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BIOLOGICAL CHARACTERISTICS OF WALNUT

A.E. Karshiev
A.Doctor of Philosophy in Agricultural Sciences (PhD)
B., Senior Lecturer, Department of "Horticulture and Viticulture",
C.Tashkent State Agrarian University

O.F. Kakhxorova
Assistant Professor, Department of "Horticulture and Viticulture",
Tashkent State Agrarian University

Annotation: The article examines the origin of the Persian walnut (Juglans regia L.) and its dissemination across Asia, driven by the complex interaction between anthropogenic and natural factors. It highlights its global cultivation across temperate and subtropical climate zones. Furthermore, the paper presents research observations conducted to study and select promising walnut varieties cultivated in the Bostanlyk district of the Tashkent region, Uzbekistan. The study emphasizes that the optimal growth and development of the walnut plant are directly linked to environmental factors. The positive influence of external factors such as temperature, light, water, air, and soil leads to enhanced fruit quality, improved environmental adaptability, and the expression of other favorable traits.

Keywords: climate, temperature, plant, shoot, quality, biological characteristics, fruit, yield, variety, external factors, selection.

Introduction. The walnut (Juglans L.) is a widely distributed crop cultivated globally on the borders of temperate and subtropical climate zones. It belongs to the Juglandaceae Lindl (walnut) family. The genus Juglans is the most populous genus within this family, encompassing nearly 40 distinct walnut species [1, 2].

The walnut forests of Central Asia, recognized as the primary genetic center of origin for the Persian walnut, thrive in the diverse conditions of mountainous terrain, specifically in the most humid areas along canals, streams, and rivers. Numerous researchers of Central Asian walnut forests have noted a high degree of polymorphism in walnuts regarding their morphological features and biological characteristics. The mountains of Central Asia are scientifically established as the center of origin for the Persian walnut (Juglans regia L.) [3, 4, 5, 6].

From this primary center, it naturally disseminated across vast territories of Eurasia and America. During the last glacial period, the walnut disappeared from Southern Europe and Turkey. However, it survived in the warmest refugia near the Black and Caspian Seas, as well as in regions naturally sheltered from northern glacial advances by mountain massifs [7, 8].

In Asia, the expansion of the Persian walnut was driven by the complex interplay between anthropogenic and natural factors. Following the Last Glacial Maximum, the walnut persisted and naturally regenerated in largely isolated pockets of Asia, extending from the Xinjiang province of western China through Central Asia to the Caucasus. Obstacles to gene flow, such as the Tian Shan and Himalayan mountain ranges, combined with progressive desertification in Central Asia during the Holocene, led to the fragmentation and isolation of natural populations in these regions [9].

The Persian walnut has been cultivated since antiquity in areas where it naturally occurs. Historical records of the walnut exist in Indian Sanskrit texts, and its domestication in China was documented around 140–150 BC. In the 18th century, Spanish colonizers introduced the J. regia genotype from Spain to South America for cultivation. Consecutively, in the 19th century, the Persian walnut was introduced into Northern California from France, and into Southern California from China [10, 11].

Results. The climate of the Tashkent region is characterized by abundant sunlight, sharp diurnal and seasonal temperature fluctuations, dry and hot summers, and unstable winters. The annual duration of sunshine ranges from 2,800 to 2,900 hours (with 360–400 hours in the summer months and 90–100 hours during the winter). The average annual air temperature is +13°C to +14°C. The average air temperature in January is -0.4°C to +1.5°C, while in July it reaches +27°C to +29°C. The absolute minimum temperature ranges from -28°C to -35°C, and the absolute maximum reaches +43°C to +44°C. Annual precipitation varies between 250 and 500 mm, occurring predominantly during winter and spring. Snow cover persists for an average of 25 to 70 days. Warm days total 220 days per year, and the period with temperatures above +15°C lasts for 173 days (from April 14 to October 5). The accumulated effective temperature sum above +15°C is 1310°C.

In the Tashkent region, a decline in air temperature to -25°C is observed once every 10 years, whereas minimum temperatures below -15°C occur with a 95% probability during the winter months.

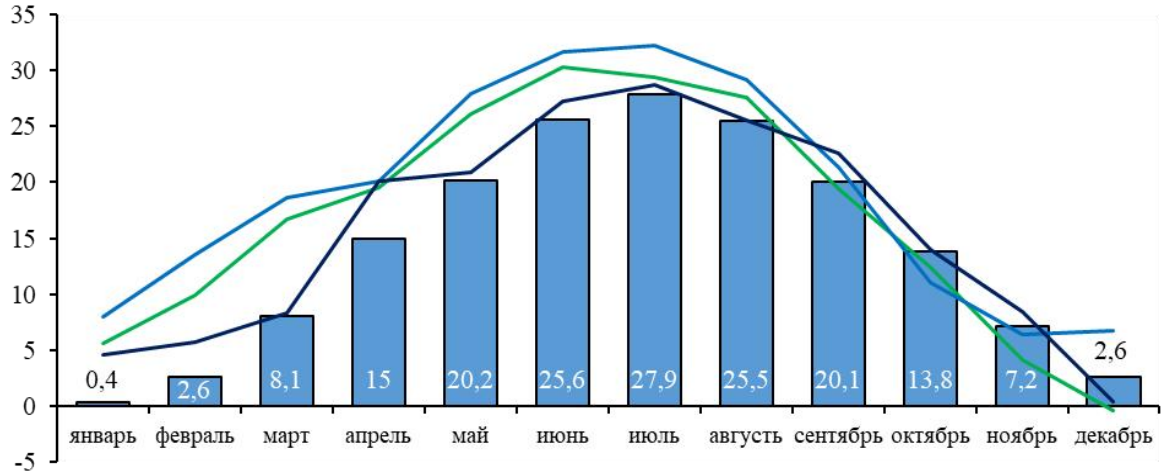
Abundant heat and light are the primary defining features of the climate in the Bostanlyk district. The average annual duration of sunshine is 2,889 hours, ranging from 361 to 395 hours per month in the summer season, and averaging 104 to 125 hours in the winter.

