

Assessment of Growth and Development of Representatives under the Conditions of Chestnut Soils

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ABSTRACT

The growth and development of woody plants allow revealing the essence of their relationship with the environment. New conditions for growing plants primarily affect their growth and development, which is associated with the amount of heat and moisture. The aim of the research was to study the dynamics of growth and development of *Gleditsia* under new cultivation conditions (chestnut soils of the Volgograd region). In the arid zone of Russia, a comparative analysis of the species of the *Gleditsia* genus: *G. texana*, *G. cassis*, *G. triacanthos*, growing in the cluster dendrological collections of the Federal Research Center of Agroecology of the Russian Academy of Sciences (cadastre. № 34:34:000000:122, 34:34:060061:10; cadastre no. 34: 36:0000:14:0178). The analysis of long-term phenological observations at various temperature parameters of the environment was carried out. The optimal temperature for the beginning of active growth of shoots and its intensity were revealed. It was established that under the conditions of arid climate of the Volgograd region, the species of the *Gleditsia* genus are characterized by a spring-summer period of shoot growth (from the first decade of May to the third decade of July). Apical shoots start to grow earlier and finish it later than the lateral ones. At the time of cessation of growth in all species, the tops of the shoots dry up together with 2–3 leaves. Then comes the process of lignification of young shoots, contributing to their resistance under winter conditions. When comparing the data on the development of shoots of different *Gleditsia* species, no clear differences were found. *Gleditsia triacanthos* has the longest growing season (195 days) compared with the rest of the studied species. During the growing season, all *Gleditsia* species go through a full cycle of development, which indicates the success of their introduction, proving that the *Gleditsia* genus is a stable plant in chestnut soils. *Gleditsia* has no special generative shoots. The period from the beginning of budding to flowering depends on weather conditions (an increase in temperature to 28 °C slows this process down). In hydrologically favorable years, at an average air temperature of 21.5 °C, continuous flowering of plants is observed). The obtained materials are necessary for selection for landscaping, assessment of aesthetic and sanitary-hygienic properties, development and implementation of measures to protect green spaces from pests and diseases. Phenological observations have a huge role for forest reclamation.

Keywords: *Gleditsia texana*, *Gleditsia cassis*, *Gleditsia triacanthos*, growth, development, phenology, growing season, flowering, development phases.

INTRODUCTION

Gleditsia is a relatively fast-growing tree. It is widely used for protection from wind and against water erosion and leaching of soil. *Gledichia* flowers are incredibly attractive for insect pollination and, thus, the tree is attractive for honeybees (Agostina Lorca, 2019).

The wood is very hard and durable. It is used to make railway sleepers and poles. It is also used

in construction, for landscaping settlements and park construction. The tree is gas-resistant; thus, it is advisable to plant it in industrial cities. *Gledichia* tolerates cutting at any age and at any height, so it can be used to create a hedge (Camare-ro, 2020). It blooms in summer, later than other woody plants. Useful substances that can be used in medicine are found in fruits, seeds and leaves. In addition, seeds and fruits are used for feeding cattle during processing (De Souza, 2020).

Due to its decorative nature and ability to grow with the formation of stable, productive plantings under the harsh, extreme conditions of the dry steppe, gledichia is of interest in the greening of cities and towns, especially in the areas with low-fertile soils (Semenyutina, 2016). Gleditsia species are suitable for alleys, group plantings and hedges. They safely tolerate cutting, form impassable hedges, are of great importance for fixing the slopes (Moreschi, 2019).

The growth and development of woody plants allows revealing the essence of their relationship with the environment. New conditions for growing plants, first of all, affect the growth and development, which is associated with the amount of heat and moisture. The aim of the research was to study the dynamics of growth and development of Gleditsia under new cultivation conditions (chestnut soils of the Volgograd region).

MATERIALS AND METHODS

The object of the study was the dendrological collection of the Federal Research Center of Agroecology of the Russian Academy of Sciences (cadastre. № 34:34:000000:122, 34:34:060061:10; cadastre no. 34: 36:0000:14: 0178). Various species of the Gleditsia genus of the Caesalpiniaceae family were studied: *G. texana*, *G. cassis*, *G. triacanthos*. The biometric observations were carried out using photofixation and temperature control (Mazía, 2019). The age of the plants is 10 years, each species is represented by twenty specimens. Planting scheme involved 3×3 m plots of chestnut soil without additional irrigation. This soil is characterized by a weak humus color and a gradual transition between horizons. The humus content is about two percent (Table 1).

