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Effects of Trellis Systems on Yield and Fruit Quality of Luffa

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Abstract Sponge gourd (*Luffa cylindrica*) is an important cucurbit vegetable widely cultivated in tropical and subtropical regions due to its high nutritional value and economic significance. Trellising cultivation is a key agronomic practice that influences plant architecture, canopy microclimate, resource utilization efficiency, and ultimately fruit yield and quality. Different trellising systems, including horizontal pergola, A-frame, fence, and vertical training systems, create distinct growing environments that affect photosynthesis, flowering, fruit set, and assimilate partitioning. This review summarizes the biological characteristics of sponge gourd and the theoretical basis of trellising cultivation, and examines the effects of various trellising systems on plant growth, yield formation, fruit quality, and production efficiency. Furthermore, representative case studies are analyzed to compare the performance of different trellis configurations under diverse cultivation conditions. The economic and ecological benefits of trellising cultivation, including labor efficiency, disease management, and sustainable production, are also discussed. Current research limitations and future directions, such as the development of innovative and intelligent trellising technologies, are highlighted. This review provides a comprehensive reference for optimizing sponge gourd cultivation practices and improving productivity and fruit quality in sustainable horticultural systems.

Keywords Sponge gourd; Trellising system; Yield formation; Fruit quality; Sustainable cultivation

1 Introduction

Sponge gourd (*Luffa cylindrica*) is an emerging, climate-smart cucurbit with growing importance for both food and industrial fiber. It is described as an "emerging high potential crop in Asia" but remains underutilized in many regions, with farmers often relying on traditional practices and limited technical guidance on morphology, floral biology, and yield optimization. Beyond its role as a vegetable, sponge gourd provides plant-based fiber and is highlighted as a niche "opportunity crop" with multiple utilities in food and industrial sectors, yet still undervalued due to limited research and product development (Mashilo et al., 2025). Reviews also emphasize increasing interest driven by health benefits, climate resilience, and market demand, and call for improved agronomic packages and high-yielding varieties to support commercialization at local and international levels.

In Sri Lanka and other producing areas, yields remain constrained by poor management; for example, farmers often allow vines to trail on fences or the ground, practices that are associated with reduced yield and fruit quality and lack of systematic trellis use. At the same time, multivariate and varietal studies show substantial genetic variability for yield, nutritional traits, and quality in sponge gourd, underscoring the crop's potential if supported by suitable production technologies (Chithra et al., 2024). Within cucurbit production systems more broadly, trellising has become a key cultural practice to intensify production, improve canopy microclimate, and enhance yield and marketable quality. In cucumber, trellised plants show consistently taller vines, larger leaves, more leaves, and higher marketable yield than untrellised plants, along with reductions in non-marketable fruits. Classic studies comparing trellis versus ground culture in field cucumber reported up to 100% increases in marketable yield under trellising, with more uniform dark-green fruits, higher Fancy grades, and fewer culls. Trellising also facilitated better control of foliar and fruit diseases by improving aeration, reducing humidity, and allowing more effective fungicide coverage. In hydroponic Beit Alpha cucumber grown in low-profile greenhouses, comparisons of high-wire and modified-umbrella systems showed that trellis architecture can shift the balance between total fruit number and yield consistency, suggesting that trellis design must be matched to growers' yield and labor objectives.