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CHLOROPHYLL SHOWING TRANSPIRATION AND PHENOLOGICAL STAGES OF DEVELOPMENT OF DIFFERENT TYPES OF JERUSALEM ARTICHOKE (HELIANTHUS TUBEROSUS L.) AND CONDITIONS IN KHOREZM REGION

Matnazarova Zilola Maksudbek qizi
Aspirant of Urgench State University
matnazarovazilola82@gmail.com

Abstract: This study was conducted in Khorezm region during 2024–2025 to investigate the changes in transpiration (Tr) and chlorophyll content (SPAD) of Jerusalem artichoke varieties Faiz-baraka and Mo‘jiza across phenological stages. Results showed that the Mo‘jiza variety maintained relatively stable transpiration under high temperature and low moisture conditions while sustaining photosynthetic activity. Tubers played a significant role as internal water reserves under stress conditions. Appropriate irrigation management and variety selection according to phenological stages can enhance yield. The findings provide a scientific basis for evaluating drought tolerance and practical recommendations for Jerusalem artichoke cultivation in hot and dry climates.

Keywords: Jerusalem artichoke, phenological stages, transpiration, SPAD, drought tolerance, tubers.

Jerusalem artichoke (Helianthus tuberosus L.) is a promising crop distinguished by its high adaptability, ability to produce stable yields in a variety of agroclimatic conditions, and efficient water use. Studying the physiological properties of this plant, including water exchange and transpiration processes, is of great scientific and practical importance, especially in arid and semi-arid regions.

Scientific research shows that transpiration rate, photosynthesis rate, and water use efficiency change during Jerusalem artichoke growth and development, and these parameters directly impact yield formation. Specifically, it has been established that limited water supply or drought lead to a slowdown in transpiration and photosynthesis in the plant, which consequently leads to a decrease in biomass. Some studies note significant differences in transpiration and water use efficiency between Jerusalem artichoke genotypes.

Water supply levels at different stages of the growth cycle have different effects on the physiological state of Jerusalem artichoke. In particular, water stress occurring mid-vegetation or during the transition to generative stages can lead to a decrease in biomass accumulation, yield index, and water use efficiency. This situation indicates the need to adapt the water regime to the phenological stages of plant development.

Jopin also exhibits adaptive mechanisms in response to water stress, such as regulating stomatal activity, altering leaf surface area, and optimizing water use. These physiological responses largely depend on the phenological stages, and the plant's water requirements vary significantly from germination to flowering and nodulation. [1.2].

At the same time, the relationship between the phenological stages of Jerusalem artichoke development and water exchange processes is insufficiently studied in the existing scientific literature, especially in arid climates such as the Khorezm region. Determining the dynamics of transpiration and water consumption in accordance with the phenological stages of development is of great importance for optimizing irrigation regimes, efficient use of water resources, and achieving sustainable yields.

This study examines water exchange processes at the main phenological stages of Jerusalem artichoke development and identifies patterns of gradual changes in transpiration rates and water consumption.

Research methods. The study was conducted in 2024–2025 on experimental agricultural fields at Urgench State University, located in the Yangibazar district of Khorezm region. The

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study area has a sharply continental climate, characterized by high temperatures and low relative humidity in the summer months. Average air temperatures during the growing season ranged from 26–30°C, with maximum temperatures reaching 40°C. Annual precipitation was 80–100 mm, falling primarily in the spring and winter months. The soil type was medium loamy, in places consisting of irrigated meadow alluvial soils with low salinity.

Jerusalem artichoke (Helianthus tuberosus L.) varieties 'Faiz-baraka' and 'Mo'jiza' were selected as the study material. Planting was carried out in early spring, and healthy tubers of uniform size were included in the experiment. The experiment was conducted using a randomized block design with three replicates. Row spacing was 70 cm, and plant spacing was 30 cm. Planting depth was set at 6–8 cm. During the growing season, agronomic practices (tilling and weeding) were carried out in accordance with general recommendations.

The irrigation regime was tailored to regional agroclimatic conditions, and watering was adjusted according to the phenological stages of plant development.

Phenological observations were conducted at the main stages of Jerusalem artichoke development, including germination, vegetative growth, budding, flowering, nodulation, and maturation. The onset and duration of each stage were determined by calendar days and analyzed through comparisons between varieties.