More complete data on the phenology of growth and development make it possible to obtain the phenospectra-summary images of the seasonal formation of all species of the genus

Gleditsia during the year. An analysis of the natural distribution areas of cultivated Gleditsia species under the conditions of chestnut soils of the Volgograd region is presented below.

The area of natural distribution of Gleditsia triacanthos is the central part of North America from western New York and Pennsylvania to southern Minnesota (43° N) and eastern Kansas and south to northeastern Texas and northern Georgia. It naturally grows in woodlands (Figure 1).

The southern part of Lankaran is considered the natural habitat of *G. SARS* is considered. There, it grows in groups and single specimens in the lowland and foothill parts. The area of natural growth has a humid subtropical climate. It is characterized by moderately warm winters, dry and hot summers, and rainy autumns. The lowest temperature can be recorded at the beginning of the year, and the warmest period begins in mid-summer. The average summer temperature is about 18 °C.

G. texana, grows in forests, river floodplains, swamps and lakes. Individual trees are seen in the lower part of the Brazos River, near the settlements of Brazoria and Texas. The distribution region is characterized by a temperate-subtropical climate, covering the southern part of the continent from various lakes in the east to the Columbia River in the West. Texas is represented by two climatic zones. In the south, a hot subtropical climate dominates, and in the north and central part – a continental climate with warm summers and cold winters. The average temperature in the central and northern parts in the middle of winter ranges from 0 °C to 18 °C, in July it rises to 30 °C (Flynn, 2018).

The research region (Volgograd region) belongs to the dry-steppe zone, the climate is continental. The characteristic features of the climate are: active wind regime throughout the year, frequent dry weather, low rainfall, falling more often in the form of showers, accompanied by heavy winds and storms.

The average annual precipitation is about 400 mm. Precipitation is distributed unevenly

Table 1. Agrochemical indicators of chestnut soil in the Volgograd region

Horizon, cm	pH	The absorption capacity of the reason, mg.-EQ. per 100 g of soil	Humus, %	Nutrient content power supply system		
				N	P ₂ O ₅	K ₂ O
				% of absolutely dry soil		
A (0–21)	7.0	23.8	1.84	0.135	0.141	1.90
In ₁ (30–40)	7.1	21.8	1.51	0.102	0.138	1.83
sun (40–70)	7.2	12.7	0.88	0.088	0.121	1.55
S (80–120)	7.2	9.5	0.16	0.036	0.100	1.38

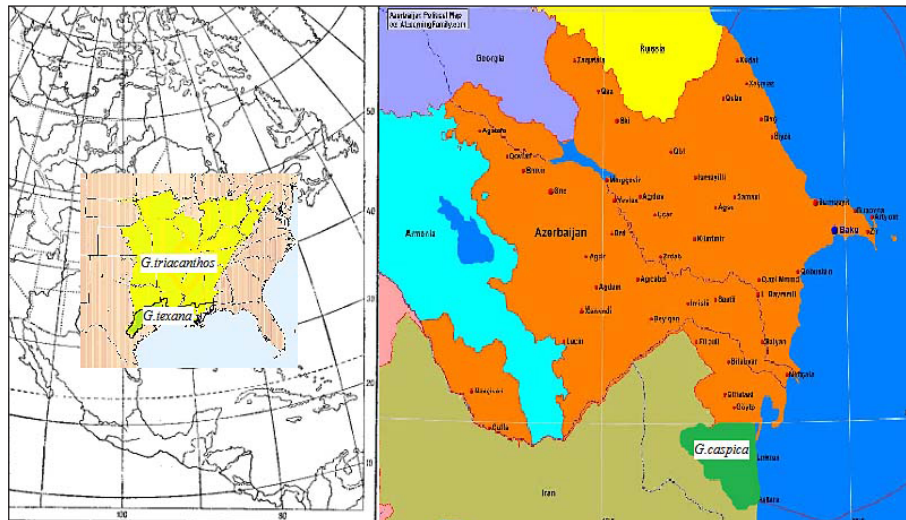


Figure 1. Natural habitats of the Gleditsia genus: *G. cassia*, *G. texana*, *G. triacanthos*

