

Overall, the optimization of understory ecological cultivation of *T. hemsleyanum* should achieve coordinated integration of germplasm resources, field techniques, and industrial organization. At the technical level, experience from controlled-environment and greenhouse systems can be used as a reference to promote biomass accumulation and active compound formation through the regulation of light intensity and spectrum, temperature and humidity, nutrient supply, and moderate abiotic stress. Meanwhile, canopy-density zoning, stereoscopic trellising, the application of organic amendments such as biochar, and rhizosphere microbial management can be used to gradually construct an understory ecological cultivation environment close to a “semi-controlled” system. At the industrial level, a coordinated management mechanism between forestry and traditional Chinese medicine sectors should be established, the quality certification and regulatory system for understory-cultivated medicinal materials should be improved, and regional standardized demonstration bases should be developed to benchmark understory ecological cultivation against greenhouse and vertical farming models in terms of quality. Through the integration of contract farming, quality traceability, brand building, and processing and marketing systems, understory ecological cultivation of *T. hemsleyanum* is expected to form a sustainable development pathway from technical optimization to large-scale promotion and from resource conservation to industrial value enhancement.

Conflict of Interest Disclosure

The author affirms that this research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

References

- Bai Y., Chen W., Liu S.Z., Xu L.Y., Li Z., and Liu B., 2021, Physiological responses of the *Tetrastigma hemsleyanum* plant under different color films, HortScience, 56(6): 672-677.
<https://doi.org/10.21273/hortsci15690-21>
- Burgess A.J., Cano M.E., and Parkes B., 2022, The deployment of intercropping and agroforestry as adaptation to climate change, Crop and Environment, 1(2): 145-160.
<https://doi.org/10.1016/j.crope.2022.05.001>
- Chen S.J., Zhang H., Wang X.S., Xu Y.S., Li X.S., Jiang Y., Lu Y.Y., and Tu P.F., 2024, Spatial distribution of differential metabolites in different parts of *Tetrastigma hemsleyanum* Diels et Gilg by ultrahigh-performance liquid chromatography/mass spectrometry and desorption electrospray ionization mass spectrometry imaging, Arabian Journal of Chemistry, 17: 105900.
<https://doi.org/10.1016/j.arabjc.2024.105900>
- Cheng H., Hu W., Zhou X., Dong R., Liu G., Li Q., and Zhang X., 2022, Fruit tree-legume-herb intercropping orchard system is an effective method to promote the sustainability of systems in a karst rocky desertification control area, Forests, 13(10): 1536.
<https://doi.org/10.3390/f13101536>
- Chu C., Lv Y., Yao X., Ye H., Li C., Peng X., Gao Z., and Mao K., 2024, Revealing quality chemicals of *Tetrastigma hemsleyanum* roots in different geographical origins using untargeted metabolomics and random-forest based spectrum-effect analysis, Food Chemistry, 449: 139207.
<https://doi.org/10.1016/j.foodchem.2024.139207>
- Deng J., Fang S., Fang X., Jin Y., Kuang Y., Lin F., Liu J., Nie Y., Ouyang S., Ren J., Tie L., Tang S., Tan X., Wang X., Fan Z., Wang Q., Wang H., and Liu C., 2023, Forest understory vegetation study: current status and future trends, Forestry Research, 3: 6.
<https://doi.org/10.48130/fr-2023-0006>
- Fu L., Zhao L., Lyu H., Yan M., Zheng Y., Liu Q., Jin L., Cheng J., Lu T., and Wang L., 2019, Effects of nitrogen level on growth of *Tetrastigma hemsleyanum* and phytochemical content and antioxidant activity in stems and leaves, Zhongguo Zhong Yao Za Zhi, 44(4): 696-702.
<https://doi.org/10.19540/j.cnki.cjcmm.20181204.006>
- Guo B., Mao Y., Yang L., Li D., Zhang H., and Zhang W., 2026, Problems and development recommendations for understory medicinal herb cultivation, Zhongguo Zhong Yao Za Zhi, 51(2): 596-600.
<https://doi.org/10.19540/j.cnki.cjcmm.20250815.401>
- Guo J., Kneeshaw D., Peng C., Wu Y., Feng L., Qu X., Wang W., Pan C., and Feng H., 2025, Positive effects of species mixing on biodiversity of understory plant communities and soil health in forest plantations, Proceedings of the National Academy of Sciences of the United States of America, 122(11): e2418090122.
<https://doi.org/10.1073/pnas.2418090122>
- Guo W., Yang Z., Hou Z., Hou Z., Qi Z., Sun Y., Ding X., Hu S., and Hu J., 2019, A comprehensive review of a Chinese folk herbal species *Tetrastigma hemsleyanum* with multiplicity of pharmacological effects, Chinese Traditional Medicine Journal, 2(1): 1-19.
- Hong C., Shao Q., Qin W., Zhang J., Wei B., Shen D., Zheng B., and Guo H., 2021, Bacterial communities are associated with the tuber size of *Tetrastigma hemsleyanum* in stony soils, Biology and Fertility of Soils, 57: 373-388.
<https://doi.org/10.1007/s00374-020-01530-4>