

BIOLOGICAL SCIENCES

SEED PRODUCTIVITY OF *CERCIS GRIFFITHII* BOISS. UNDER INTRODUCTION CONDITIONS

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Abstract

This study examines a 58-year-old *Cercis griffithii* introduced into the Tashkent Botanical Garden, which is currently in the senile stage of its ontogenetic development. It was found that light is the primary ecological factor influencing the development of both vegetative and generative branches, as well as the formation of numerous pods and fruits. This observation indicates that the species is naturally photophilous. The species predominantly reproduces generatively (through seeds), and the biometric characteristics of the seeds are provided. Furthermore, based on phenological observations, a series of scientific findings were obtained concerning the annual growth and developmental parameters of the species.

Keywords: Red Data Book, *Cercis griffithii*, rare, introduction, Tashkent Botanical Garden, growth and development, generative reproduction, bioflavonoid.

Despite measures that have increasingly expanded over the past twenty years, the global biodiversity crisis continues. Rare and endangered species of animals, plants, and fungi represent the most vulnerable yet highly important components of biodiversity, which, first and foremost, necessitates their protection. These species play a crucial role in various ecosystems and serve as indicators of their condition. Trees, as is well known, play a significant role in human well-being worldwide. They provide favorable ecological conditions essential for the economic and cultural development of populations. Ornamental and promising tree species are among the key tools for effectively improving the living conditions of urban populations and adapting to significant changes in the natural environment of entire regions [1].

Currently, approximately 4,400 species of higher wild plants are found in the territory of our Republic. Among them are many rare, endemic, and relict species that require serious protection. The number of such species exceeds 300, accounting for 10–12% of the flora of Uzbekistan. The *Red Book of the Republic of Uzbekistan* [2] includes 314 species of trees, shrubs, semi-shrubs, and herbaceous plants belonging to 48 families that are considered rare, endangered, or endemic in our local flora. Protected natural areas, as well as botanical gardens, play a crucial role in preserving the natural populations of rare, endangered, relict, and endemic species and protecting them from anthropogenic impacts.

Since its establishment, the Tashkent Botanical Garden has tested over 6,000 species of herbaceous plants, trees, and shrubs under ecological conditions. Among these are rare ornamental species, trees, and shrubs included in the *Red Book*, and currently, 37 species that have successfully undergone ecological testing are preserved as natural gene pools. The species listed in the *Red Book* have primarily been introduced into the Central Asian Exposition and the Systematics Department.

Biological studies, seed productivity assessments, biometric measurements, and phenological observations were conducted on one of these rare and unique species, the violet-flowered Judas tree (*Cercis griffithii* Boiss.), under introduction conditions.

The violet-flowered Judas tree (*Cercis griffithii* Boiss.) is a member of the genus *Cercis* L., belonging to the Fabaceae (legume) family. Its trunk has a grayish color. The leaves are 5–8 cm long and 7–10 cm wide. The flowers are pink or violet, appearing before the leaves, with a width of 5–6 mm and a length of 4–4.5 mm [3]. *Cercis griffithii* is a rare endemic species growing in the Western Tien-Shan and Pamir-Alay mountain ranges. It is a broad-branched tree reaching 3–4 m in height. It flowers in May and bears fruit in June. It is considered an ornamental tree. In Uzbekistan, it grows in the Tashkent and Surkhandarya regions: Western Tien-Shan – Ugam and Kurama ranges; Pamir-Alay – Gissar range and Babatag. It is also found in Tajikistan and Afghanistan. The species grows on rocky, gravelly, and fine-textured soils in the lower parts of mountains. The main causes of its declining population and range are cutting for construction materials and firewood. No specific conservation measures have been developed, though the species is listed in referenced sources [2, 4, 5]. It mainly grows on mountain slopes. The pods are winged, flat, and pinkish-yellow, bean-like in appearance. The pods remain on the tree for a long time. The species can be used in green landscaping [6, 7, 8]. According to physicians and biologists, *Cercis* leaves contain flavonoids, which have antibacterial and anti-inflammatory properties. The bioflavonoids in *Cercis* leaves can kill *Koch* bacillus and help treat pulmonary and bone tuberculosis. Numerous flowers bloom not only on the branches but also on the bare trunk of the tree [14].

