

3 Key Points of Environmental Control in Facility-Based *Ganoderma lucidum* Cultivation

3.1 Temperature and humidity control during *Ganoderma lucidum* growth

Temperature and humidity are the core environmental factors affecting mycelial growth, primordium formation, fruiting body development, and active component accumulation in *Ganoderma lucidum*. During the mycelial incubation stage, *G. lucidum* generally shows the growth characteristics of a relatively thermophilic fungus, with the suitable temperature mostly concentrated around 25°C~30°C. Laboratory and facility-based studies have shown that *G. lucidum* mycelia can exhibit strong radial growth at 25°C~30 °C or 30°C~35°C, although the specific suitable range may vary depending on the medium, strain, and cultivation system (Lengare et al., 2023; Al-Kaabi and Hussien, 2025). In bag and substrate cultivation, early mycelial colonization is usually suitable at 25°C~30 °C, 60%~70% relative humidity, and under clean, low-light or dark conditions (Huynh and To, 2023). If the temperature is below the suitable range, mycelial growth slows significantly and the cultivation cycle is prolonged; if the temperature is too high, it may lead to mycelial aging, abnormal substrate fermentation, and an increased risk of contamination. Therefore, facility-based cultivation should dynamically adjust temperature according to different growth stages of *G. lucidum* and maintain environmental stability through heat preservation, cooling, shading, and ventilation measures.

Humidity management should be matched with the growth stage of *G. lucidum* to balance water supply, gas exchange, and contamination risk. During the mycelial incubation stage, air humidity can generally be maintained at 60%~70% to prevent substrate water loss and mycelial shrinkage. After entering the stages of primordium formation and fruiting body development, air humidity should be appropriately increased to promote primordium differentiation, pileus expansion, and tissue fullness of fruiting bodies. Studies have shown that in controllable mushroom houses, when the temperature is maintained at approximately 28°C, a relative humidity close to 90% during the fruiting stage is conducive to pileus expansion and fruiting body weight gain (Liu et al., 2024). Stage-specific humidity management, such as maintaining 60%-70% humidity during early colonization, increasing it to 80%~90% during active fruiting body development, and then reducing it back to 60%~70% before harvest, has also been associated with relatively high polysaccharide content around day 75 of cultivation on lignocellulosic substrates (Huynh and To, 2023). This indicates that humidity regulation affects not only the morphogenesis of *G. lucidum*, but also the accumulation of functional components such as polysaccharides.

Climatic conditions vary greatly across seasons and regions, placing higher requirements on facility-based *G. lucidum* management. Field and semi-controlled system studies have shown that, compared with cooler environments, warmer cultivation sites can shorten the cultivation cycle and accelerate primordium and fruiting body development, indicating that temperature differences significantly affect the developmental process of *G. lucidum* (Figure 1) (Bijalwan et al., 2021). During high-temperature summers, shading, wet-pad cooling, air circulation, and automatic spraying should be used to reduce the internal temperature of the facility. In winter, heat preservation and heating management should be strengthened to prevent low temperatures from inhibiting mycelial activity. In recent years, low-cost IoT systems have been applied to continuous temperature and humidity monitoring in indoor *G. lucidum* cultivation, enabling real-time tracking of environmental fluctuations and helping maintain facility conditions within suitable ranges, thereby supporting both yield improvement and quality compliance (Nguyen et al., 2023). Therefore, temperature and humidity control should shift from traditional experience-based management to precise regulation based on real-time data.

3.2 Ventilation and light regulation during fruiting body formation of *Ganoderma lucidum*

During fruiting body formation, ventilation management mainly regulates CO₂ concentration and oxygen supply within the facility, and is an important factor ensuring normal fruiting body morphogenesis. *G. lucidum* continuously respire during growth. If air exchange in the facility is insufficient, CO₂ concentration increases, which may easily lead to elongated stipes, smaller pilei, incomplete pileus expansion, and even atypical fruiting body structures. In log and bag cultivation systems, sufficient ventilation during the fruiting stage is usually as important as moisture management and helps maintain suitable air and substrate conditions (Bijalwan et al., 2021). Studies on CO₂ regulation have shown that elevated CO₂ levels, such as approximately 0.3% or below 5%, can