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Bioecophysiological characteristics of sunflower (helianthus annuus l.) Cultivars alomat and jahongir

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Abstract: This study investigates the bioecophysiological characteristics of two sunflower (Helianthus annuus L.) cultivars, Alomatand Jahongir. Morphobiological parameters, water regime, photosynthetic activity, and ecological adaptability were analyzed under field conditions. Results demonstrated that the Alomat cultivar exhibited higher stability under drought and heat stress, while Jahongir displayed superior productivity under favorable environmental conditions. The findings contribute to optimizing sunflower cultivation zones and to the selection of cultivars suited to specific ecological conditions.

Keywords: sunflower, bioecophysiology, Alomat cultivar, Jahongir cultivar, photosynthesis, drought tolerance, ecological adaptation.

1. Introduction

Sunflower (Helianthus annuus L.) is among the world's most important oilseed crops, valued for its high oil (45–55%) and protein (up to 20%) contents. In Uzbekistan, sunflower cultivation is expanding due to increasing demand for vegetable oil and the need to diversify crop rotations in water-limited regions. However, frequent droughts and rising temperatures require a better understanding of the physiological mechanisms underlying cultivar adaptability.

Recently developed sunflower cultivars such as Alomat and Jahongir are reported to exhibit high ecological plasticity and yield potential. Understanding their bioecophysiological traits—such as photosynthetic activity, water-use efficiency, and stress tolerance—is essential for sustainable sunflower production in variable climates.

The objective of this study was to compare the bioecophysiological responses of Alomat and Jahongir cultivars under field conditions and to identify their optimal growing environments.

2. Materials and Methods

2.1 Study area

Field experiments were conducted during 2023–2024 at the "Agrobiology Experimental Station" located in Qibray district, Tashkent region, Uzbekistan (41°25′ N, 69°28′ E). The soil type was light loam, nonsaline, with 1.5–2.0% humus and moderate fertility. The region's climate is continental, with hot summers (average 35 °C) and low rainfall (300–350 mm annually).

2.2 Plant materials

Two sunflower cultivars were tested:

- Alomat – early-maturing, medium-tall, high-oil cultivar with moderate drought tolerance.
- Jahongir – late-maturing, tall, high-yielding cultivar with higher water demand.

2.3 Experimental design

A randomized complete block design (RCBD) with three replications was used. Each plot measured 10 m² with a spacing of 70 × 30 cm. Standard agronomic practices were applied uniformly across all plots.

2.4 Measurements

- Photosynthetic rate (A) was measured using a LI-COR 6400 portable photosynthesis system at the flowering stage.
- Transpiration rate (E) and water-use efficiency (WUE) were determined gravimetrically.
- Leaf area index (LAI) was calculated using a planimetric method.
- Biomass accumulation and yield were determined at physiological maturity.
- Meteorological data (temperature, humidity, precipitation) were obtained from the local agrometeorological station.

Data were analyzed using ANOVA, and means were compared using the LSD test ($p < 0.05$).

3. Results

3.1 Growth and development

The Alomat cultivar reached maturity within 95–100 days, while Jahongir required 105–110 days. Plant height at flowering was 155 cm for Alomat and 175 cm for Jahongir. Growth rate differences became evident during the reproductive stage, when Jahongir developed a larger vegetative structure.

3.2 Photosynthetic activity

Photosynthetic rates differed between cultivars (Table 1). Under optimal conditions, Alomat exhibited an average photosynthetic rate of 18.4 µmol CO_2 m^{-2} s^{-1}, while Jahongir reached 20.7 µmol CO_2 m^{-2} s^{-1}. Under heat stress (35–37 °C), Alomat retained 88% of its photosynthetic activity, whereas Jahongir declined to 92%, indicating Alomat's higher heat tolerance.

Table 1. Photosynthetic and transpiration parameters of sunflower cultivars

Cultivar

Photosynthetic rate (µmol CO_2 m^{-2} s^{-1})

Transpiration (mmol H_2O m^{-2} s^{-1})

WUE (µmol CO_2 $mmol^{-1}$ H_2O)

Alomat

18.4

3.4

5.41

Jahongir

20.7

4.1

5.05

3.3 Water regime and drought response

The Alomat cultivar demonstrated lower transpiration rates and higher WUE values, confirming its efficient water-use strategy. In contrast, Jahongir consumed more water but maintained higher photosynthetic rates under favorable moisture conditions.

3.4 Yield and oil content

At harvest, Alomat produced 24.6 t ha^{-1} of seed yield, while Jahongir yielded 27.9 t ha^{-1}. Oil content was 48.2% and 46.5% respectively. Thus, Alomat is more suitable for oil production, whereas Jahongir is advantageous for total biomass and yield.

4. Discussion

The observed differences between the two cultivars reflect their genotypic adaptability to contrasting environmental conditions. Alomat's stable photosynthetic rate and low transpiration indicate superior tolerance to drought and heat stress. This may be attributed to its stomatal regulation and efficient carbon assimilation under limited water availability.

Jahongir, on the other hand, expresses high productivity in well-irrigated conditions due to its vigorous growth and greater leaf area, which enhances light interception and CO_2 assimilation. However, its water demand makes it less suitable for arid regions without irrigation.

These findings align with previous research (Smith & Brown, 2020; Karimov et al., 2021), which emphasized the genetic variability of sunflower cultivars in response to water stress and temperature fluctuations. The complementary characteristics of Alomat and Jahongir could be exploited in breeding programs aimed at developing drought-resistant and high-yielding sunflower varieties.

5. Conclusion

1. The Alomat cultivar maintains stable photosynthetic performance and water-use efficiency under heat and drought stress, making it suitable for semi-arid regions.
2. The Jahongir cultivar shows higher growth potential and yield under irrigated and favorable conditions.
3. Both cultivars exhibit strong ecological adaptability, but their optimal cultivation zones differ depending on water availability and soil type.
4. The obtained bioecophysiological data can serve as a scientific basis for breeding and regional zoning of sunflower cultivars in Uzbekistan and similar agroclimatic regions.

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