The chemical composition of essential oil from *Cercis griffithii* growing in Tajikistan was studied in 2018 by F. Sharopov, S. Numonov, A. Safomuddin, and I.S. Gulmurodov [9]. Its ecological characteristics

in western Iran were investigated in 2011 by M. Rezaipor, M. Akbariniya, and G.H. Jafare [10]. The effects of organic fertilizers on the growth and productivity of *Cercis griffithii* seedlings were studied by Iranian researchers M. Heydari, D. Pothier, E. Jaferyan, and others [11]. In Khorasan (Iran), the morphological adaptations of *Cercis griffithii* under arid and saline conditions were examined in 2018 by S.H. Tabatabaei et al. [12].

Cercis griffithii was brought from the Kopetdag region in 1964 by Academician F.N. Rusanov, and currently, five specimens are maintained in the Central Asian Exposition collection.

According to phenological observations conducted in 2022, the beginning of flowering was recorded in early March (March 4) when the air temperature was 20–22 °C and relative humidity was 54–56%; full flowering occurred in early April (April 3) at an air temperature of 23–25 °C and relative humidity of 52–54%; and the end of flowering was observed in mid-April (April 18) at an air temperature of 27–28 °C and relative humidity of 44–46%.

The leaves are rounded-cordate, 5–7 cm long and 7.5–12 cm wide; the upper leaves are dark green with entire margins and are positioned 2–3 cm apart along

the leaf petiole. The pods are flat, reddish in color, 6.5–7 cm long, and 1–1.5 cm wide. In sunlit areas, the fruits of *C. griffithii* are reddish, with 50–115 pods per generative branch. Each pod contains 7–8 seeds measuring 0.3–0.5 mm in length and 0.2–0.3 mm in width. The weight of 1,000 seeds of *C. griffithii* planted in the Central Asian Exposition of the Tashkent Botanical Garden was 16–17 g.

The annual growth and development of this species were observed in both sunny and shaded areas. In spring, the annual shoots of *C. griffithii* grew rapidly, reaching 10–14 cm, whereas in summer, growth slowed. Specifically, observations conducted in June (every 10 days) showed that the annual shoots had grown only 1 cm, and in subsequent observations, shoot growth had completely ceased.

Additionally, the growth of annual vegetative and generative shoots, the number of pods on productive shoots, and the number of pod fruits and seeds on mother trees growing in sun and shade in the Central Asian Exposition were studied. The growth and development indicators of *Cercis griffithii* mother trees under introduction conditions (sun and shade) in the Tashkent Botanical Garden are presented in Table.

Table.

Growth and development indicators of *Cercis griffithii* mother trees under introduction conditions (sun and shade) in the Tashkent Botanical Garden

Diameter of mother trees, cm		Length of annual vegetative shoots, cm		Length of annual generative shoots, cm		Number of pods per shoot, units		Number of pod fruits/seeds per pod, units	
<i>In sun</i>	<i>In shade</i>	<i>In sun</i>	<i>In shade</i>	<i>In sun</i>	<i>In shade</i>	<i>In sun</i>	<i>In shade</i>	<i>In sun</i>	<i>In shade</i>
16-22	12-22	–	14,8-198,2	2,8-19,1	3,4-80,4	82-116	68-110	4-11	3-9

As seen from the table, the growth indicators of mother trees growing in sun and shade differ. In the sun, vegetative shoots developing from the main trunk were not observed. During the study, it was found that the shoots of the species begin to transform into generative (fruit-bearing) shoots starting from the second year.

The fruits of *Cercis griffithii* growing in the sun are reddish in color. On generative shoots, there are 82–116 pods per shoot, and each pod contains 4–11 legume

fruits measuring 0.4–0.6 mm in length and 0.4–0.5 mm in width. In shaded clumps, the fruits are light green. The shaded clumps have 3–7 large lateral shoots, whereas those growing in the sun have 5–9 lateral shoots. The number of pods per shoot in shaded clumps ranges from 68 to 110, with 3–9 fruits per pod, each 0.6–0.7 mm long and 0.3–0.4 mm wide.

