adequate (Barros et al., 2024). Under drought, however, arbuscular mycorrhizal colonization improved root development, protected chloroplast ultrastructure, and maintained higher photosynthetic efficiency, leading to better water status and greater accumulation of soluble sugars and osmolytes, mechanisms that support sustained assimilate delivery to developing fruits under water-limited conditions.

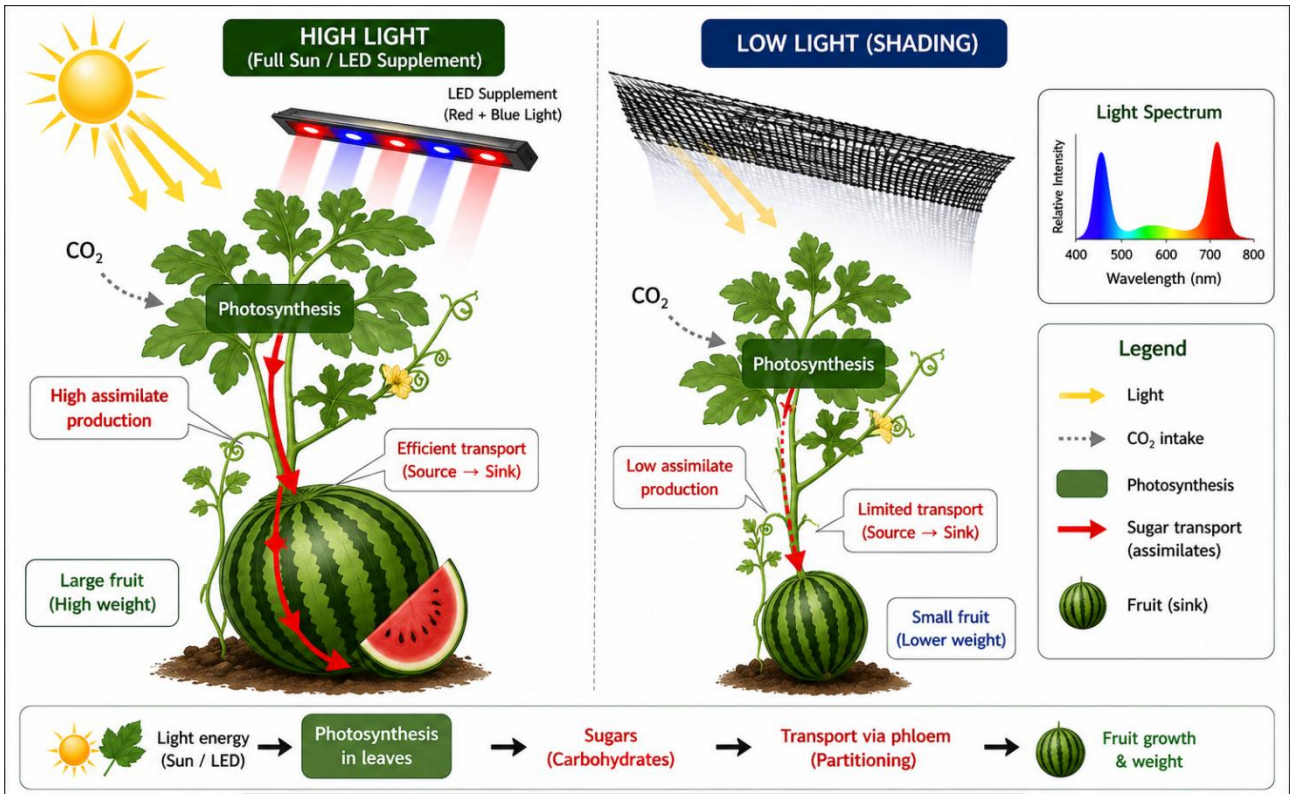

Figure 1 Role of light intensity and spectral quality in regulating photosynthetic carbon assimilation and its allocation to watermelon fruits. Increased light availability enhances assimilate supply and promotes fruit growth and weight formation

Soil nutrient status, particularly calcium and magnesium around the fruit set region, further modulates fruit growth and quality. Heating treatments at 18 °C near the fruiting zone not only increased fruit weight and soluble solids but were accompanied by elevated Ca^{2+} and Mg^{2+} concentrations in leaves adjacent to the fruit set node, implying improved nutrient uptake and transport under optimized temperature, which likely stabilizes cell wall structure and photosynthetic function during critical phases of fruit expansion. Supplemental LED lighting in winter crops likewise increased Ca^{2+} and Mg^{2+} in leaves at the fruit set region, enhancing photosynthetic rates and supporting consistent plant growth, which translated into larger fruit size, thicker flesh, and higher sugars, indicating tight coupling between nutrient status, carbon assimilation, and fruit weight formation under low-light, cool-season conditions (Hossain et al., 2025).

4 Data Acquisition and Experimental Design for Watermelon Fruit Weight Research

4.1 Design of watermelon field experiments

Field experiments on watermelon fruit weight are typically structured as factorial randomized or randomized block designs to evaluate genetic and management factors simultaneously. Representative studies select two or more commercial cultivars differing in fruit size class or adaptation, such as ‘Crimson Sweet’, ‘Sugar Baby’, or locally important hybrids, and test them across multiple locations or seasons to account for environmental variation. Treatments often include mulching materials, fertilizer regimes, or pruning and fruit-thinning levels, arranged with three or more replications to enable analysis of variance and proper error estimation (Deka et al., 2024). This design supports estimation of main and interaction effects on average fruit weight and yield components, while maintaining uniform baseline agronomic practices such as irrigation and pest management across plots (Yismaw et al., 2024).