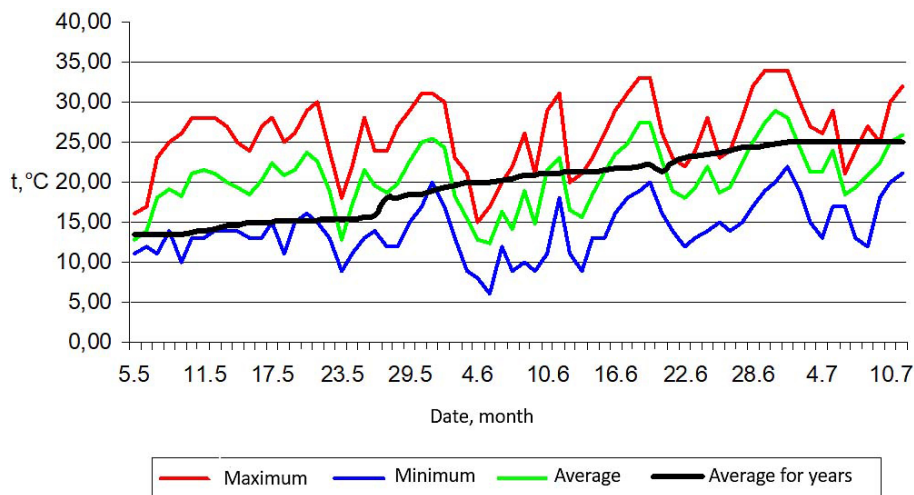


Figure 2. Temperature regime during the growth of shoots of the Gleditsia genus

throughout the year, which is typical for the entire south-east of the European part of the Russian Federation. Most of the precipitation falls in the spring-autumn period. The precipitation in summer falls mainly in the form of short rains and does not have time to saturate the ground.

The average annual temperature during the study period was 19.96 °C. The data of the temperature regime during the growth of shoots (May 5–July 11) showed fluctuations in the minimum temperature from 6 °C to 22 °C, the maximum values reach from 15 °C to 34 °C, while the average temperatures ranged from 12.8 °C to 29 °C (Kazemzadeh Chakusary, 2019). Comparing temperatures, a cold snap can be observed in the first decade of June (Figure 2).

While analyzing the data obtained from observations of the growth and development of representatives of the Gleditsia genus under the

conditions of non-irrigated lands, it should be noted that the observed species of the Gleditsia genus showed slight differences in the timing of the beginning and end of shoot growth. Hence,



Figure 3. *Gleditsia triacanthos* spikeless form in the flowering phase

Table 2. Data of phenological observations of *G. texana* L., *G. caspica* L.

Indicator		Average periods (months, decades) of phenological parameters		
		of <i>G. texana</i> L.	<i>G. caspica</i> L.	<i>G. triacanthos</i> L.
Blooming	Start	15 V 26 V–16 VI	3 VI 18 V–16 VI	2 VI 23V–12 VI
	Mass	12 VI 30 V–12 VI	9 VI 24 V–18 VI	30 V 28 V–14 VI
	End	16 VI 6 VI–26 VI	19 VI 11 VI–22 VI	18 VI 3 VI–18 VI
End of shoot growth		3VII	11VII	3VII

