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## BIOECOLOGICAL FEATURES AND REPRODUCTION OF *Carica papaya* L. IN CLOSED CONDITIONS (AZERBAIJAN)

©**Mammadov T.**, Dr. habil., Corresponding Member of Azerbaijan NAS,  
Institute of Dendrology of Azerbaijan NAS, Baku, Azerbaijan, [denrary@mail.ru](mailto:denrary@mail.ru)

©**Huseynova A.**, Institute of Dendrology Azerbaijan NAS,  
Baku, Azerbaijan, [aynur.huseynova.1968@mail.ru](mailto:aynur.huseynova.1968@mail.ru)

## БИОЭКОЛОГИЧЕСКИЕ ОСОБЕННОСТИ И РАЗМНОЖЕНИЕ *Carica papaya* L. В ЗАКРЫТЫХ УСЛОВИЯХ (АЗЕРБАЙДЖАН)

©**Мамедов Т. С.**, д-р биол. наук, член-корр. НАН Азербайджана,  
Институт дендрологии НАН Азербайджана, г. Баку, Азербайджан, [Dendary@mail.az](mailto:Dendary@mail.az)

©**Гусейнова А.**, Институт дендрологии НАН Азербайджана,  
г. Баку, Азербайджан, [aynur.huseynova.1968@mail.ru](mailto:aynur.huseynova.1968@mail.ru)

*Abstract.* The article for the first time at the Institute of Dendrology of Azerbaijan NAS presents the introduction, reproduction, bioecological features, and dynamics of growth and development of the species *Carica papaya* L. in closed conditions. The seed and vegetative methods of propagation of the species *Carica papaya* L., which we consider promising, can be successfully applied in interior gardening, and the results of studies of the last 3 years on them have been studied. To achieve this goal, the following studies were carried out: the study of seed and vegetative methods of reproduction; the determination of the morphological features of seedlings obtained at the initial stage of development (ontogenesis), the study of biorhythms of development, the study of the dynamics of growth and development of the root system of annual plants.

*Аннотация.* В статье впервые в Институте дендрологии НАН Азербайджана представлены данные интродукции, размножения, биоэкологических особенностей, динамики роста и развития вида *Carica papaya* L. в закрытых условиях. Изучены семенной и вегетативный способы размножения вида *Carica papaya* L., которые считаются перспективными и которые могут быть успешно применены в озеленении интерьера, и результаты исследований последних 3 лет по ним. Для достижения поставленной цели были проведены следующие исследования: изучение семенного и вегетативного способов размножения, определение морфологических особенностей сеянцев, полученных на начальном этапе развития (онтогенезе), изучение биоритмов развития, изучение динамики роста и развития корневой системы однолетних растений.

*Keywords:* introduction, bioecology, reproduction, morphology, growth and development.

*Ключевые слова:* интродукция, биоэкология, репродукция, морфология, рост и развитие.

### Introduction

Species *Carica papaya* L. — belongs to the family Caricaceae, genus *Carica* L. It is native to southern Mexico, and North and Central America, and is currently grown in India and Brazil, all tropical countries. It is a palm-like, not fully woody, 5–10 m tall, evergreen, perennial tropical plant.

Although *Carica papaya* L. is a tropical plant, it is also grown in subtropical climates. The large leaves are 50–70 cm in diameter, arranged in the form of a rosette at the apex of the branchless body, long-stalked, and divided into 5 or 7 parts. The flowers, which develop from the leaf axils, then turn into large fruits 10-30 cm in diameter and 15–45 cm long. *Carica papaya* L. has three types - male, female, and hermaphrodites. *Carica papaya* L. is a pollinated plant both by itself and by insects. Some species produce parthenocarpic (without pollination) fruits but are less productive and of poor quality. Fully ripe fruits are soft and orange in color. The flesh of ripe fruits is yellow, orange and red. The nucleus of the stem of a young plant contains soft tissue, while the nucleus of an adult plant is empty [2].

One of the interesting features of the species *Carica papaya* L. is that over time, depending on the temperature of the environment in which it is located, the male becomes a female or, conversely, the female becomes a male.

