

RESEARCH ARTICLE

Experimental study on ornamental plants in gardens by introduction and cultivation technique

Wanting He¹, Hai Huang^{2, *}

¹Chongqing Industry Polytechnic College, Yubei, Chongqing, China. ²Chongqing Vocational Institute of Engineering, Jiangjin, Chongqing, China

Received: December 9, 2023; accepted: February 8, 2024.

Ornamental plants are an indispensable element in landscape design. The introduction and cultivation technology can introduce ornamental plants from the outside of the local area to increase the diversity of landscape. This research studied the conditions for introduction and cultivation technology to briefly introduce the garden ornamental plants and the introduction and cultivation technology, and then discuss the adaptability of three peony varieties including Dingxiangzi, Chunhongjiaoyan, and Ruhuasiyu. The Dingxiangzi variety of peony flowers was taken as the subject for the case study, and three influence factors including watering frequency, shade, and temperature during the introduction and cultivation were tested. The results showed that the adaptability of the Dingxiangzi variety was the best. When watering frequency, shade, and temperature increased, the growth state of peony showed a trend of good first and then declined. The increase of temperature increased the disease susceptibility. The results of this study validated the application of introduction and cultivation technology for peony flowers in remote planting and provided an effective reference for the transplantation of ornamental plants to different locations.

Keywords: garden; ornamental plant; introduction and cultivation; peony flower.

*Corresponding author: Hai Huang, Chongqing Vocational Institute of Engineering, Jiangjin, Chongqing 402260, China. Email: huanglia826@yeah.net.

Introduction

Garden ornamental plants are an indispensable element in garden landscape design and play an important role in creating a beautiful and comfortable environment. The different types, colors, and forms of ornamental plants can increase the color and layer of the landscape, making it more attractive. In addition, garden ornamental plants can improve air quality [1]. Cultivating a large number of garden ornamental plants can increase the vegetation coverage of a city, absorb harmful substances in the air, and purify the air. Moreover, garden ornamental plants can also absorb noise, regulate

temperature, and improve the quality of life in cities. The garden ornamental plants also have certain economic value. Through reasonable planning and design, garden ornamental plants can attract tourists, promote the development of local tourism, and thus stimulate economic development [2]. Therefore, as an important part of urban greening and garden construction, garden ornamental plants play an important role in beautifying the environment and improving the quality of life [3]. However, due to the restrictions of climate, soil, and other environmental factors, the introduction and cultivation of many ornamental plants in specific areas are difficult [4]. To solve this problem,

introduction and cultivation technology becomes the most important method, which can promote the growth of ornamental plants in gardens by adjusting environmental conditions, improving soil quality, and screening more adaptable varieties. However, different ornamental plants have different adaptability to the environment, and the success rate of plant introduction and cultivation will also be affected by environmental and management factors [5].

Peony is a popular ornamental plant and one of the traditional famous flowers in China. Its cultivation history can be traced back to the 3rd century BC. Known as the national flower of China, peonies play an important role in Chinese culture and are endowed with the symbolic meaning of wealth, prosperity, happiness, and glory [6]. Peonies are perennial herbs belonging to the genus *Peonies* in the rose family. Their flowers are usually large and plump with rich petals in a variety of colors including red, pink, yellow, white, and purple. The leaves of peonies are usually dark green, and the plants are generally of moderate height with woody stems and luxuriant foliage. Tang *et al.* introduced and cultivated four varieties of *Feijoa sellowiana* and verified that they all had adaptability in the environment of Hunan Province [7]. Zhao *et al.* conducted a study to enrich the ornamental vegetable plant resources in Kunming and found that nine kinds of ornamental vegetables could be applied to urban agriculture in Kunming [8]. Liu *et al.* observed the survival rate and growth vitality of 59 medium woody landscape plants introduced in Fujian park landscaping project for 15 years, and found that wind damage and low temperature were the key factors affecting the introduction of woody landscape plants in Linzhi City [9]. The results from previous studies suggest that it is necessary to conduct targeted research on the introduction and cultivation of different ornamental plants, select the varieties with stronger adaptability, and summarize the appropriate cultivation conditions.

