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Optimization of some Agronomic Practices to Enhance Yield of Scotch Bonnet Pepper (*Capsicum chinense* Jacq.) under Controlled Cultivation

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ABSTRACT

Scotch Bonnet (*Capsicum chinense* L), locally known as "*Nai Miris*", has gained prominence in Sri Lanka's Protected Agriculture sector due to its high market value. But, the lack of specialized management practices suited for protected culture of this species is a challenge. This study seeks to optimize the agronomic management practices to enhance the yield of Scotch Bonnet grown in polytunnels. The experiment was conducted at the Regional Agriculture Research and Development Centre, Bandarawela during *Yala* 2022. Two growth media: a coir dust and partially burned paddy husk mixture (Medium A) and a topsoil and compost blend (Medium B), Two plant spacings (75 x 50 cm and 100 x 75 cm) and two pruning management systems (pruned and un-pruned) were tested using split plot design with 4 replicates. Results revealed that plant spacing did not significantly affect yield. However, pruning had a negative impact on fruit yield ($p < 0.0123$), where un-pruned plants yielding more, especially in Medium A at closer spacing (1.048 kg/plant). Medium B produced the highest yield (1.022 kg/plant) with un-pruned plants and wider spacing. Growth media significantly influenced yield ($p < 0.0054$), and the interaction between pruning and media was highly significant ($p < 0.0003$). These findings indicate that selecting optimal growth media and spacing configurations can enhance Scotch Bonnet Capsicum production in polytunnels.

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Scotch Bonnet (*Capsicum chinense* L.), commonly referred to as "*Nai Miris*", in Sri Lanka, has recently emerged as a significant crop in the Protected Agriculture (PA) industry in the country. It holds considerable market value, often surpassing that of bell pepper, the most prized vegetable grown in polytunnels in Sri Lanka. Pepper production is found from the humid tropics to dry deserts and cool temperate climates. Peppers can be grown as an annual or perennial crop, in open fields or under protective cover. The ability of peppers to grow and produce a quality crop in such a wide range of climates has made them a common crop worldwide, and their annual production has increased substantially over the years (Bosland and Votava, 2012).

The high abundance of insect pests coupled with diseases necessitates effective control measures to prevent economic loss during commercial cultivation of scotch bonnet (Ofori, Enoch, et al. (2015), as a perennial crop, outside in open fields or under protective cover.

The current practices of cultivating Scotch Bonnet in polytunnels vary among farmers. Some utilize soil beds or grow bags filled with soil and compost mixtures, while others adopt techniques similar to those used for bell pepper cultivation. Despite these efforts, achieving optimal yields remains challenging due to the complexities involved in transiting from open-field to polytunnel cultivation. Issues such as plant spacing, growing medium and crop maintenance, often relying on practices designed for open-field conditions. Therefore, the successful cultivation of Scotch Bonnet in polytunnels is hindered by the lack of specialized technologies and practices tailored specially for this system.

Understanding these challenges, the present study aims to address key issues associated with Scotch Bonnet pepper cultivation in polytunnels. By systematically investigating factors such as plant spacing, fertilizer management, and crop maintenance, the study sought to enhance the productivity and profitability of the crop. While providing science-based recommendations and comprehensive guidelines, this research attempts to support the sustainable growth of the industry, ultimately benefiting both farmers and consumers.

The study was conducted during *Yala* 2022 in a 170 m^2 naturally ventilated polytunnel at the Regional Agricultural Research and Development Centre in Bandarawela, situated in the Up-country Intermediate zone of Sri Lanka. A commonly available local Scotch Bonnet cultivar was used, and the standard cultivation practices typically employed for bell peppers in raising seedlings and managing the crop were implemented. One-month-old seedlings were transplanted into 9 L polythene bags. The experiment followed a split-plot design, with the spacing as the main plot factor and plant management and growth media as the subplots. Two different growth media were used: A. Coir dust (CD) and partially burned paddy husk mixture (PBPH) (1:1), and B. Topsoil and compost blend (1:1). Two plant spacings (75 cm inter-row and 50 cm within the row, and 100 cm inter-row and 75 cm within the row) were tested in combination with two distinct plant management systems within the two-growth media: two-stem pruning (Dutch V2) and un-pruned (Spanish).

The bags were arranged in a double-row system within the polytunnel. Fertilization was applied using Albert's mixture (a commercially used complete plant nutrient mixture), supplemented with $Ca(NO_3)_2$, $MgSO_4$, and Krista K 44 (a commercially available K supplement with 44% K_2O) to meet the plants' nutritional requirements. Adjustments were made based on plant growth and observed deficiency symptoms. The number of fruits per plant and weight of fruits harvested as fruit yield per plant, were recorded and statistically analyzed using SAS software, with means separation conducted using the LSD mean separation method.

