

3 Physiological Basis of Sugarcane Yield and Sugar Content Formation

3.1 Effects of photosynthesis and dry matter accumulation on yield and sugar formation

Photosynthesis is the fundamental physiological basis for sugarcane yield and sugar accumulation. As a typical C₄ crop, sugarcane possesses high photosynthetic efficiency and carbon assimilation capacity, enabling it to maintain high net photosynthetic rates under conditions of high temperature and strong light. It efficiently converts solar radiation into dry matter, providing the primary carbon source for cane yield and sucrose accumulation. Assimilates fixed by leaves are converted into sucrose through primary metabolism and transported via the phloem to the stem, supporting stalk elongation, tissue development, and subsequent sugar deposition. Therefore, parameters such as net photosynthetic rate, stomatal conductance, chlorophyll content, leaf area index, and radiation use efficiency are closely associated with biomass production and final yield (Figure 1).

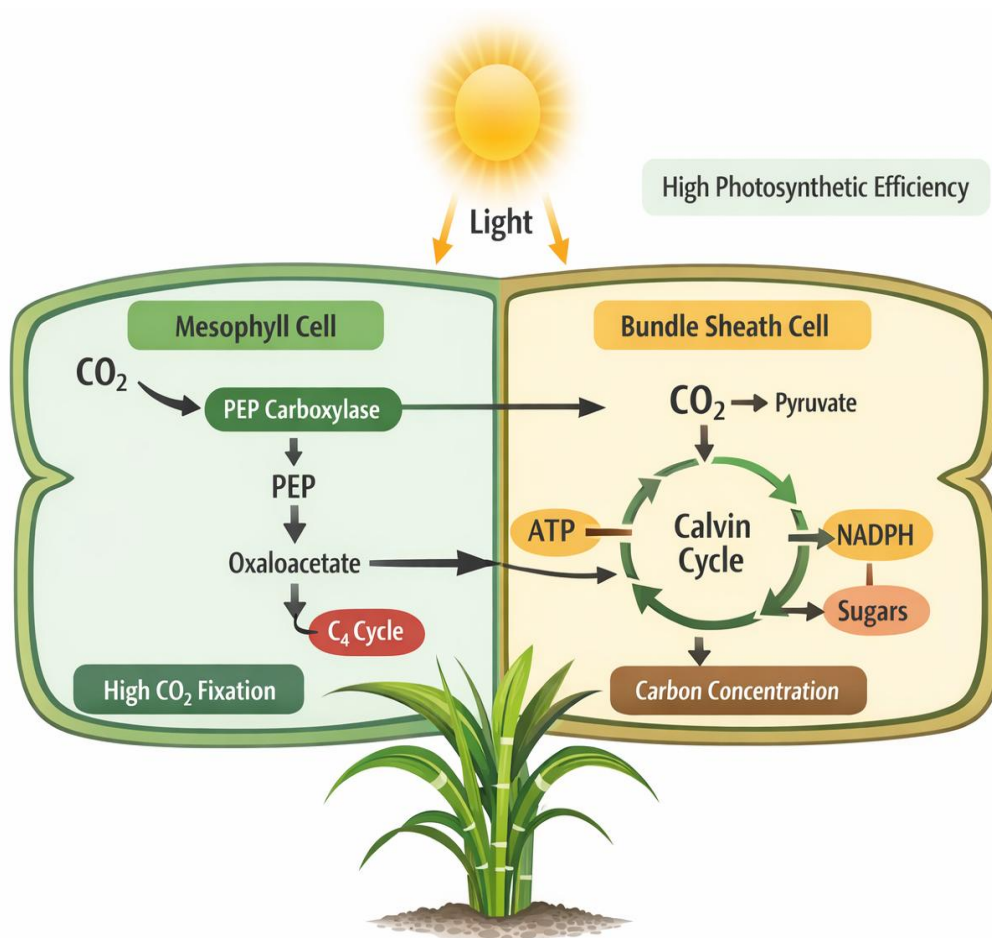


Figure 1 Schematic representation of the C₄ photosynthetic pathway in sugarcane

Image caption: CO₂ fixation in mesophyll cells and carbon concentration in bundle sheath cells to enhance photosynthetic efficiency

Dry matter accumulation serves as the key link between photosynthesis and both yield and sugar formation, reflecting the dynamic balance among carbon assimilation, respiratory consumption, and structural construction costs. During the early growth stage, sugarcane is dominated by vegetative growth, and photosynthates are mainly used for the development of leaves, stems, and roots. In the mid- to late-growth stages, as internodes mature, assimilates shift from structural carbon synthesis to soluble sugar accumulation, leading to gradual sucrose enrichment in parenchyma tissues (Martins et al., 2024; Mehdi et al., 2024). Thus, higher dry matter production efficiency, longer functional leaf duration, and sustained photosynthetic capacity are generally favorable for maintaining both high biomass and high sucrose accumulation. In essence, dry matter accumulation determines not only how many stalks are produced but also how much sugar can be stored within them.