Introduction and cultivation technology is a method of planting and cultivation by

introducing plants from other places or abroad to new areas [10]. Its main purpose is to increase the beauty and diversity of the garden landscape. Introduction and cultivation technology mainly includes variety selection, variety source, adaptability test, cultivation technology, maintenance and management, genetic improvement, monitoring, and evaluation [11]. The introduction and cultivation steps of ornamental plants are to investigate the ornamental plants that need to be introduced and cultivated including their adaptability, ornamental value, economic value, ecological habits, *etc.* At the same time, the climate, soil environment, and other factors in the introduced area will also be investigated before introduction and transportation [12]. Suitable introduced plants are selected according to the information known in the investigation. In the process of transportation of introduced plants, protection measures should be set according to the sources of introduction to ensure the activity of introduced plants. After the introduction of plants to the destination, the cultivation and maintenance, mainly including soil preparation, planting, watering, fertilization, and other works are performed. Different plants require different conservation and management measures based on their ecological habits and growth environment needs. The growth process of plants needs to be regularly monitored and evaluated to timely find problems and take corresponding measures to ensure the growth of plants and the effect of garden landscape. This research focused on the introduction and cultivation techniques of peonies using peony varieties to investigate the influence factors to the non-native ornamental plant introduction and cultivation in gardens. It would provide valuable references for enhancing landscape diversity in gardens.

Materials and Methods

Peony varieties

Peonies have numerous different varieties and cultivars, each with unique flower shape, color, and fragrance. This research focused on the

cultivation of three peony varieties including Dingxiangzi, Chunhongjiaoyan, and Ruhuasiyu, which are all the subspecies of *Paeonia L.* in the family *Paeoniaceae* and originally from Heze, Shandong, China. The Dingxiangzi plant is medium size, and its flowers have a diameter of approximately $10 \times 19 \text{ cm}^2$. It blooms with medium-sized flowers throughout the year, characterized by purple color and ball-shaped petals that open sideways. Dingxiangzi belongs to the late-flowering variety. Its flower buds are round and pointed, with only two or three layers of outer petals. The leaves are narrow, long, thin, and elegant. Chunhongjiaoyan plant grows tall with a compact and upright form. Chunhongjiaoyan has heavily-petaled flowers that resemble chrysanthemums, with layers of petals and a light yellow center. The flower color can range from purplish red to light pink. Ruhuasiyu belongs to the medium-sized flower variety and has a chrysanthemum-like flower shape with pink color. The outer petals are large and flat, while the inner petals are delicate and finely divided. There are black spots at the base of the petals. The stamens are partially petalized, while the pistils are completely petalized. The medium size seedlings were used for cultivation with 100 plants for each variety.

Plant cultivation

To facilitate the adjustment of the environment faced by plants in the process of introduction and cultivation, and to analyze the influence of introduction and cultivation technology on peony flowers, the peony varieties were planted in greenhouses located in Yubei district, Chongqing, Sichuan, China, which were equipped with ventilation system, heating and cooling air conditioner, and automatic irrigation system [13]. The temperature, humidity, soil matrix, fertilizer application amount, and pesticide amount of the planting site were controlled by artificial means. The cultivation adaptability of the three varieties of peonies was first tested. In the process of introduction and cultivation, the local common soil was adopted and well-drained, the watering frequency was set to twice a month, the shading degree of the greenhouse was set to 50%, and

the temperature was set to 15°C. Observation records of the three varieties of peonies were kept for three months after planting. The survival rate of different varieties of peonies was also recorded. The peony variety with the highest survival rate was then determined to study the effects of watering frequency, shade, and temperature on the growth of peony during the introduction and cultivation process of this variety.

