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Shade effects on okra and eggplant growth and productivity in fruit-tree agroforestry systems, Kenya

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Abstract

Smallholder vegetable production in coastal Kenya faces growing climate pressure from elevated temperatures and high evapotranspiration, threatening crop productivity and food security. Fruit tree–based agroforestry systems offer a promising pathway toward multi-functional agro-ecosystems buffering climatic stresses through shade-induced microclimate regulation while diversifying farm output. Yet crop-specific responses to shade remain poorly understood, limiting evidence-based design of climate-resilient agroforestry arrangements. This study evaluated growth and yield of okra (*Abelmoschus esculentus* L.) and eggplant (*Solanum melongena* L.) under four shade levels (full light, partial, intermediate, and full shade) in mango (*Mangifera indica* L.)- and baobab (*Adansonia digitata* L.)-based systems in Kilifi County, Kenya. A factorial randomised complete block design was implemented across three sites with three replications. Plant height (PH), total fruit number (TF), and summed-up fruit weight (FW) were recorded from eight plants at crop maturity and analysed using ANOVA with Tukey HSD tests. Shade significantly affected all parameters ($p \leq 0.05$), with responses varying by crop and tree system. In the mango-based system, okra PH was greater under full light than shaded conditions (46 vs. ~32 cm; $p = 0.002$), while TF and FW were higher under full light and partial shade than full shade (3.5–3.6 vs. 1.3–1.8 and 55–60 vs. 10–24 g, respectively; $p < 0.001$). Eggplant yielded higher TF and FW under full light than shaded treatments (4.2 vs. 1.1–2.2 and 145 vs. 24–64 g, respectively; $p < 0.001$). Under baobab, okra showed highest FW under partial and lowest under full shade (90 vs. 38 g; $p < 0.001$). Eggplant remained shade-sensitive with higher TF and FW under full light than shaded conditions (8.1 vs. 1.9–3.5 and 506 vs. 128–167 g, respectively; $p < 0.001$). These findings confirm that tree–crop interactions in agroforestry systems are crop- and system-specific. Eggplant requires full light for optimal productivity, while okra benefits from partial shade under baobab. Strategic matching of vegetables and fruit trees based on crops' shade tolerance can enhance agro-ecosystem functionality and sustainability, support smallholder livelihoods, and may strengthen climate resilience of horticultural farms in Kilifi County and beyond.

Keywords: Agro-ecosystem, climate resilience, horticulture, shade tolerance, vegetables

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