#### Material and Methods

The research was conducted in 2020–2022 in the experimental areas of the laboratory “Introduction and acclimatization of trees and shrubs” of the Institute of Dendrology of Azerbaijan NAS.

The research work was based on the methods of U. M. Agamirov, M. R. Gurbanov — introduction [1], I. V. Sokolov — biological features [2], M. K. Firsova — seed propagation [3], I. G. Serebryakov — the morphology of seedlings [4], Iskandarov E. O. — bioecological features [5], of A. A. Molchanov, V. V. Smirnov — annual growth [6], L. S. Plotnikov — vegetative propagation [7], and morphology and development of the root system of V. A. Kolesnikov [8].

#### Analysis and Discussion

For the first time, introduction, reproduction, bioecological features, growth and development dynamics of *Carica papaya* L. species in closed conditions were studied on a scientific basis. Bioecology, morphogenesis, phenology and anatomical structure of the initial stage of ontogeny (juvenile, germination phases) were studied.

The seeds obtained as a result of the exchange from the Portuguese Institute of Agronomy were sown indoors in the first ten days of April (04.03.2020) on a special substrate (peat, sand, perlite, forest soil) in a ratio of 1:1:1:1, at a depth of 2 cm (Table 1).

Table 1

REPRODUCTION OF THE SPECIES *Carica papaya* L. INDOORS BY SEEDS

<i>Place where seeds were sent from</i>	<i>Sowing time</i>	<i>Depth of sowing, in cm</i>	<i>Number of seeds sown</i>	<i>Selected substrate</i>	<i>First sprout</i>	<i>Mass germination</i>	<i>% of germination</i>
Portugal — Tapada da Ajuda Agronomic University	03.04.2020	2	100	forest land, peat, sand, perlite (1:1:1:1)	11.05.2020	19.05.2020	50-55

The seeds are washed and dried on paper for about a day [3]. The first sprouts are observed 25–30 days after sowing. The first seedlings (11.05.2020) gave a result of 50–55%. The seedlings are seed-based. As soon as the first green leaf is formed after germination, photosynthesis begins freely in the seedling. Cotyledon leaves are formed 4–5 days after germination. Cotyledon leaves are divided into two, oval, entire, convex, and dark green. Real leaves appear after 2–3 days. After

12 days, the plant produces 5–6 leaves, the height of the plant reaches 8 cm, and the diameter of the umbrella reaches 6.5 cm. The length of the hypocotyl is 4.8 cm, and the epicotyl is 2.7 cm [4]. The lifespan of cotyledon leaves in the species studied ranges from  $54 \pm 2$  to  $73 \pm 3$  days. Seedlings grow rapidly and in the first year, they are transplanted 2–3 times — each time they are transplanted into larger pots.



Figure 1. *Carica papaya* L. first seedlings

In the closed conditions of Absheron, the growth and annual growth of I-III single specimens of the species *Carica papaya* L., and the dynamics of seasonal growth were studied. During the vegetation period, the height of the plant, and the diameter of the umbrella were measured every 10 days and at the same time for months, and the annual growth was calculated. Growth in 1–3-year-old plants is divided into 2 periods: in the first period, intensive growth from the second decade of May to the end of June, in the second period, growth begins in the third decade of August and continues until the first or second decade of September. The growing season varies from  $245 \pm 5$  days [6].



Figure 2. 1–3-year-old specimens of *Carica papaya* L.

The height of plants varies from 27.5 to 35 cm, in the second year from 73 to 85 cm, and in the third year from 155 to 172 cm. An intensive increase in height and umbrella diameter is observed after the second year (Table 2). *Carica papaya* L. morphological parameters, annual growth, number of leaves, umbrella and root throat diameter were studied.