Effects of three major cultivation factors

The effects of watering frequency, shade, and temperature on the growth of selected peony variety were examined when the remaining cultivation environment factors were fixed, which included that the local common soil was used, good drainage was ensured during the laying of soil, the frequency of fertilizing the soil was three times a year, the budding tillering buds at the root and stem of peony were removed at the end of spring and summer, the plants were sprayed with germicidal solution once every two weeks. The watering frequency was tested at 2, 3, 4, 5, and 6 times/month [14], while the shade was set at 50% and the temperature was set at 20°C. The influence of shade degree was tested at 0, 25, 50, 75, and 100%, respectively, when the temperature was set at 20°C and the watering frequency was set at 4 times/month. The influence of temperature during the introduction and cultivation was tested at 10, 15, 20, 25, and 30°C, respectively, when shade degree was set at 50% and watering frequency was set at 4 times/month. The growth states of selected peony variety under different watering frequencies, shades, and temperatures were recorded during the flowering period. The indicators used to evaluate the growth of peony plants included plant height, stem diameter, leaf length, flower diameter, flowering duration, and disease susceptibility [15].

Statistical analysis

The data was analyzed using SPSS software (IBM, Armonk, New York, USA). The statistical results were presented as $\bar{x} \pm s$, and t-tests were conducted to compare the differences.

Table 1. Growth under different watering frequencies during the flowering.

Watering frequency	2 times per month	3 times per month	4 times per month	5 times per month	6 times per month
Plant height (cm)	43.84 ± 11.45	52.42 ± 11.23	59.74 ± 13.04*	56.58 ± 10.47	44.25 ± 9.87
Stem thickness (mm)	6.57 ± 0.97	8.11 ± 0.89	9.55 ± 1.90*	8.36 ± 0.96	7.11 ± 0.87
Leaf length (cm)	18.98 ± 4.23	23.56 ± 5.21	29.20 ± 5.46*	24.25 ± 3.69	17.85 ± 3.26
Flower diameter (cm)	8.97 ± 1.02	11.22 ± 1.21	13.27 ± 1.97*	10.87 ± 1.23	9.11 ± 1.14
Flowering duration (day)	8 ± 1	9 ± 1	11 ± 2*	9 ± 2	8 ± 1
Susceptibility rate (%)	3.6	2.5	1.2*	2.2	3.4

Note: * indicated significant difference ($P < 0.05$).

Results

The survival rate of the three varieties of peonies

Within three months of introduction and cultivation, the survival rate of the three varieties of peonies decreased with the increase of cultivation time (Figure 1). The survival rate of the Dingxiangzi variety was the highest one, while the survival rates of the Chunhongjiaoyan and Ruhuasiyu varieties were the second and the third one, respectively. From the change trend of the survival rate in the cumulative three months, only the Dingxiangzi variety tended to have a stable survival rate among the three varieties, which indicated that the Dingxiangzi variety had the best adaptability among the three varieties.

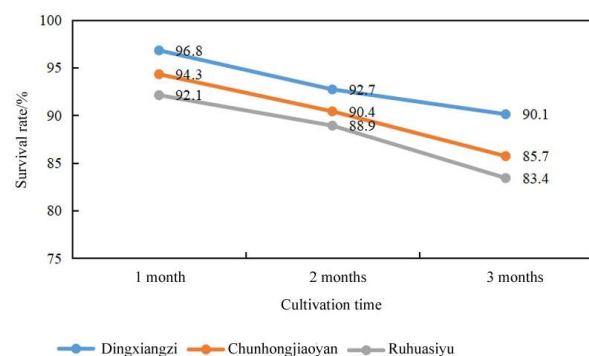


Figure 1. Survival rate of three varieties of peony flowers within three months of planting.

The growth status of the three varieties of peonies

In the process of introduction and cultivation, the growth status of the peony in the continuous stage of flowering under different watering frequency demonstrated that the plant height, stem diameter, leaf length, flower diameter, and flowering duration of the peony all showed a trend of first increasing and then decreasing with the increase of watering frequency, while the disease susceptibility rate decreased first and then increased (Table 1). When the watering frequency was 4 times/month, the growth condition of peony was the best. The examination of the effects of different shade levels on the growth status of the peony in the continuous stage of flowering showed that the plant height, stem diameter, leaf length, flower diameter, and flowering duration of the peony increased first and then decreased with the increase of shade, while the susceptibility rate decreased first and then increased (Table 2). When the shade was 50%, the growth of the peony was the best. The effects of different temperatures on the growth conditions of the peony in the continuous stage of flowering showed that the plant height, stem diameter, leaf length, flower diameter and flowering duration of the peony all increased first and then decreased with the increase of temperature, while the susceptibility rate showed an increasing trend (Table 3). After comprehensive consideration, the growth of the peony was the best when the temperature was 20°C.

