Beyond cucurbits, perennial climbing fruit crops such as passion fruit also rely heavily on support systems, where simple trellis arrangements have been associated with the highest productivity and superior fruit quality compared with more complex “T” and total trellis systems. For sponge gourd specifically, trellising and training systems are increasingly recognized as central components of improved production technology, yet their effects on yield and fruit quality are still being defined. In Sri Lankan sponge gourd, evaluation of three trellising methods showed that horizontal trellising was “ideal” under local conditions, achieving an average yield of 8.4 t ha^{-1}; trellis type did not significantly change fruit length and diameter, but did significantly alter fruit number per plant.

A recent study comparing four above-ground training systems—bower, single plant training, netting, and ground trailing—found that bower trellising produced the maximum yield, fruits per plant, fruit length, fruit width, and vine length, with substantial percentage yield increases of up to 71% over ground trailing, further supporting the value of structured support for sponge gourd vines. In subtropical Mexico, open-field sponge gourd cultivation with “trellis mesh” oriented to optimize light exposure and row spacing tailored to the long vines has been shown to support good yields and efficient management, and even allows the use of circular trellis designs to maximize space. Related work in ridge gourd, another Luffa species, demonstrates that different trellis geometries (e.g., pandal versus T-trellis) affect not only yield and benefit-cost ratio but also fruit quality traits, implying that trellis system choice can be a fine-tuning tool for both productivity and market value in Luffa crops.

2 Cultivation Characteristics of Sponge Gourd and Theoretical Basis of Trellising

Overall, sponge gourd has high but underexploited agronomic and economic potential, and trellising is a critical, yet still inadequately optimized, component of its cultivation. Evidence from sponge gourd and related cucurbits indicates that well-designed trellis systems can substantially increase yield, improve fruit quality, and facilitate disease and crop management. However, the specific effects of different trellis architectures on sponge gourd yield components and quality traits remain insufficiently characterized, justifying focused research on the effects of trellis systems on yield and fruit quality of Luffa.

2.1 Biological characteristics and growth requirements of sponge gourd

Sponge gourd (*Luffa cylindrica*) is a monoecious cucurbit bearing separate male and female flowers on the same plant, with flowering starting about 6-7 weeks after seeding and an initially high proportion of male flowers. The crop produces long climbing vines and cylindrical fruits which, when fully mature and dried, form fibrous sponges typically 17-20 cm in length with densely arranged fibers. As a short-day species, sponge gourd thrives under cool temperatures and shorter photoperiods, with kharif conditions providing particularly favorable environments for vigorous vegetative growth, flowering, and fruit set (Vidya et al., 2025). Growth and yield are also shaped by soil and nutrient conditions.

In subtropical Mexico, plants established by direct seeding on fertile Luvisols amended with an organo-mineral substrate reached vine lengths of nearly 39 m and produced 5-20 fruits per plant, whereas plants on less fertile Andosols showed shorter vines and lower fruit size and weight (Fernández-Lambert et al., 2025). Optimized fertilization regimes combining reduced mineral N and P with K and bio-fertilizers have produced vine lengths around 2.8 m, earlier flowering, and yields up to 30.8 t ha^{-1} together with improved fruit quality traits such as higher soluble solids and ascorbic acid.

2.2 Vine growth patterns and spatial distribution characteristics

As a climbing cucurbit, sponge gourd exhibits vigorous, indeterminate vine growth with substantial variation in vine length and branching among genotypes and environments. In seasonal evaluations, individual inbred lines have produced vines exceeding 8 m in length with high numbers of branches and extended harvest durations, illustrating the inherently expansive canopy potential of this crop (Vidya et al., 2025). Direct-sown plants in open-field systems have attained mean plant lengths above 30 m, reflecting an ability to explore large horizontal or vertical spaces when physical support and resources are not limiting. Early establishment factors such as shallow sowing depth promote more vigorous vine elongation and leaf development, indicating that initial root–shoot balance and resource capture strongly influence later canopy expansion.