

SEASONAL DEVELOPMENT STAGES (PHENOLOGY) OF *LAGERSTROEMIA*
INDICA L.

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Abstract

This article presents the results of phenological observations conducted on *Lagerstroemia indica*. The research was carried out on shrubs growing and developing in Tashkent city during 2022-2024. The bud swelling process began when the average air temperature reached 9.9°C, with a humidity level of 62%, and a total positive temperature sum of 563°C. The complete leaf fall occurred in late autumn when the average temperature ranged from 5.9°C to 6.8°C. During the vegetation period of *Lagerstroemia indica*, the total positive temperature sum reached 6090°C, and the vegetation period lasted up to 235 days.

Keywords

Lagerstroemia indica, seasonal development stages (phenology), vegetation, budding, flowering, temperature, humidity, leaf fall.

Introduction. *Lagerstroemia indica* is a shrub belonging to the *Lythraceae* family and the *Lagerstroemia* genus, which includes 50 species. Among them, *Lagerstroemia indica* is one of the most widespread species due to its unique features and high adaptability. It was first described by Carl Linnaeus in the 18th century [1, 7]. *Lagerstroemia indica* is native to the warm-temperate and subtropical regions of East Asia. Its natural distribution covers central and southern China, the Korean Peninsula, Japan, and large parts of northern and eastern India [3, 4, 7]. In these regions, it typically grows in open forests, valleys, riverbanks, and the edges of woodlands.

Due to its remarkable aesthetic appearance and adaptability, *Lagerstroemia indica* has become widely distributed across various continents, including North and South America, Europe, Africa, and Oceania. In the United States, it is one of the most commonly planted species for landscaping and ornamental purposes, particularly in the southeastern states such as Georgia, Florida, Texas, and South Carolina [5, 8]. The introduction of *Lagerstroemia indica* to Europe began in the 18th century through European horticultural trade networks. In Southern Europe, it is commonly found in Mediterranean coastal regions, including Spain, Italy, Greece, and southern France.

In Australia, this species has been introduced mainly in two regions: New South Wales and Queensland. Similarly, it is found in South Africa, Brazil, Argentina, and Chile. Despite its widespread cultivation, *Lagerstroemia indica* is rarely invasive in non-native ecosystems due to the limitations of the natural climate. However, in favorable conditions, it shows unique development characteristics [9].

In Uzbekistan, *Lagerstroemia indica* was introduced in 1935 in the city of Denov [4]. Currently, it grows in various environmental conditions across almost all regions of the republic. It prefers fully sunny and well-drained soils [5, 6]. After planting, it is relatively drought-tolerant, but additional irrigation is required during prolonged dry periods. *Lagerstroemia indica* is typically a deciduous shrub or small tree that grows to a height of 2 to 8 meters. It has smooth bark and presents an attractive appearance with its light pink color [2]. Its leaves are simple, opposite, and range from egg-shaped to elliptical, with a length of 2 to 8 cm. The edges of the leaves are entire, glossy, dark green, turning orange at the onset of leaf fall.

Research Object and Methodology. Phenological observations of *Lagerstroemia indica*'s seasonal development were conducted during 2022-2024 on 1000 shrubs of *Lagerstroemia*



indica growing in the "Flowers Garden" LLC area in Tashkent city, which were monitored through five key phenophases. Additionally, a seasonal development phenospectrum for *Lagerstroemia indica* was created. The general development period and its duration were studied using methods developed by I.N. Beydeman (1974) in his work "Methodology for Studying Plant Phenology and Plant Communities" and G.N. Zaysev (1973) in "Methodology for Biometric Calculations." Observations focused on the start of growth, active growth, the appearance and number of leaves during the vegetative period, as well as the formation and development of buds and flowers. The flowering period was analyzed by tracking bud formation, flower dynamics, daily flowering patterns, seasonal flowering dynamics, and the duration of the flowering period. Observations on *Lagerstroemia indica* were carried out based on a plan, and individual trees were marked with specific numbers and symbols for identification. All data was analyzed and recorded in tables.

Results and Discussion. The phenology of any plant studies all periodic biological events in relation to climate, which is a crucial field for understanding the interactions between the plant and the environment. It provides general information about the timing of biological processes such as flowering, leafing, and fruiting, which are directly influenced by climate variables like temperature and precipitation. Detailed scientific studies on *Lagerstroemia indica* in Central Asia, particularly in Uzbekistan, are still lacking.

During the vegetative phase, key events such as bud swelling, bud opening, leaf unfolding (opening), stem formation, and the initiation of growth were observed. For example, the beginning of bud swelling was recorded on March 22 (2022), March 14 (2023), and March 28 (2024) when the average temperature and humidity were 8.8°C, 63%, 9.9°C, 59.4%, and 11.4°C, 62%, respectively, with a total positive temperature sum of 563°C (see Table 3.10).