Discussion

Table 2. Growth under different shade levels during the flowering.

Shade (%)	0	25	50	75	100
Plant height (cm)	41.74 ± 10.41	51.23 ± 12.23	59.74 ± 13.04*	55.47 ± 9.47	43.25 ± 9.37
Stem thickness (mm)	6.21 ± 0.36	8.78 ± 0.68	9.55 ± 1.90*	8.11 ± 0.78	7.36 ± 0.71
Leaf length (cm)	17.88 ± 3.23	23.11 ± 5.33	29.20 ± 5.46*	24.58 ± 3.74	17.58 ± 3.62
Flower diameter (cm)	8.74 ± 1.14	11.33 ± 1.12	13.27 ± 1.97*	10.57 ± 1.65	9.27 ± 1.02
Flowering duration (day)	8 ± 2	9 ± 2	11 ± 2*	9 ± 1	8 ± 1
Susceptibility rate (%)	3.2	2.4	1.2*	2.1	3.5

Note: * indicated significant difference ($P < 0.05$).

Table 3. Growth under different temperatures during the flowering.

Temperature (°C)	10	15	20	25	30
Plant height (cm)	43.72 ± 11.33	52.31 ± 11.27	59.74 ± 13.04*	56.24 ± 10.27	44.52 ± 9.77
Stem thickness (mm)	6.23 ± 1.97	8.28 ± 0.78	9.21 ± 1.75*	8.65 ± 0.87	7.35 ± 1.87
Leaf length (cm)	18.52 ± 4.11	23.43 ± 5.58	29.20 ± 5.46*	24.52 ± 3.45	17.54 ± 3.67
Flower diameter (cm)	8.57 ± 1.16	11.64 ± 1.28	13.27 ± 1.97*	10.57 ± 1.64	9.25 ± 1.33
Flowering duration (day)	8 ± 1	9 ± 2	11 ± 2*	9 ± 1	8 ± 1
Susceptibility rate (%)	1.0	1.1	1.2*	2.3	3.6

Note: * indicated significant difference ($P < 0.05$).

Garden ornamental plants are an integral element of urban greenery and can enhance the color and layering of a city or garden landscape, while also improving air quality. There are various kinds of garden ornamental plants, and garden landscape designers can combine the characteristics of different plants to achieve the overall planning and decorative effect of garden landscape. However, different regions have different environmental conditions. It is impossible to include all kinds of ornamental plants, so the introduction and cultivation technology comes into the most important step. Introduction and cultivation technology refers to a method of introducing plants native to other areas into a specific geographical environment and cultivating them. This technique can enrich the types of ornamental plants in the garden and improve the adaptability of ornamental plants. In addition, the introduction and cultivation technology can be used to conduct experimental research on different kinds of ornamental plants. The growth of ornamental plants in different environments is adjusted artificially to provide scientific basis for the design of garden landscape and the cultivation of better ornamental plants.

The results of this study showed that the Dingxiangzi variety of peony had the best adaptability among the three tested varieties and was used to study the factors that would have influence on plant growth during introduction and cultivation. The influences of watering frequency on plant growth demonstrated that, with the increase of watering frequency, the growth state of the peony showed an increased trend first and then declined. A possible reason for this phenomenon might be that peony plants needed water in the beginning of the growth process, and a low watering frequency would lead to insufficient water required for growth and affected the growth state. However, the roots of peony are fleshy, which have a certain capacity of water storage and do not need too much water. Therefore, when the watering frequency increased, the water in the soil was difficult to drain away in time, which might rot the roots of peony and eventually affected the growth state. The influence of shade on the growth state of peony showed that with the increase of shade, the growth state of the peony showed a trend of increase at first and then decline. The reason might be that the growth of peony needs light

and a small shade means a large light intensity, which was good to plant in the beginning stage. However, excessive illumination could subject peony leaves to high temperature, leading to withering in severe cases and ultimately affecting their growth status. On the other hand, when the shade was high, the lack of light would make plant photosynthesis weaker than respiration, which would also affect the growth state in the long run. The influence of temperature on the growth state of peony demonstrated that the growth state of the peony showed a trend of increase first and then decreased with the increase of temperature, and the susceptibility rate increased with the increase of temperature. The possible reason might be that, when the temperature was low, the growth activity of plants would be inhibited, while the pathogenic bacteria activity was also inhibited, which caused poor growth state and low susceptibility rate. When the temperature was high, the growth activity of the plant would also be inhibited, so the growth state was also poor.