Plant spacing alone did not significantly affect the fruit yield ($p < 0.2720$). Unander et al. (1991) found that increased fruit yield increased pepper population density from 3.6 to 7.2 plants per m^2. There were two plant densities maintained in the present study: 2.6 plants/m^2 (75 x 50 cm) and 1.3 plants/m^2 (100 x 75 cm). Both spacings used in this study may not have created competition among

plants for space, light, and air and therefore, no significant impact on plant growth was observed.

Stem pruning significantly influenced the yield ($p < 0.0123$), suggesting that different pruning methods have a notable impact on Scotch Bonnet pepper yield (Table 1). Previous studies have shown that an increase in the fruit yield of sweet pepper with an increase in shoot number under soilless media in protected agriculture (Cebula, 1995; Jovicich et al., 2004; Maboko and Pooly, 2008). The results showed that the two-stem pruning treatment significantly affected plant growth and flowering characteristics in terms of plant height (194.75 cm), number of days to first flower (20.25 days) in the *cv. Indra*. The same cultivar when left unpruned recorded a greater number of fruits per plant (23.64 fruits), but fruit yield per plant (4.14 kg) was observed in four stem pruning treatment in *Indra* cultivar of capsicum than in other cultivars (Esiyok et al., 1994). Pruning methods vary based on branching habits and planting densities of Capsicum cultivars (Dasgan and Abak, 2003; Maniutiu et al., 2010). Research on *C. chinense* indicated that a significant morphological variation in traits such as fruit shape, size, and plant growth habits (Bharath et al., 2013; Jarret et al., 2008).

Growth media had a significant effect on the yield ($p< 0.0054$), (Table 1) highlighting the importance of media composition in determining crop productivity. The interaction between pruning method and media (Prune * Media) was also significant ($p < 0.0003$), This suggests that the combining of different pruning methods with suitable growth media can increase the fruit yield of Scotch Bonnet. However, other interaction effects (Space * Prune, Space * Media, Space * Rep, Space * Prune * Media) were not significant ($p > 0.05$), suggesting that these combined factors do not have a significant impact on fruit yield.

In Medium A, unpruned plants consistently produced higher fruit yield than in pruned plants (Table 2.). This suggests that the combination of coir dust and PBPH is particularly effective in promoting yield without the need for pruning. The combination of CD and PBPH enhances both physical and chemical properties of the growing medium, providing better aeration, water retention, and nutrient availability. Research has shown that biochar improved the structure and fertility of the growth medium, supporting strong root development and plant growth. CD with its excellent water-holding capacity and aeration properties, complements biochar, leading to increase seedling vigor and productivity in capsicum plants (Fussy and Papenbrock, 2022; Raphael et al., 2021).

Table 1. Effects of different factors and their interactions on fruit yield of Scotch Bonnet

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Space	1	0.05258251	0.05258251	1.23	0.2720
Pruned	1	0.28668151	0.28668151	6.72	0.0123
Media	1	0.35898601	0.35898601	8.41	0.0054
Space*pruned	1	0.00850781	0.00850781	0.20	0.6571
Space*media	1	0.07818751	0.07818751	1.83	0.1816
Prune*media	1	0.62357461	0.62357461	14.61	0.0003
Space*pruned*media	1	0.00128801	0.00128801	0.03	0.8628

Table 2. Fruit Yield of Scotch Bonnet in different media and pruning systems

Potting medium	Spacing (cm)	Plant management system	Yield (kg/plant)
Medium A (CD + PBPH)	75 x 50	Pruned	0.772
		Un-pruned	1.048
	100 x 75	Pruned	0.767
		Un-pruned	0.798
Medium B (Soil + PBPH+ Compost)	75 x 50	Pruned	0.865
		Un-pruned	0.796
	100 x 75	Pruned	0.671
		Un-pruned	1.022

Note: CD-coir dust, PBPH-partially burnt paddy husk

When analysing the effects of spacing, closer spacing (75 cm x 50 cm) generally resulted in higher fruit yields compared to wider spacing (100 cm x 75 cm), particularly in Medium A. This closer spacing likely promotes a more competitive environment that benefits plant growth when the right growth medium is used. However, the results for Medium B suggest that wider spacing may be beneficial under certain conditions, as evidenced by the highest fruit yield of 1.022 kg/plant in un-pruned plants. The inconsistent effects of pruning across different media highlight that the need for further research to refine pruning practices for specific growing conditions. These findings also emphasize the importance of customizing plant management strategies to the unique requirements of each growth medium to optimize yield.

Compositions of the growth media impacts significantly on fruit yield of Scotch Bonnet cultivated in polytunnels. The mixture of CD and PBPH performs better than the topsoil and compost blend in promoting yield without pruning. Pruning has mixed effects, emphasizing the need for tailored management practices. These findings also highlight the importance of selecting appropriate growth media and adopting suitable pruning techniques to optimize Scotch Bonnet production in polytunnels, contributing to a sustainable cultivation of this high-value crop in Sri Lanka.

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