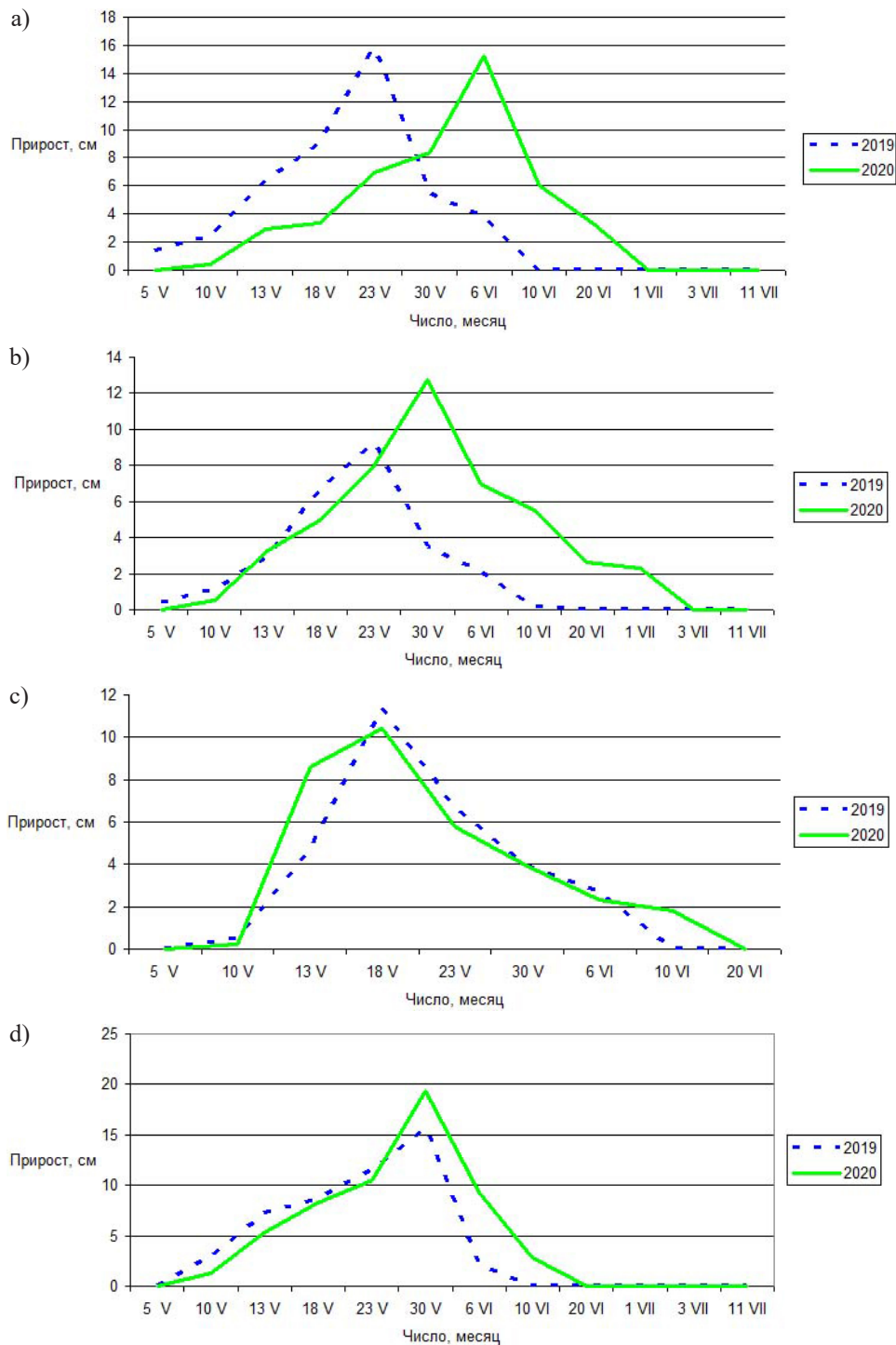


Figure 4. Dynamics of growth of shoots of various species of the *Gleditsia* genus; a) *Gleditsia triacanthos*; b) *Gleditsia triacanthos* f. *inermis*; c) *Gleditsia caspica*; d) *Gleditsia texana*

