

With the increasing recognition of its medicinal value and the continuous growth of market demand, the utilization of *T. hemsleyanum* has gradually expanded in Chinese medicinal material processing, health product development, and the construction of local specialty medicinal herb industries. Its artificial cultivation area has also increased accordingly. However, the development of the *T. hemsleyanum* industry is still in a transitional stage from wild harvesting to standardized artificial cultivation, and shortcomings remain in seedling propagation, cultivation cycles, yield stability, quality control, processing and storage, and industrial chain construction (Hu et al., 2023; Pang et al., 2024). For a long time, *T. hemsleyanum* resources have mainly depended on wild harvesting. Due to its long natural growth cycle, slow tuberous root formation, overharvesting, and habitat destruction, wild resources have declined significantly, and in some major producing areas it has been regarded as a rare, endangered, or even nearly extinct medicinal plant resource (Ji et al., 2020; Zhu et al., 2020; Shi et al., 2022). Therefore, artificial cultivation has become an inevitable choice for alleviating the contradiction between resource supply and demand, protecting wild populations, and promoting sustainable industrial development.

T. hemsleyanum is naturally distributed in shaded and humid habitats such as gullies, valley slopes, and forest margins. It prefers shaded and humid conditions, is sensitive to strong light, and grows well in humus-rich, loose, and well-drained soils. Its growth and secondary metabolite accumulation are highly sensitive to environmental factors such as light, temperature, and moisture (Shi et al., 2022; Wang et al., 2025). Understory cultivation of medicinal plants is a new ecological cultivation model based on the principle of forest-medicine symbiosis, which makes use of forest canopy, light, temperature, moisture, and soil conditions for medicinal plant production (Li et al., 2025). Existing studies have shown that factors in the understory environment, such as light intensity, air temperature and humidity, soil fertility, pH, and microbial communities, can affect the yield and quality of medicinal plants by influencing photosynthesis, respiration, and secondary metabolism. Meanwhile, understory cultivation also contributes to forest resource conservation, biodiversity maintenance, ecological environment improvement, and sustainable forestry development, and has become an important direction for the forest medicinal herb industry (Guo et al., 2026).

This study explores the construction pathway of an understory ecological cultivation model for *T. hemsleyanum*. Existing studies have mainly focused on its pharmacological activity, chemical composition, quality control, and greenhouse or field cultivation, whereas systematic research on its understory ecological cultivation model remains relatively insufficient. Considering that relatively mature technical frameworks have gradually been established for the understory cultivation of other medicinal plants, including the optimization of shading intensity, canopy structure regulation, soil management, economic benefit evaluation, and ecological function analysis, it is necessary to systematically examine the understory ecological cultivation of *T. hemsleyanum* in relation to its biological characteristics and ecological adaptability. Therefore, this study analyzes the resource value, understory habitat adaptability, ecological cultivation model construction, key cultivation techniques, and industrial development needs of *T. hemsleyanum*, with the aim of providing theoretical references and practical support for suitable stand selection, cultivation technology optimization, and standardized production of this species.

2 Biological Characteristics and Growth Requirements of *Tetrastigma hemsleyanum*

2.1 Morphological characteristics and growth habits of *Tetrastigma hemsleyanum*

Tetrastigma hemsleyanum is a perennial herbaceous climbing vine of the genus *Tetrastigma* in the family Vitaceae, with distinct climbing characteristics. Its stems are slender and flexible, with longitudinal ridges, and adventitious roots may develop from the lower nodes. Young stems are mostly green and cylindrical, while older stems gradually become flattened and purplish brown, usually glabrous or sparsely pubescent (Zhu et al., 2020). The leaves of *T. hemsleyanum* are mostly palmately compound, usually composed of three leaflets and arranged alternately along the stem. The leaflets are generally lanceolate to ovate-lanceolate, with serrated margins, acuminate tips, and cuneate or nearly rounded bases. The leaves are dark green and can adapt well to the diffuse light environment under forest canopies (Guo et al., 2019). Its flowers are small and yellow-green, often borne in axillary umbels. The flowering period generally lasts from April to June, and the fruiting period from August to November. The berries turn bright red when mature and may remain on the plant for a relatively long time (Ji et al., 2020).