

# Overview of the Research Status of *Lilium davidii* var. *unicolor*

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**Abstract** This paper reviews the current research status of *Lilium davidii* var. *unicolor*, encompassing its growing environment, cultivation techniques, virus diseases and their impacts, nutritional value, and edible methods. Additionally, it outlines potential future research directions, thereby establishing a foundational basis for the industrial development of *L. davidii*.

**Key words** *Lilium davidii*; Growing environment; Cultivation technique; Virus disease; Research status

## 1 Introduction

*Lilium davidii* var. *unicolor*, a perennial herbaceous crop with a long history of cultivation, is recognized not only for its distinctive medicinal and edible properties but also for its specific environmental requirements and high nutritional value. The medicinal and nutritional properties of *L. davidii*, recognized as the sole sweet lily in the world, underscore its significance in both agricultural production and healthcare. However, *L. davidii* is vulnerable to bacterial, fungal, and viral infections during its growth, resulting in a decrease in both yield and quality. This susceptibility has emerged as a significant constraint to its industrial development. This paper aims to present a comprehensive overview of the current research state of *L. davidii*, encompassing its growing environments, cultivation techniques, virus diseases and their impacts, as well as potential future research directions.

## 2 Growing environment and cultivation technique

**2.1 Growing environment** *L. davidii* exhibits significant ecological requirements, thriving in regions situated at an altitude of approximately 2 200 m. Optimal conditions for its cultivation include deep, well-drained soils with a loose texture, a high content of organic matter, and a cool, humid climate characterized by substantial diurnal temperature variation. The mountainous regions surrounding Lanzhou City experience significant rainfall in summer and autumn, accompanied by abundant sunshine. These climatic conditions create a distinctive environment conducive to the growth of *L. davidii*. The ecological environment of Lanzhou contributes to the unique characteristics of *L. davidii*, which are distinguished by their jade-like whiteness, plump and sweet flesh, and a rich array of nutrients. As a result, *L. davidii* has gained recognition as a notable specialty of Gansu Province.

**2.2 Cultivation technique** The cultivation cycle of *L. davidii* is long, typically requiring a duration of 4–6 years for the development of small bulbs into commercially viable large bulbs. The initial phase of cultivating the seed ball necessitates a period of 2–3 years. Through meticulous cultivation practices, the small

bulbs can attain the requisite standards for commercial lily cultivation seed balls. The planting of *L. davidii* can be categorized into two distinct seasons: spring and autumn. Spring planting typically occurs from middle to late March, while autumn planting is generally conducted from late October to early November. In the cultivation process, several measures are essential for enhancing the yield and quality of *L. davidii*, including selecting appropriate soil and plots, applying adequate basal fertilizers, conducting timely ploughing and weeding, implementing reasonable irrigation and fertilization practices, and promptly removing flower buds.

In recent years, agricultural experts and research institutions have been investigating novel cultivation techniques and methods to enhance lily production and optimize lily varieties. For example, new initiatives, including the implementation of high ridges and shallow planting, the application of straw and film coverings, the utilization of drip and sprinkler irrigation, as well as the adoption of slow-release and microbial fertilizers, have significantly enhanced the soil environment and the growth conditions for lilies. Concurrently, the application of plant cloning and tissue culture seedling technology facilitates the production of virus-free dominant seedlings, thereby enhancing both disease resistance and growth advantages of seed balls.

## 3 Virus diseases and their impacts

**3.1 Main virus diseases** *L. davidii* exhibits susceptibility to various virus diseases throughout its growth, with Lily Symptomless Virus (LSV) and Cucumber Mosaic Virus (CMV) being the most significant. The co-infection rate of LSV and CMV reaches as high as 41.9%, which adversely affects both the growth and nutritional quality of lilies.

There are four primary types of lily virus diseases: lily mosaic disease, necrotic spot disease, ring spot disease, and witches' broom. These diseases are predominantly transmitted through overwintering viruses present in the bulbs, sap inoculation, and vector insects, such as aphids, that facilitate virus transmission. In the initial stages of the disease, lily plants exhibit symptoms including mottled and twisted leaves, deformed flowers, or buds that fail to open. In severe cases, these symptoms may result in stunted growth and ultimately the death of the plant.

### 3.2 Effect of viruses on the growth and nutritional quality of lilies

The study demonstrated that co-infection with LSV and CMV had a more pronounced impact on the growth and nutritional status of lilies than single infections. Specifically, the height, stem thickness, and yield per plant were significantly reduced by 19.9% , 16.9% , and 61.7% , respectively, in co-infected plants when compared to healthy controls. Nevertheless, co-infection and LSV infections have been shown to enhance the concentration of medicinal compounds in lily bulbs, with total phenolic content and total flavonoid content increasing by 20.3% and 34.8% , respectively. Conversely, CMV infection appears to have a negative impact on the accumulation of these medicinal components in lily bulbs.