Table 2

MORPHOLOGICAL PARAMETERS OF I–III ANNUAL COPIES  
 OF *Carica papaya* L. SPECIES (cm) 2020–2022 years

Species	Years	Heigh	Umbrella diameter	Plant stem	Leaves		
					Leaf count	Petiole length	Diameter
<i>Carica papaya</i> L.	I annual	67,5–75	24	3,5	7	9–11	14–16
	II annual	85–102	40	8,5	11	11–15	15–17
	III annual	155–172	143	12	15	45–50	37–44

Vegetative propagation is also possible: it is necessary to choose 1–2-year-old plants with a diameter of 1.5 cm. The root is divided into sections 10 cm long and the cuttings are placed on a sandy substrate to take root. Proper microclimate conditions must be selected to accelerate the regeneration process of pens. In areas cultivated with a pen (greenhouse, room, etc.), the air temperature should be 22–25 °C, and the relative humidity should be 60–65%. Substrates and pens should be properly selected to ensure the subsequent strong development of calluses and roots in the cracks. If reproduction is carried out with woody pens, it is better to have pen lengths from 10 cm to 40 cm [7].

Temperature, humidity and light play an important role in plant development. *Carica papaya* L. is a thermophilic species that grows better at high temperatures. Another factor necessary for successful cultivation is high humidity. The humidity during the growing season must be 66%. In winter, these plants need special protection. In particular, the substrate must not be too wet, otherwise, the papaya roots may rot. The requirements of *Carica papaya* L. to heat, light, humidity, cold airflow and soil nutrition in the greenhouse were studied. The results of the study are given in Table 3.

Table 3

RELATION OF THE SPECIE *Carica papaya* L. TO ENVIRONMENTAL FACTORS

Specie	Environmental factors				
	Heat	Daylight	Humidity	Cold airflow	Soil
<i>Carica papaya</i> L.	+	+	+	–	±

Note: (+) very demanding, (–) slightly demanding, (±) relatively demanding. Note: (+) very demanding, (–) slightly demanding, (±) relatively demanding. *Carica papaya* L. is highly demanding on environmental factors during the period of growth and flowering, fruiting, and less demanding towards the end of the growing season [5].

*Carica papaya* L. specie has a taproot. The taproot system is characterized by the presence of a well-defined main root, which is much longer and wider than the lateral roots. The main root branches to a depth of 35.5–58.0 cm in the soil, forming a large number of fibrous suction roots. At 3–5 cm below the root collar of the studied species, the diameter of the main root ranges from 4.5–6.0 cm. The length of the primary lateral roots reaches 7–9 cm. There is an increase in the number and length of secondary and tertiary lateral roots, thickening. The number of lateral roots is 11–18, the length is 34.0–38.0 cm. The lateral roots are mostly spread in the layer close to the top surface of the soil (Figure 3). Grade II and III side roots are formed and spread horizontally in the soil on both sides. It is very rare for these roots to spread in only one direction. In cultivated plants, the root is spread in the area close to the top surface of the soil. The formed root system ensures the normal growth of the aboveground part of plants [8].



Figure 3. The root system of 1-year-old seedlings of *Carica papaya* L.

The roots of the plant are close to the soil surface, so in the hot season, they need abundant watering. In early October or November, watering should be significantly reduced. In cool weather, the root system weakens, which leads to stagnation of fluid in the substrate, at that time the root slowly begins to rot.

#### Conclusion

It was found that the best time for sowing the plant is spring when 50–55% of seedlings have sprouted. As *Carica papaya* L. is a tropical plant, sunlight is a very important factor in the development of seedlings. During this period, air temperature and humidity provide normal growth of seedlings (24–25 °C and 70–80%). Height growth is 60–70% of the total growth during the growing season. Morphological description of seedlings, growth dynamics of 1–3-year-old seedlings, and correlation between aboveground and underground parts were studied. It was determined that in the first year of seedlings the aboveground part (67.5–75 cm) develops better than the underground part (35.5–58.0 cm).

The optimum temperature should be between 21 °C and 33 °C. When the temperature is 12–14° C, the plants stop growing. Frost tolerant, water-loving plant, grown in all tropical and subtropical zones, at any time of the year — at 0.5<sup>0</sup>C the plants are destroyed. *Carica papaya* L. needs high humidity. The duration of vegetation varies between 245±5 days, and the humidity during this period must be 66%. It is demanding to the soil and does not like saline soils. The plant bears fruit at the age of 3–4 years, its lifespan is about 8-10 years, and in cultural conditions, it lives 15–20 years.

Taking into account the possibilities of adaptation, biological and decorative features, perspective criteria, as well as therapeutic and nutritional significance, it is expedient to cultivate *Carica papaya* L. on farms.

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