In shaded clumps, the number of vegetative shoots is higher, while in sunlit areas, a greater number of generative shoots and fruits are produced (Figure 1).



Figure 1. Generative shoots of *Cercis griffithii*: in sun (a) and in shade (b)

It is well known that studying seed productivity and identifying the causes of low seed quality, as well as developing recommendations for cultivating high-quality planting material, are of both scientific and economic significance for the successful domestication of plant species. According to T.A. Rabotnov [13], seed productivity refers to the number of seeds produced on a generative (fruit-bearing) shoot, depending on internal and external factors.

Seed productivity was studied in two categories: **potential seed productivity (PSP)** and **actual seed productivity (ASP)**. Potential seed productivity (PSP) is the maximum number of seeds that a plant, population, or phytocoenosis can produce within a certain period. Actual seed productivity (ASP) represents the number of mature, viable seeds formed on an individual clump or generative shoot. ASP varies considerably under the influence of numerous abiotic and biotic factors, such as pollination methods and conditions, the presence of phytophagous organisms, and changes in weather conditions.

By mid-June (June 12), the annual shoots of *Cercis griffithii* had ceased growth, while fruit ripening was recorded in early September (September 8). During our study, PSP and ASP were calculated for trees growing in both sunny and shaded areas. It was found that

seed productivity in sunny conditions was **96.7%**, while in shaded conditions it was **90.7%**.

Based on the results, it was concluded that under the introduction conditions of the Tashkent Botanical Garden, *Cercis griffithii* demonstrates high seed productivity in both sun and shade.

Thus, it was determined that the 58-year-old *Cercis griffithii* introduced to the Tashkent Botanical Garden is currently in the senile stage of its ontogenetic development. It was found that the main ecological factor influencing the formation of vegetative and generative shoots, as well as the numerous pods and fruits they bear, is light, which indicates that the studied species is biologically light-loving by nature.

Under introduction conditions, the species was found to reproduce mainly by the generative (seed) method. It was established that when reproducing generatively, seed germination is more effective when treated with various growth stimulants before sowing. The average length of a single seed was 0.7 mm, and the average width ranged from 0.2 mm to 0.3 mm. These parameters were determined by taking biometric measurements of ten cleaned seeds and calculating their average values.

In addition, seed weight was measured using a special seed balance, and the average seed weight was determined (Figure 2).

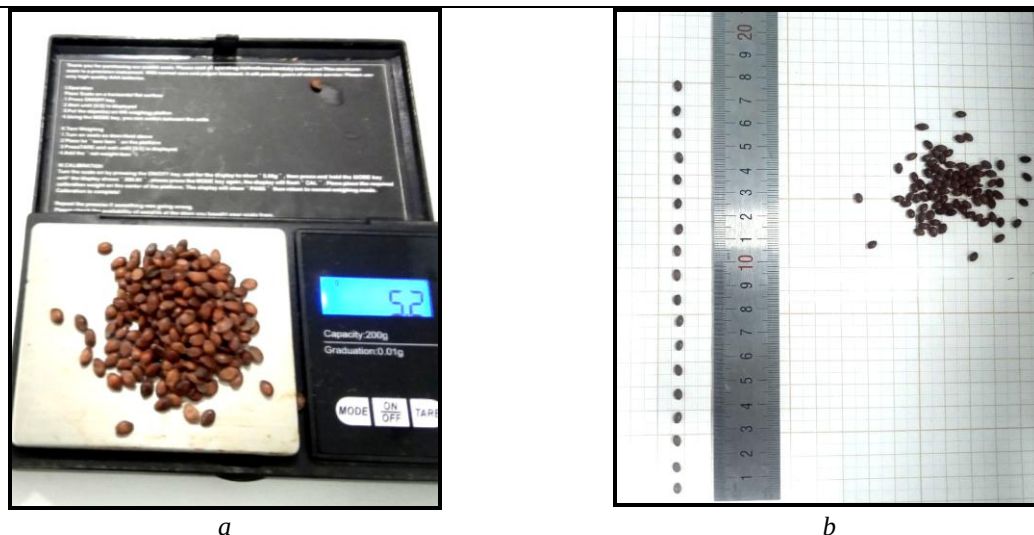


Figure 2. Weight of 100 seeds of *Cercis griffithii* (a), biometric parameters of the seeds (b)