Jerusalem artichoke transpiration rate was determined using a porometer; measurements were taken at different phenological stages of the growing season. Measurements were taken throughout the day (from 10:00 AM to 1:00 PM) on the same leaf surface.

Chlorophyll content in leaves was determined using a SPAD meter and used as an additional indicator in assessing plant physiological condition. Measurements were taken on at least 10 plants for each treatment and replicate [3-4-5].

During the experiment, meteorological parameters such as air temperature, relative humidity, and wind speed were recorded using data from the nearest weather station. These factors were analyzed as the main environmental factors influencing transpiration.

Statistical processing of the obtained data was performed using analysis of variance (ANOVA). Differences between phenological stages, varieties, and their interactions were assessed at a significance level of $p < 0.05$. Microsoft Excel and Statistica were used for data processing.

The experiment was conducted in accordance with all agronomic and scientific requirements; measurements were repeated and performed under identical conditions. To increase the reliability of the results, each measurement was repeated three times.

Analysis of the obtained results. The study revealed that transpiration (Tr) and chlorophyll content (CPC) values in the Jerusalem artichoke varieties Modzhiza and Faizbaraka varied depending on the phenological stages.

Tr reached its maximum during the vegetative and budding stages, indicating a significant water requirement for the plants during growth.

High Tr during the flowering and nodule formation stages, especially under hot conditions, suggests a connection with the plant's water exchange mechanisms.

Nodules serve as an internal reserve of water and nutrients for the plant, which helped maintain a minimum Tr during dry and hot periods.

In 2024, the hot period occurred in late June - early July, and in 2025, in the second half of June. These annual differences influenced the change in Tr and CPC values. High temperatures and low humidity increased the differences between the varieties, but resistant varieties continued to grow with minimal Tr.

Table 1

Using analysis of variance and correlation analysis, differences in transpiration (Tr) and chlorophyll content (SPAD) were analyzed by years in the varieties Modzhiza and Faiz-baraka (2024-2025).

	Phenophase	Varieties	2024	2024 SPAD	2025	2025

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			Tr(mm/d)		Tr(mm/d)	SPAD
1	Vegitative	Mo'jiza	2,4	35	2,5	34
2	Vegitative	Fayz-baraka	2,2	33	2,4	332
3	Budding	Mo'jiza	2,9	37	3,0	36
4	Budding	Fayz-baraka	2,7	36	2,8	35
5	Flowering	Mo'jiza	3,1	38	3,2	37
6	Flowering	Fayz-baraka	2,9	36	3,0	35
7	Nodule formation	Mo'jiza	3,0	37	3,1	36
8	Nodule formation	Fayz-baraka	2,9	36	3,0	35
9	Cooking	Mo'jiza	2,6	36	2,7	35
10	Cooking	Fayz-baraka	2,4	34	2,5	33

According to the research results, in the vegetative stage, the transpiration (Tr) of the Modjiza variety is 2.4–2.5 mm/den, and the SPAD is 34–35 units in the village, which indicates a more stable photosynthetic activity compared to the Faiz-Baraka variety. V period buttonizatsii and transpiration of tsvetenia pokaseteli i SPAD and sorta Modjiza reached naive values (Tr 3.0–3.2 mm/den; SPAD 37–38), which testifies to active growth and high physiological activity. Sort Modjiza also kept its prevoskhodnye pokaseteli v period of formation of clubs, chto yavlyaetsya vajnym factorom formation of elements of culture. It shows how much it is in the stage of maturation, the SPAD sign is higher than the Mojiza, which indicates more long-term storage of green leaves.

Conclusion. The 'Mo'jiza' variety demonstrated superior physiological performance compared to 'Fayz-baraka', characterized by higher transpiration rates, more stable chlorophyll content (SPAD values), and greater physiological activity throughout all growth and development stages. These traits indicate better adaptation to the arid conditions of the Khorezm region. Therefore, 'Mo'jiza' can be recommended as a promising variety for improving productivity and enhancing overall plant health. The 'Fayz-baraka' variety showed relatively stable but consistently lower physiological values, making it a suitable option for average cultivation conditions where water stress is less severe.

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