5.2 Effects of environmental factors on the stability of yield and sugar accumulation

Sugarcane yield and sugar content are not only controlled by genetic background but are also strongly influenced by environmental factors. Temperature, light, water availability, soil nutrients, and biotic stresses jointly affect photosynthesis, dry matter accumulation, carbon allocation, and maturation processes, thereby altering the stability of biomass formation and sugar accumulation (Figure 3) (Mehdi et al., 2024). Suitable temperatures and sufficient light generally enhance photosynthetic efficiency and sucrose synthesis, whereas extreme temperatures can inhibit photosynthesis, increase respiratory consumption, and disrupt sugar storage, ultimately reducing both yield and quality.

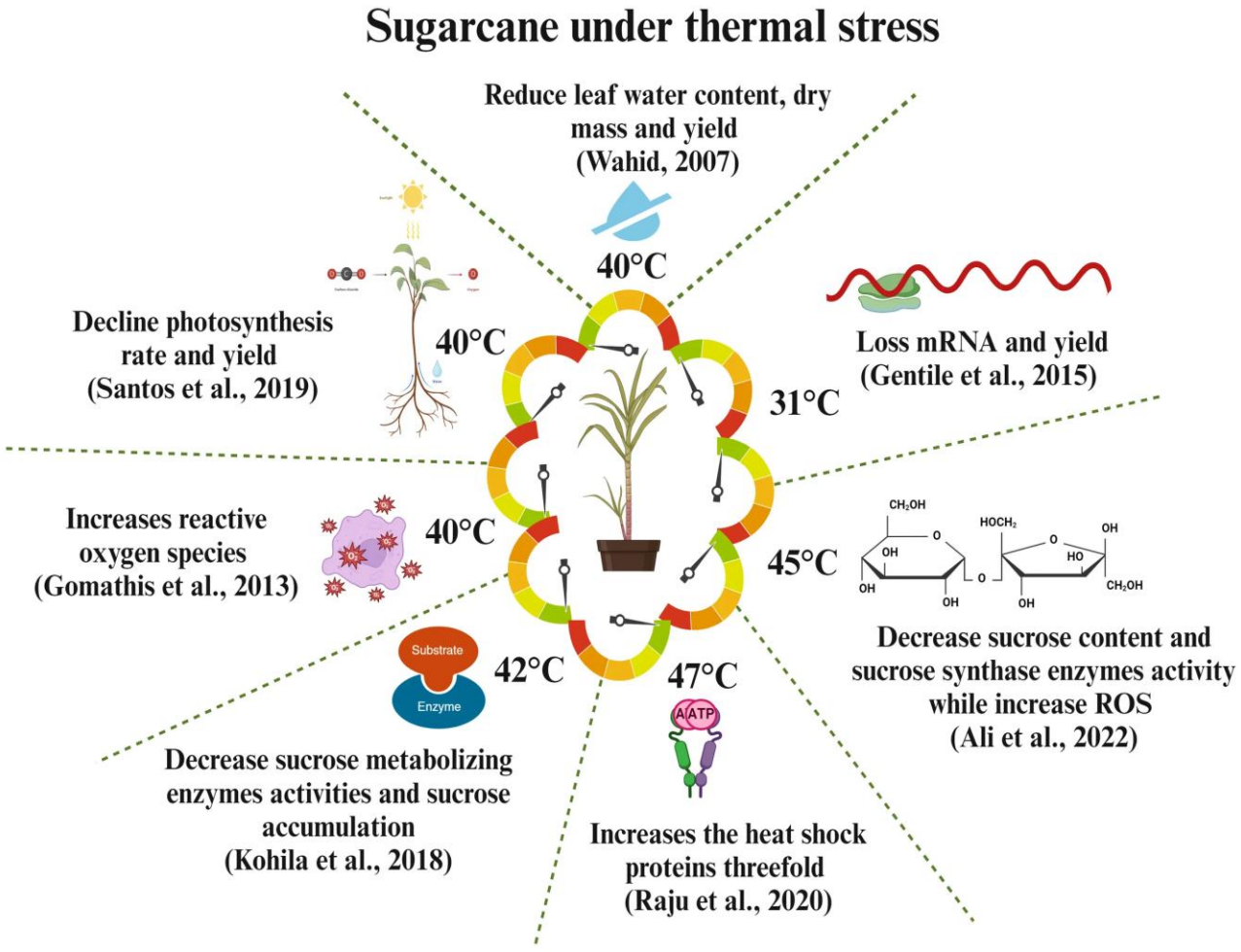

Figure 3 Response of sugarcane crop to different thermal stress conditions (Adopted from Mehdi et al., 2024)

Image caption: High temperatures can affect molecular, physiological, and biochemical processes in sugarcane, leading to reduced yield and sucrose production (Adopted from Mehdi et al., 2024)

Water conditions are particularly critical for the coordinated formation of high yield and high sugar content. Water deficit during the growth stage reduces stomatal conductance and radiation use efficiency, thereby limiting biomass production. Conversely, excessive rainfall or high soil moisture during the maturation stage may increase fresh weight but dilute sucrose concentration in the stalk, leading to the phenomenon of high yield but low sugar. It was mentioned in the article by Saavedra-Diaz et al. (2024), in humid production regions, high rainfall in the late growth stage promotes stalk growth but significantly reduces sucrose accumulation, resulting in lower sugar yield per unit area (Saavedra-Diaz et al., 2024). In addition, nutrient imbalance can disrupt coordination between yield and sugar content, as excessive nitrogen delays maturity and reduces sugar content, while nutrient deficiency suppresses overall growth.