

restricts planting area and geographical distribution, and lowers ornamental quality by impairing water relations and developmental performance (Xu et al., 2020). In commercial production systems, drought can also delay marketability and reduce profitability, while physiological symptoms commonly include dehydration, wilting, membrane damage, and suppressed gas exchange, indicating that *Chrysanthemum* is highly sensitive to inadequate water supply (Gogoláková and Paganová, 2020; Huang et al., 2026). More broadly, drought acts as a complex whole-plant stress that disrupts transpiration, photosynthesis, respiration, and cellular homeostasis, so its effects extend beyond visible growth inhibition to fundamental metabolic processes that determine survival and productivity. This is especially important under current climate trends, because increasing drought frequency and severity are likely to intensify water limitation during nursery, field, and postharvest phases of *Chrysanthemum* production.

Research on drought-induced photosynthetic regulation in *Chrysanthemum* has shown that photosynthesis is among the earliest and most sensitive processes affected by water deficit. Under drought conditions, net photosynthetic rate, stomatal conductance, transpiration rate, chlorophyll concentration, chlorophyll fluorescence, and PSII performance decline, with stronger or earlier reductions typically observed in drought-sensitive cultivars, indicating that both stomatal limitation and damage to the photosynthetic apparatus contribute to performance loss (Sahithi et al., 2020). At the same time, comparative physiological studies indicate that cultivar differences in drought tolerance are associated with variation in leaf structure, antioxidant capacity, and maintenance of photosynthetic function, while water-regime experiments show that reduced water availability significantly depresses stomatal conductance, transpiration, and photosynthesis and can alter intercellular CO₂ dynamics (Gogoláková and Paganová, 2020). These findings have established a useful physiological framework for understanding how drought reshapes carbon assimilation and water use in *Chrysanthemum*, and they also highlight the close coupling between leaf water status, oxidative stress, and photosynthetic stability.

Recent work has expanded this framework from whole-plant physiology to molecular and regulatory mechanisms, but important knowledge gaps remain. Drought-response studies in *Chrysanthemum* have identified genes and pathways related to ABA signaling, stomatal adjustment, cuticle formation, ROS detoxification, and stress-responsive transcriptional regulation, while genome-wide and transcriptomic analyses have emphasized that drought tolerance is a complex multigenic trait whose causal architecture remains incompletely resolved (Yang et al., 2020). Likewise, dehydration transcriptomics has shown large-scale reprogramming of hormone signaling, metabolism, and protective pathways, yet the integration of these molecular responses with dynamic changes in photosynthesis and water use efficiency under different drought intensities is still insufficiently characterized. In particular, more work is needed to link gas-exchange traits, chlorophyll fluorescence, leaf water status, and biochemical protection systems into a unified model of drought adaptation in *C. morifolium*. Therefore, examining the effects of drought stress on photosynthesis and water use characteristics is necessary for clarifying the physiological basis of drought injury and for supporting the breeding and cultivation of more water-efficient, drought-resilient *Chrysanthemum* cultivars.

2 Physiological Responses of *Chrysanthemum morifolium* to Drought Stress

2.1 Effects of drought stress on plant growth and biomass accumulation

Drought stress consistently suppresses vegetative growth and biomass accumulation in *Chrysanthemum*. Comparative physiological studies show that water deficit reduces biomass, flower development, transpiration, stomatal conductance, and photosynthetic performance, while cultivar-specific responses indicate that tolerant genotypes maintain growth better than sensitive ones under the same drought regime (Sahithi et al., 2020). This inhibitory effect is also evident at the production level, where drought decreases leaf increment, leaf area, and total biomass, although some cultivars partially compensate by increasing the root-to-shoot ratio to improve soil water use (Gogoláková and Paganová, 2020).

Growth reduction under drought is closely associated with impaired water status and declining physiological quality. Across diverse *Chrysanthemum* genotypes, relative water content, membrane stability, chlorophyll traits, fluorescence, and biomass are strongly correlated under stress, indicating that biomass loss reflects coordinated