This research briefly introduced garden ornamental plants and introduction and cultivation techniques, and compared the adaptability of three peony varieties, Dingxiangzi, Chunhongjiaoyan, and Ruhuasiyu. The Dingxiangzi variety was taken as the test target to investigate the effects of three factors including watering frequency, shade level, and temperature on the growth status of introduced plant. The results showed that the Dingxiangzi variety had the best adaptability for introduction and cultivation. When the watering frequency was 4 times/month, the shade level was 50%, and the temperature was 20°C, the Dingxiangzi peony variety reached the best growth status.

References

1. Anderson RM, Varga WA. 2020. Sego supreme: Pathway to cultivation. *Native Plants J.* 21(3):325-333.
2. Komar-Tyomnaya LD. 2018. Characteristics of morphological and biological traits of ornamental Chinese and Japanese peach cultivars in the conditions of introduction on the Black Sea coast. *Acta Horticult.* 2018(1208):119-124.
3. Honchar GY, Gnatiuk AM. 2020. Urban ornamental plants for sustenance of wild bees (*Hymenoptera, Apoidea*). *Plant Introd.* 85-86:93-108.
4. Yanai Z, Dayan T, Mienis H, Gasith A. 2017. The pet and horticultural trades as introduction and dispersal agents of non-indigenous freshwater molluscs. *Manag Biol Invasions.* 8(4):523-532.
5. Lekawatana S, Suwannamek B. 2017. Ornamental plants in Thailand. *Acta Horticult.* 2017(1167):11-16.
6. Gera A, Beckelman E, Maslenin L, Zeidan M. 2015. Trends in ornamental production, virus detection and identification. *Acta Horticult.* 2015(1072):141-148.
7. Tang L, Cui M, Zou F, Yuan D, Tan X, Zhao S. 2016. A preliminary study on introduction and cultivation of *Feijoa sellowiana* in China. *Adv J Food Sci Technol.* 11(1):43-48.
8. Zhao X, Wang H, Wu Y, Peng S, Chen Z, Wang J, *et al.* 2018. Introduction performance and application evaluation of leafy ornamental vegetables in Kunming City. *Agricult Biotechnol.* 7(3):36-40.
9. Liu Z, Xing Z, Yao X, Zhou P. 2016. Introduction of woody landscape plants in Linzhi City of Tibet. *Landscape Stud.* 2016(4):98-102.
10. Koroleva EV, Petrov AF, Chudinova YV. 2021. Intraspecific variability of oral and ornamental plants of *Onagraceae* family and mechanisms of their variety formation. *Bullet NSAU (Novosibirsk State Agrarian University).* 2021(2):18-42.
11. Bergstrand KJ, Asp H. 2020. End-of-day treatments as a way of controlling growth in ornamental pot plants. *Acta Horticult.* 2020(1296 Pt.1):287-291.
12. Alvaro B, Godoy O, Maurel N, van Kleunen M, Vila M. 2021. Proportion of non-native plants in urban parks correlates with climate, socioeconomic factors and plant traits. *Urban For Urban Gree.* 63:1-14.
13. Zucchi MR, da Silva MW, Sibov ST, Pires LL. 2019. Ornamental and landscape potential of a bromeliad native to the Cerrado. *Ornament Horticult.* 25(4):425-433.
14. Arpaia ML. 2022. An introduction to avocado cultivation with specific references to South India. *Planters Chron.* 118(2/3):4-13.
15. Karlovi K, Purgar DD, Jeran N. 2020. Current status of new ornamental crops market in Croatia. *Acta Horticult.* 2020(1288):199-205.