Bud opening occurred between March 22 and April 10, with variations observed depending on the location of the plants. Vegetative development in *Lagerstroemia indica* is highly dependent on early spring temperatures, as this stage was significantly influenced by temperature.

The appearance of young leaves was observed by April 1 (2022), March 26 (2023), and April 16 (2024). During the study, variation in leaf unfolding was noted across the years, particularly in 2024 when new leaves were delayed until April 16. During this developmental stage, the temperature ranged from 14.8°C to 16.4°C, with a positive temperature sum of 904°C.

Moreover, the growth of young shoots was observed between April 1 and April 22. The appearance and development of young shoots were noted at an average air temperature of 16.2°C to 19.5°C, with a positive temperature sum of 981°C.

The study also showed that annual variations in the vegetative phases were closely related to the temperature factor and had significant implications for development (see Figure 3.3). In years with favorable and warm temperatures (2022 and 2023), vegetation began earlier. Conversely, in 2024, cooler temperatures resulted in delays in bud swelling and leaf opening. These findings align with research conducted along the Mediterranean coast. Specifically, due to milder winters and an early start to spring, vegetative development of *Lagerstroemia indica* began earlier [80; 281–288].





Figure 1. *Lagerstroemia indica* young seedlings in spring (May) and autumn (November).



The budding and flowering phases of *Lagerstroemia indica* are considered crucial transitional stages for reproductive development. The study results indicated that spring temperatures had a significant impact on reproductive development (see Figure 3.2).

Budding Phase – This phase includes the progressive swelling, expansion, and readiness of flower buds for blooming. During the study of the reproductive development phase of *Lagerstroemia indica*, the formation and maturation of flower buds were observed on May 29 (2022), May 30 (2023), and June 15 (2024). Research in 2024 showed that the cooler spring temperatures resulted in a delay in the overall development of the plants. In this phase, the average temperature was recorded at 23.1°C in 2023 and 26.6°C in 2024, with a positive temperature sum of 1270°C.

Flowering Phase – As a result of the observations, the flowering dates of *Lagerstroemia indica* were determined. In the experiments, the first flowers appeared on June 3 (2022), June 4 (2023), and June 22 (2024), with a positive temperature sum of 1637°C. The research showed that the overall flowering period of *Lagerstroemia indica* lasted from the end of June to mid-July, with a positive temperature sum of 3138°C. The flowering period continued until the end of October, with the positive temperature sum reaching 5765°C (in 2023, until the first frost). The duration of flowering in *Lagerstroemia indica* was observed to range from 115 to 125 days depending on the year.

