

Effects on individual fruit weight are more nuanced. In sponge gourd, single-plant vertical training produced the highest average fruit weight, whereas the bower system maximized fruit number and overall yield, indicating a trade-off between fruit size and fruit load under different trellises. In bottle gourd, trailing systems increased fruit number and total fruit weight per plant, but training systems altered fruit diameter and other size traits, suggesting that trellis design can shift assimilate allocation between fruit number and individual fruit mass (Singh et al., 2023).

5.2 Regulatory mechanisms of trellising systems on yield components

Differences in fruit number and weight among trellis systems are closely linked to canopy light distribution and the balance between vegetative and reproductive sinks. In hydroponic cucumber, a modified-umbrella trellis increased fruit number and fruit weight per plant relative to a high-wire system, largely because directing apical meristems downward improved light access to the most photosynthetically active leaves within the canopy. Modeling work shows that increased solar radiation interception raises individual cucumber fruit weight, while excessive shading in umbrella-type systems reduces lower-canopy contribution and can trigger fruit abortion, illustrating how trellis-driven LAI and light gradients regulate yield components (Kile et al., 2024).

At the physiological level, trellises also alter hormonal balances and assimilate partitioning. In kiwifruit, an umbrella-shaped trellis more than doubled yield compared with a traditional overhead pergola, partly by promoting vegetative growth of canes in the most productive diameter class and creating an upper shading canopy that improved pigment accumulation and hormonal status in the fruiting zone. The most productive cane zones under this system contained higher levels of cytokinin and auxin and favorable ratios with gibberellin and abscisic acid, suggesting that trellis-induced changes in canopy structure can indirectly regulate flower bud differentiation and fruit set through hormone dynamics (Deng et al., 2023).

5.3 Yield enhancement under different ecological conditions

Trellis systems interact strongly with ecological conditions such as season, radiation level and planting density to shape yield responses. In sponge gourd, above-ground training on bower or netting markedly increased yield over ground trailing under open-field conditions, with yield gains up to 71% in some systems, showing that elevating the canopy improves performance in typical subtropical environments (Thakur and Pathania, 2025). Off-season trellis cultivation of bottle gourd further indicates that while absolute yield per area can be lower in hotter or less favorable seasons, trellis-based systems may still provide higher net returns due to advantageous market prices, highlighting economic resilience across seasons.

In greenhouse cucumbers, interactions between canopy structure, light environment and trellis type are especially pronounced under low irradiance. Inter-lighting within a high-wire canopy improved photosynthetic characteristics of lower leaves but did not increase total fruit production because extreme leaf curling reduced horizontal and vertical light interception, demonstrating that architectural responses can negate potential gains from improved light distribution. Modeling of intracanopy lighting similarly predicted that, in the absence of such morphological issues and with unchanged partitioning, fruit yield could increase by about 8%, largely through enhanced light absorption, emphasizing that under constrained light climates, trellis-lighting combinations must maintain favorable canopy architecture to fully realize yield enhancement (Trouwborst et al., 2011).

6 Effects of Trellising Systems on Fruit Quality

6.1 Effects on external fruit quality attributes

Trellis systems often improve external appearance traits such as color uniformity, size, and shape, which are critical for Luffa market acceptance. In acorn squash, trellised plants produced fruits that were more uniformly black-green and firmer than those from ground culture, indicating reduced blemishes and more consistent epidermal development under supported growth (Adeeko et al., 2024). Trellising also increased fruit length in greenhouse cucumber, where a high-wire system produced the longest fruits, suggesting that vertically oriented canopies can favor more elongated, regular fruit shape (Figure 3).