In this study, the following results were obtained:
the average weight of one seed was 0.015 g;
the weight of ten seeds was 0.18 g;
the weight of one hundred seeds was 1.6 g;
and the weight of one thousand seeds was 17 g.

The color of the seeds ranged from dark brown to pale yellow. It was noted that the dark brown seeds were denser and larger than the pale yellow ones.

Based on the reviewed literature and the results of our scientific research, it was established that this species is well adapted to the conditions of the Tashkent Botanical Garden, regularly flowers, and produces viable seeds. The seed ripening period was found to be stable, and fruit productivity relatively high.

Cercis griffithii Boiss. can be widely used in introduction and landscaping projects. Due to its drought resistance, ornamental value, and adaptability, it is recommended as a promising species for the southern and central regions of Uzbekistan.

References

1. Eastwood, A., Lazkov, G., & Newton, A. (2009). *Red Book of Woody Plants of Central Asia*. United Kingdom: Fauna & Flora International.
2. *The Red Data Book of the Republic of Uzbekistan*. (2019). Tashkent: Chinor ENK, pp. 15–257.
3. Sokolov, S.Ya. (1958). *Trees and Shrubs of the USSR* (Vol. IV). Moscow: Academy of Sciences of the USSR Publishing House, p. 43.
4. Zapryagaeva, V.I. (1976). *Forest Resources of the Pamir-Alay*. In P. N. Ovchinnikov (Ed.), *Academy of Sciences of the Tajik SSR, Botanical Institute*. Leningrad: Nauka, Leningrad Branch, pp. 309–312.
5. Tulyaganova, M. (1981). *Genus Cercis*. In *Plant Identification Guide of Central Asia* (Vol. 6, p. 12). Tashkent: Fan.
6. Grozdova, N.B., Nekrasov, V.I., & Globa-Mikhaylenko, D.A. (1986). *Trees, Shrubs, and Lianas*. Moscow: Lesnaya Promyshlennost, p. 117.
7. Palibin, I.V. (1945). *Flora of the USSR* (Vol. 11, pp. 16–19). Moscow–Leningrad: Academy of Sciences of the USSR Publishing House.
8. Pidotti, O.A. (1958). *Genus Cercis L.* In: *Trees and Shrubs of the USSR: Wild, Cultivated, and Promising for Introduction* (Vol. 6, p. 43). Moscow–Leningrad: Academy of Sciences of the USSR.
9. Sharopov, F., Numonov, S., Safomuddin, A., & Gulmurodov, I.S. (2018). Chemical composition of essential oil from *Cercis griffithii* growing in Tajikistan. *Chemistry of Natural Compounds*, 54(5). <https://doi.org/10.1007/s10600-018-2535-4>
10. Rezaipor, M., Akbarinia, M. & Jafare, G.H. (2011). Ecological survey of *Cercis griffithii* L. tree in western Iran.
11. Heydari, M., Pothier, D., Jaferyan, E., Merzaei, V., & Heidarpour, A. (2015). Effect of organic soil amendments on growth and efficiency of Redbud (*Cercis griffithii*) seedlings in nurseries. *EcoPersia*, 3(1), 867–879.
12. Tabatabaei, S.H., Sharif, M.E., & Djalilvand, H.J. (2018). Morphological adaptation of *Cercis griffithii* seedlings in response to progressive drought and salinity stresses. February 2018.
13. Rabotnov, T.A. (1960). Methods for studying seed reproduction of herbaceous plants in communities. In *Field Geobotany* (Vol. 2, pp. 20–40). Moscow–Leningrad.
14. <https://infodacha.com/derevo-s-rozovymi-cvetami-cercis-polezno-v-sadu>