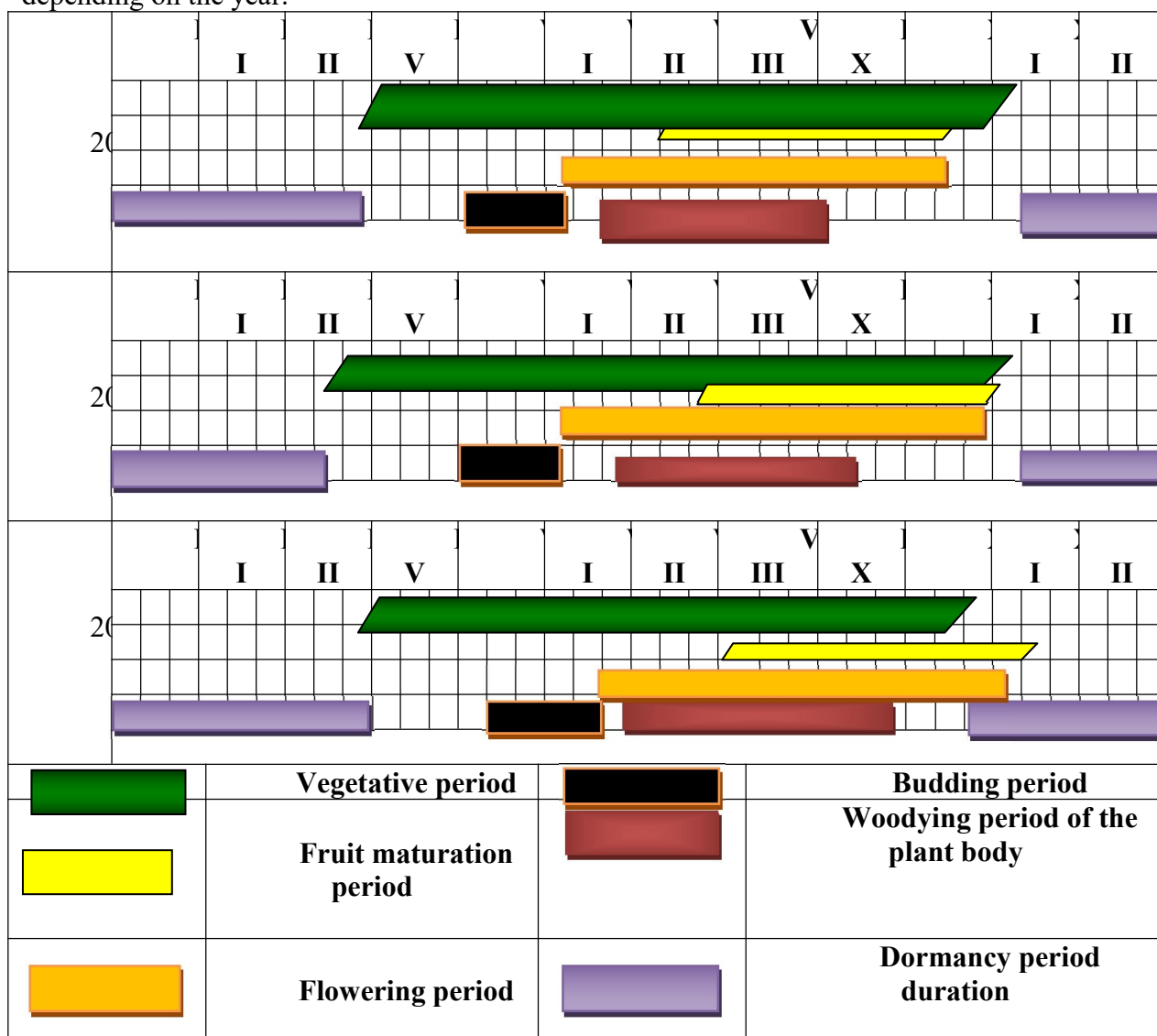


Figure 2. Phenological spectrum of *Lagerstroemia indica* development during the vegetation period in Tashkent conditions (2022-2024).

Fruit Phase – Fruits began to form at the end of June. The first fruits were observed on June 20 (2022), June 23 (2023), and July 11 (2024), with a positive temperature sum of 3041°C. The average temperature at the start of fruit development was between 28.9°C and 30.7°C, in line with studies conducted in subtropical regions. Fruit development in *Lagerstroemia indica* was closely monitored after flowering, with noticeable annual variations affected by climate conditions.

Full maturity of the fruit was observed between July 22 and August 6, with year-to-year variation. In 2024, the maturation period was shorter due to higher temperatures, with an average summer temperature of 25.9°C to 30.1°C, and a positive temperature sum of 3859°C. The period from fruit ripening to full maturity ranged from 25 to 40 days, depending on climate conditions.

The final stages of fruit ripening mostly occurred during cooler days. The last fruits ripened on October 17 (2022), and by November 15 (2024), fruit maturation was still observed. After this, it was noted that fruits did not fully ripen, and seeds failed to mature (see Figure 2).

End of Vegetation – The first signs of leaf yellowing were observed on October 16 (2022), October 23 (2023), and November 12 (2024). These dates show significant annual variability, with leaf coloration delayed in 2024 due to warmer autumn temperatures.

The average temperature during the onset of leaf senescence ranged from 8.2°C to 10.1°C. Due to the warmer conditions in 2024, leaf senescence was delayed, which was mainly linked to delayed physiological processes.

Throughout the years, the process of leaf color change from green to yellow and red took approximately 20 to 30 days. In 2024, this process was slower due to the warmer weather, and leaf senescence started later.

Full leaf drop occurred on December 1 (2022), December 7 (2023), and December 28 (2024). This was closely linked to the average temperature in late autumn, which ranged from 5.9°C to 6.8°C.

The completion of vegetation in *Lagerstroemia indica* is highly dependent on ecological factors, such as temperature, humidity, day length, and light intensity. As the days shortened, hormonal changes in *Lagerstroemia indica* led to changes in leaf coloration. During this period, chlorophyll degradation was observed, and photosynthesis slowed down.

Conclusion. During the research, it was observed that *Lagerstroemia indica* gradually adapts to ecological factors. Its stable growth indicators and long flowering period (115-125 days), timely fruit production, and consistent seasonal development in Tashkent conditions were demonstrated. Minor changes in the timing of phenophases over the years were related to fluctuations in temperature and precipitation, indicating a moderate sensitivity to climate variables while maintaining stable growth and development. Considering its prolonged flowering period, resistance to heat and drought, and low maintenance requirements, *Lagerstroemia indica* is a promising plant for urban landscaping and widespread use in general green spaces.

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