

Cucurbit vine architecture is also shaped by genetic regulation of branching, tendril development, and shoot indeterminacy. In cucumber, a model cucurbit, shoot architecture is determined by coordinated control of branch outgrowth, tendril identity, and vine length, with leaves and flowers produced continuously from axillary meristems along the vine. Comparative phylotranscriptomic work in Cucurbitaceae shows that specialized tendrils and climbing habit are linked to a cucurbit-specific tendril identity gene, reflecting evolutionary innovation that enables vertical exploration of surrounding vegetation and supports (Guo et al., 2020). These genetic and anatomical features underpin the ability of sponge gourd vines to distribute foliage and fruits three-dimensionally, but without deliberate training they often trail along fences or the ground, leading to suboptimal spatial distribution and compromised yield and quality.

2.3 Ecological and agronomic principles of trellising cultivation

Trellising modifies the ecological environment experienced by sponge gourd canopies by altering light distribution, air movement, and plant-soil interactions. In general crop canopies, modern management seeks to optimize stand-level light use efficiency rather than individual plant competitiveness, with canopy modeling highlighting that more uniform light distribution within the canopy can improve productivity and close yield gaps. Studies in trellised orchard systems show that espalier-type training can enhance light distribution efficiency per unit leaf area, although total productivity then depends on the balance between leaf area and light interception. Applied to climbing vegetables, trellis structures create vertically layered foliage where upper leaves intercept direct radiation while lower leaves receive filtered light, supporting photosynthesis throughout the canopy and improving microclimatic conditions for flowers and fruits (Figure 1).

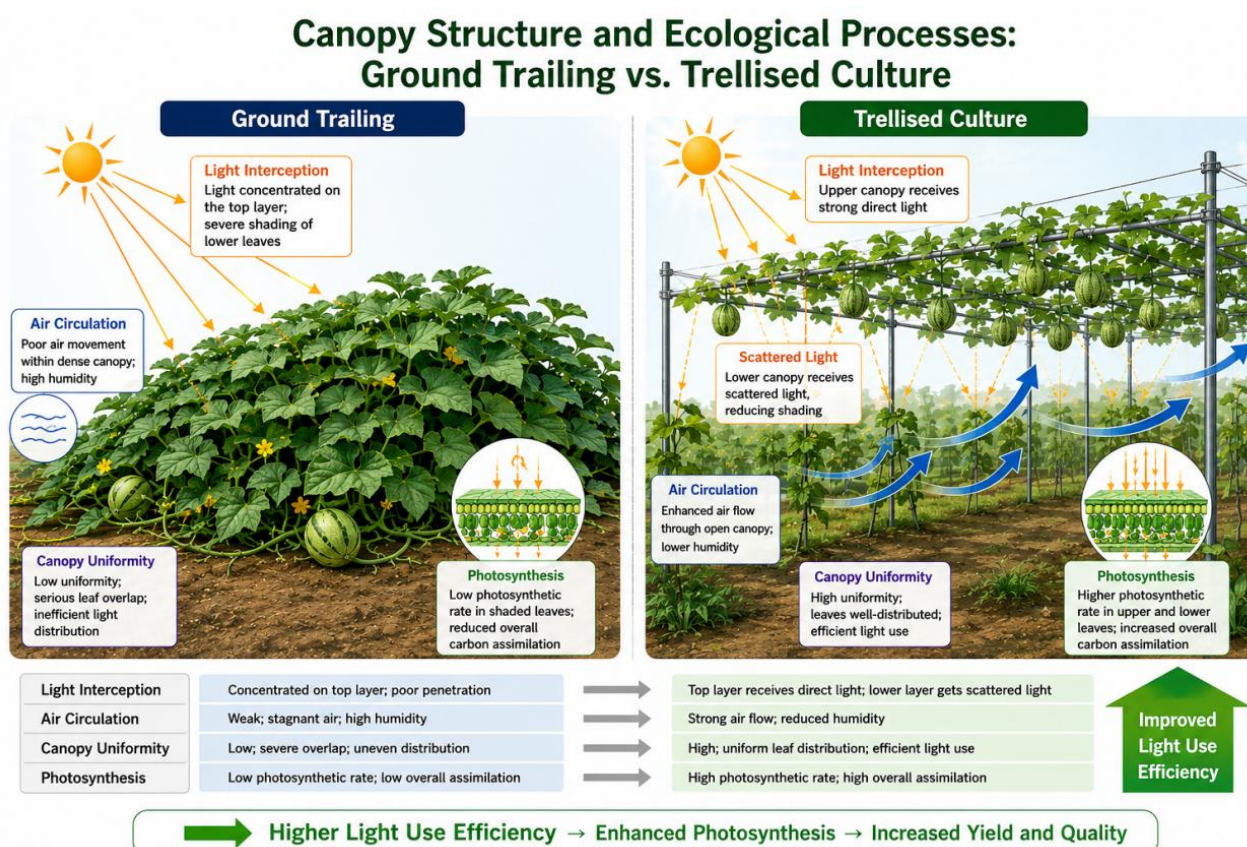


Figure 1 Conceptual illustration of how trellising systems modify canopy architecture, light interception, and air circulation in sponge gourd cultivation

For sponge gourd and related cucurbits, these ecological effects translate into concrete agronomic benefits. In Sri Lanka, supporting vines on horizontal trellises increased fruit yield and quality compared with prostrate growth, providing a basis for developing a full agronomic package for the crop. Comparisons of training systems show that above-ground structures such as bower or high trellis consistently produce higher yields, greater fruit size,