

(Gálvez et al., 2021). At the organ level, pepper fruit size depends strongly on early auxin and cytokinin accumulation that promotes rapid cell division, while high gibberellin accumulation supports later pericarp cell elongation and expansion, showing how hormone-regulated developmental processes can translate canopy resource status into final yield components (Figure 1) (Tang et al., 2025).

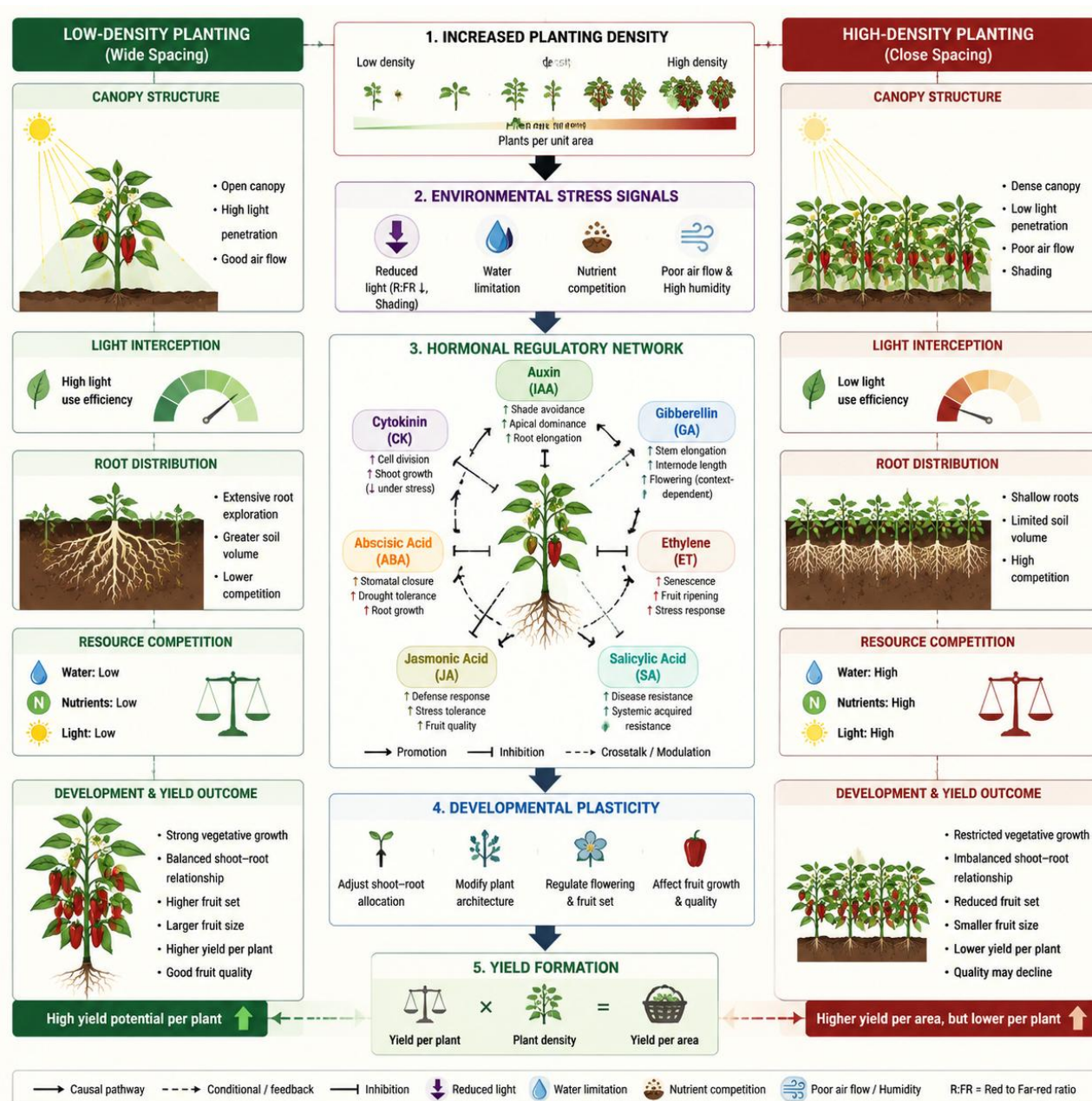


Figure 1 Conceptual model illustrating the regulation of pepper (*Capsicum annuum* L.) development by planting density-mediated hormonal pathways

5.2 Microclimate changes within pepper populations

Density-driven yield formation is also mediated by microclimate changes within the crop stand, especially shifts in light, temperature, and humidity. Studies on pepper-related systems show that denser or more shaded canopies reduce irradiance and temperature while increasing relative humidity, thereby creating a cooler but less illuminated internal environment (Oliosi et al., 2021). This general canopy effect is consistent with broader microclimate evidence showing that higher crown density is strongly associated with lower light intensity and temperature and with higher humidity, which helps explain why dense pepper populations often experience reduced evaporative demand but greater within-canopy shading (Kartika and Marjenah, 2023).