovdiv region, and unsaturated - in the conditions of Dobrudzha. 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 most high-oleic. The content of crude protein in the seeds is higher in the Plovdiv region for 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).

The stability of sunflower hybrids in the genotype × environment interaction is described in the fifth subsection. 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.

The last subsection describes the correlations between quantitative and qualitative indicators in sunflower. Strong positive correlations between seed yield and oil yield are reported, and of the structural elements of the plant, the mass and number of seeds in the cob have the strongest influence on yield. A positive and proven relationship between oil content and hectoliter weight was reported only. The remaining reliable correlations were negative – with crude protein content and saturated fatty acid content.

Based on the obtained and analyzed results, the doctoral student formulated 13 conclusions that summarize the research in abbreviated form.

The cited literature demonstrates the excellent theoretical preparation of the doctoral student and his high level of awareness of the fundamental and latest scientific achievements on the researched problems both in our country and abroad.

6. Contributions of the dissertation work.

The excellent theoretical and practical preparation of the doctoral student, as well as the precisely conducted experiments and analyses of the data from them, enable him to form a total of 8 contributions as follows:.

Scientific and theoretical contributions:

1. It has been established that the growing season of sunflowers 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. The Dalena hybrid ranks second, Sunny third, Deveda fourth, and in last place as the most unstable in terms of yield are the P64LP170 and Krasela hybrids .
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 was found that the highest oil content in both regions is the hybrid Sunny, which also recorded 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 highest in both regions for the hybrid Krasela .

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 amount of proteins, lysine, methionine and cystine accumulate in the standard P64LP170.

7. Critical notes and questions.

8. Published articles and citations.

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

CONCLUSION:

Based on the various research methods learned and applied by doctoral student Bojidar Frantsov Tanchev, 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 Agricultural Research and Development 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 Bojidar Frantsov Tanchev the educational and scientific degree of "**Doctor**" in the scientific specialty of Crop Science.

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Plovdiv


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