

and chlorophyll fluorescence under drought, with earlier and stronger reductions in sensitive cultivars, while severe drought in other model systems causes disassembly of PSII supercomplexes, degradation of the PSII core, and reduced operative quantum efficiency, indicating that the light reactions themselves become structurally and functionally compromised (Sahithi et al., 2020; Hu et al., 2023).

As photochemical efficiency declines, plants appear to increase protective energy dissipation and reroute electron flow, but these defenses are only partly effective under stronger stress. Drought studies across species show that PSII electron transport declines, non-photochemical quenching rises to relieve excitation pressure, and cyclic electron flow around PSI is activated to generate proton motive force and protect both photosystems; however, prolonged or severe stress also impairs carbon fixation by limiting ATP supply, RuBP regeneration, and Rubisco-related assimilation capacity, which helps explain why photosynthesis remains depressed even after stomatal effects are no longer the dominant constraint.

4 Water Relations and Water Use Characteristics under Drought Stress

4.1 Changes in plant water status and hydraulic regulation

Drought stress directly impairs plant water status in *Chrysanthemum morifolium*, primarily through a mismatch between water uptake and transpirational demand. Physiological studies show that reduced soil moisture lowers leaf water potential and relative water content, and varietal comparisons indicate that drought-tolerant materials maintain hydration more effectively than sensitive ones under stress (Sahithi et al., 2020; Zhang et al., 2022). This pattern is consistent with broader *Chrysanthemum* experiments showing that leaf relative water content declines progressively as drought intensifies, making tissue hydration one of the clearest indicators of water deficit severity and tolerance differences among cultivars (Luo et al., 2023).

Hydraulic regulation under drought depends strongly on stomatal control and epidermal barriers that limit water loss from leaves. In *Chrysanthemum*, transgenic and physiological evidence shows that reduced stomatal opening and thicker cuticles slow water loss, while exogenous ABA rapidly decreases stomatal conductance and delays wilting, indicating that hormonal and structural regulation act together to stabilize plant water balance during dehydration (Wang et al., 2021). Substrate-drying studies further show that more drought-tolerant cultivars conserve water by closing stomata earlier and retaining more water in the growing medium, suggesting that hydraulic regulation in *Chrysanthemum* is not only a leaf trait but also a whole-plant water conservation strategy.

4.2 Effects of drought stress on transpiration and water consumption patterns

Drought stress consistently suppresses transpiration in *Chrysanthemum*, and this response is closely tied to reduced stomatal conductance. Under reduced water availability, *Chrysanthemum* plants show marked declines in transpiration rate, while comparative cultivar studies confirm that transpiration decreases earlier and more strongly in drought-sensitive genotypes than in tolerant ones (Gogoláková and Paganová, 2020). Pot studies also show that both transpiration and stomatal conductance decrease as drought severity increases, and that tolerant cultivars maintain relatively higher gas exchange capacity under the same stress level.

Water consumption patterns in *Chrysanthemum* are shaped not only by soil drying but also by organ-specific and environmental controls on water loss. In cut *Chrysanthemum*, leaf transpiration decreases during desiccation because of stomatal closure, whereas stems and flowers show little active regulation, and leaf transpiration strongly predicts whole-cut-flower water loss (Fanourakis et al., 2021). Long-term growth under low vapor pressure deficit also alters later drought behavior: plants formed larger, denser stomata and then lost water faster during desiccation, showing that prior humidity conditions can modify subsequent transpiration control and wilting risk.

4.3 Water use efficiency responses to drought stress

Water use efficiency in *Chrysanthemum* generally increases under moderate drought because transpiration declines proportionally more than carbon assimilation during the early phase of stress. Ground-cover *Chrysanthemum* showed a progressive increase in water use efficiency with increasing drought, reaching 1.34-fold