Metabolomic analyses provide insights into the impact of viral infections on metabolic pathways and networks in lilies. Co-infection has been shown to influence tyrosine metabolism, leading to an increased accumulation of antioxidants, including flavonoids and glycosides. Additionally, the LSV affects carbohydrate metabolism, resulting in elevated levels of steroids, terpenoids, and other compounds. Conversely, the CMV influences fatty acid and tryptophan metabolism, which in turn alters the concentrations of unsaturated fatty acids, alkaloids, and various other metabolites. These findings not only enhance the understanding of the impact of viral infections on the metabolic processes of lilies, but also establish a scientific foundation for the development of new high-quality, high-yield, virus-resistant lily varieties.

## 4 Nutritional value and edible methods

**4.1 Nutritional value** *L. davidii* is abundant in a diverse array of nutrients, including crude fiber, crude fat, potassium, protein, carotenoids, calcium, zinc, iron, vitamin B, vitamin C, *etc.* Furthermore, it provides eight essential amino acids and a range of trace elements, with particularly high levels of zinc. The synergistic effects of these ingredients on the human body not only provide beneficial nutritional tonic properties, but also play a significant role in alleviating various seasonal discomforts associated with dry climatic conditions.

**4.2 Edible methods** *L. davidii* can be consumed in various forms, including raw, stir-fried, or boiled in congee, soup, or steamed dishes. Fresh lilies contain no crude fiber, and upon cooking, they become soft and tender, making them suitable for individuals of all ages. The following are several common methods for preparing and consuming lilies. Honey steamed lilies: the clean *L. davidii* is placed into a container for steaming and subsequently drizzled with a solution of diluted honey water, forming a soft and sweet flavor. Tremella lily soup: the fresh tremella, lilies, wolfberries, and jujubes are stewed together, offering a nourishing effect that promotes beauty. Sweet potato lily sugar water: sweet potatoes, lilies, and jujubes are prepared by cooking and incorporating an appropriate quantity of rock sugar for flavor enhancement, resulting in a sweet and moist taste. Fried lily with celery: celery and lily are stir-fried together, with the lily being cooked until it becomes slightly translucent before being removed from the pan. This preparation

brings a dish that is both refreshing and flavorful.

## 5 Future research directions

Although *L. davidii* has shown advancements in cultivation techniques and the management of virus diseases, numerous challenges remain that require further investigation and resolution. The following outlines the primary directions for future research. (i) Mechanisms of virus disease control: it is imperative to conduct comprehensive investigations into the pathogenic mechanisms and transmission pathways of viruses such as LSV and CMV, while also exploring more effective methods and measures for virus control. (ii) Cultivation of high-quality and disease-resistant new varieties: utilizing modern biotechnological approaches, including gene editing and molecular marker-assisted selection, we aim to develop new varieties of lilies characterized by superior traits and enhanced disease resistance. (iii) Research on nutritional and functional components: this research will further elucidate the physiological functions and health benefits associated with the various nutrients and biologically active substances found in *L. davidii*, thereby providing a scientific foundation for its application in healthcare. (iv) Cultivation technology optimization and standardization: by integrating modern agricultural science and technological methods, we seek to optimize the cultivation techniques and management practices for *L. davidii*, establish standardized production processes and norms, and enhance both the yield and quality stability of lilies.

## 6 Conclusions

*L. davidii*, a perennial herbaceous crop known for its distinctive medicinal and edible properties, has garnered significant attention regarding its research status and potential for development. An examination of the growing environment, cultivation techniques, virus diseases, and their associated impacts can offer substantial scientific and technological support for the industrial development of *L. davidii*. In the future, as research progresses and technological innovations continue, the yield and quality of *L. davidii* are expected to improve further, thereby contributing significantly to human health and agricultural advancement.

## References

- [1] WANG SL, WANG MX. The several thoughts and suggestions to the industrial development of Lanzhou-lily bulb[J]. Journal of Gansu Agricultural University, 2002, 37(3): 82–87, 91. (in Chinese).
- [2] HAN HL, GUO CJ. The tissue culture method of Lanzhou lily[J]. Journal of Tianjin Normal University: Natural Science Edition, 2009, 29(3): 62–65. (in Chinese).
- [3] YANG YH, HUANG P. Effects of planting modes on growth characteristics and yield of *Lilium davidii* var. *unicolor*[J]. Journal of Gansu Agricultural University, 2006, 41(2): 35–38. (in Chinese).
- [4] ZHAO XM, WANG FL, DONG T. Effects of soil moisture content on the germination and emergence of Lanzhou lily bulbs[J]. Northern Horticulture, 2006(1): 43–44. (in Chinese).
- [5] TENG HW, SONG HH. High-quality and high-efficiency cultivation techniques for Lanzhou lily[J]. China Vegetables, 2005(6): 46–47. (in Chinese).