Extreme continentality is a fundamental characteristic of the Tashkent region's climate. It is manifested by sharp annual and diurnal variations in air temperature, relative humidity, precipitation, and other meteorological variables. The amplitude of the average diurnal air temperature fluctuations reaches 27°C to 30°C in January and July.

The coldest months are December, January, and February. In certain years, the absolute minimum temperature can drop to -25°C or -28°C. The snow cover is typically thin and unstable, with an average depth ranging between 5 and 10 cm.

Spring begins early—at the end of February or the beginning of March—and is characterized by frequent cold spells and late spring frosts. In this climatic zone, late spring frosts are recorded between March 20 and March 26, while the first autumn frosts occur from October 19 to November 6. The average duration of the frost-free period spans 207 to 230 days. The period with an average daily temperature above 10°C lasts for 211 to 223 days, while the duration of the period above 15°C ranges from 167 to 177 days.

According to data from the Chimgan agrometeorological station in the Tashkent region, the air temperature, relative humidity, and precipitation levels recorded during the field experiments from 2020 to 2022—covering the period from leafing out to fruit ripening (March to September) in Persian walnut varieties—are presented in Appendix 1.



During the research years (2020–2022), the long-term average air temperature was 0.4°C. The average air temperature in January ranged from +4.6°C to +8.0°C. Starting from February, temperatures increased to +5.7°C ... +13.5°C, and reached +8.3°C ... +18.6°C in March, demonstrating a clear warming trend compared to January (Figure 1).

Figure 1. Air temperature, °C

During the 2020–2022 period, the average air temperature in April was found to be +4.5°C to +5.1°C higher than the long-term average, while from May to August, it remained +1.9°C to +4.8°C above the baseline. Conversely, from October to December, the recorded temperatures were -0.3°C to -1.9°C lower than the long-term average.

In the field experiments conducted on Persian walnut seedling production between 2020 and 2022, soil temperature at a depth of 10 cm—specifically during the second decade of March—was determined to be +7.1°C higher than the long-term average. This elevated soil temperature was observed to accelerate the germination rate of stratified Persian walnut seeds.

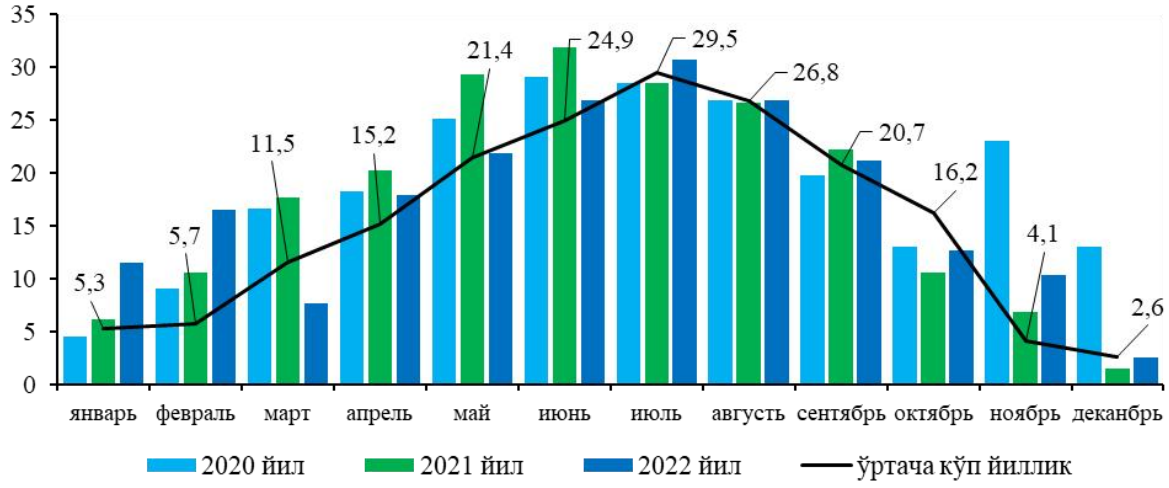


Figure 2. Soil temperature at a depth of 10 cm, °C

The long-term average precipitation was 62.5 mm in January and 73.6 mm in February. In March, precipitation levels rose significantly, exceeding the January and February values by 24.7 mm and 13.6 mm, respectively, reaching a total of 87.2 mm. Conversely, during April and May of

2021–2022, precipitation levels were lower compared to 2020. This reduction in rainfall exerted a positive influence on the pollination of female flowers by male flowers.

Conclusion

According to scientific literature, species belonging to the genus Juglans L. possess a broad geographical range and adapt to diverse regional conditions. This wide adaptability enables their effective utilization in breeding programs aimed at developing locally adapted varieties, as well as in the establishment of landscape parks and commercial walnut orchards.

Successfully adapted varieties have been developed in this region, which seamlessly progress through all phenological phases during their vegetative period.

For extensive application in the food and pharmaceutical industries to ensure a steady supply of raw materials, it is essential to establish high-density commercial walnut plantations utilizing compact-grown varieties. Achieving this objective requires the cultivation of high-quality planting material (seedlings).

The attractiveness of the walnut as a fruit and industrial crop lies in several critical factors. Prominent among these are the high market demand for its valuable timber and the relatively low operational costs associated with establishing and managing commercial orchards.

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