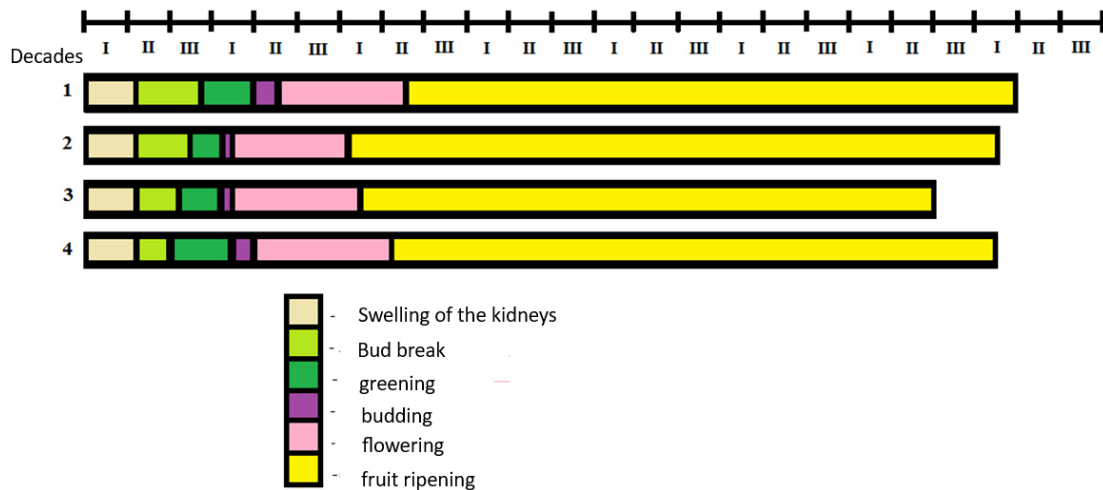


Figure 5. Phenospectrums of various species of the *Gleditsia* genus under the conditions of the Volgograd region according to long-term data (1-*G. texana*., 2-*G. triacanthos*., 3-*G. caspica*., 4-*G. triacanthos f. inermis*)

there is a continuous flowering of plants during a fairly long summer period (Figure 3; Table 2).

In 2019, the growing season of *Gleditsia triacanthos* was 195 days with the beginning of growth of shoots on 05.05. *Gleditsia cassia* – 172 days, the beginning of growth was noted on 10.05. The *Gleditsia texana* species had a growing season of 188 days. The growth of shoots of this taxon began on 10.05. In the first year of observation, the *Gleditsia* shoots have an average growth of up to 16 cm. In the following year, the length of growth of such shoots increases to an average of 19 cm, but the indicators of *Gleditsia cassia* almost do not change.

In *Gleditsia triacanthos*, shoot formation began at 10.05 in 2020. On June 6th, when the temperature increased to +26 °C, the maximum increase was observed, which was 15.85 cm. During the following days, the growth slowed down three times, the end of the growth of shoots in this species occurred 10 days later than in the previous year. *Gleditsia triacanthos f. inermis* was almost identical to *Gleditsia triacanthos*. The beginning of growth of *Gleditsia texana* shoots was noted on 10.05 at an average decadal temperature of +19.75 °C. The rise in growth was recorded from the 2nd decade of May to the 1st decade of June, as in the previous year.

In the shoots of *Gleditsia cassia*, growth began in the second decade of May at a temperature of +21.0 °C and during the first 10 days, they recorded a maximum increase of up to 10 cm. A slight increase in the June temperature to +27 °C contributed to a gradual slowdown in growth (Figure 4).

The obtained data of phenological observations under the conditions of chestnut soils allowed establishing that the timing of the beginning of swelling and budding in all species is generally the same, with small deviations of 2–4 days. In *Gleditsia cassia*, the end of shoot growth occurs around the first decade of July, this is the longest period among the studied species; the fruits ripen earlier than in other species. The flowering period of *Gleditsia triacanthos* and *Gleditsia texana* has a long duration of about a month (Figure 5).

CONCLUSIONS

On the basis of phenological and biometric observations, it was found that under the conditions of chestnut soils, the *Gleditsia* shoot system does not have special generative shoots. After a steady transition of the average daily air temperature above +16 °C (I–III decades of May), the growth of shoots becomes visible in *Gleditsia*, while the growth intensity increases significantly at an average daily temperature above +20 °C. The termination of the formation activity of apical meristems was recorded in the second decade of July, at an average daily temperature of +25 °C.

When comparing the data on the development of shoots of different *Gleditsia* species, no clear differences were found. *Gleditsia triacanthos* has the longest growing season (195 days) compared to the rest of the studied species. During the growing season, all *Gleditsia* species go through a full cycle of development, which indicates the

success of their introduction. This proves that the *Gleditsia* genus is a stable plant in chestnut soils.

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