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SHORT COMMUNICATION

Evaluation of Green Chilli Grown Using Different Grow Bag Packages and Fertilizers for Developing a Domestic Growing Model

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Abstract

Chilli (*Capsicum annuum* L.) is one of the most valuable cash crops in Sri Lanka. The purpose of the study was to develop a chilli growing domestic model by synergizing effects of growth media and fertilizers on the growth and yield performances. This experiment was carried out for chilli variety MICH 3 and the study was laid out using a randomized complete block design with two factors, namely, grow bag packages and fertilizers, with four replicates. The grow bag packages consisted of two levels, i.e., commercial coco peat grow bag and multilayer gunny bag, and fertilizers consisted of two levels, i.e. Albert's fertilizer and compost tea. Both growing medias were characterized for desirable physical and chemical properties. Multilayer gunny bag showed significantly different (p<0.05) growth performance and higher yield compared to the commercial coco peat grow bag. Albert's fertilizer resulted significantly best growth performance compared to compost tea. However, yield performances were similar in both fertilizers. The combination of multilayer gunny bag and compost tea can be recommended for chilli growing domestic model

***Keywords**: Coco peat, Grow bags, Multilayer gunny bags*

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1. Introduction

Food insecurity is a concern in many parts of the world today. Land use practices have to be intensified to maximize food production on available arable lands, especially with smallholdings. Home gardening or backyard gardening has been identified as an efficient strategy for providing all year-round access to food for rural households. Home gardens can make a significant contribution for providing daily household needs by enhancing nutrition and health (Musotsi et al. 2008). A hazard free environment is main expectation in sustainable agriculture. With the increasing population, production of agricultural systems increases with excessive use of agrochemicals rather than increasing overall quality and health of agricultural production. Eco-friendly concepts have emerged as a solution for the problems of chemical based agricultural practices. Organic agriculture is "a system for crops, livestock and fish farming that emphasizes environmental protection and the use of natural farming techniques" (De Albuquerque, 2019). Organic farming has been shown to support human ecology, culture, and community in Sri Lanka. Karalliyadda and Kazunari (2018) reported, the organic agricultural sector in Sri Lanka encompasses 96,318 hectares of land, with nearly 8,695 growers, 189 processors, and 311 exporters. However, domestic, organic backyard farming is not much actively popular in Sri Lanka. Several bottlenecks such as difficulties in farm bed and land preparation, lack of land area, lack of water resources and lack of adequate time was identified in common. Soilless backyard gardening can be considered as a solution. Soilless culture could be established with the best environmental conditions for crop development in order to achieve optimum yield and high-quality agricultural products. As a result, less land space is required for agriculture production, resulting in higher land productivity (Guuml et al. 2010). Most Sri Lankans attempted to grow organic backyard gardens, particularly during the COVID-19 outbreak in 2020. The prevalence of chronic kidney disease discourages farmers from applying agrochemicals particularly to their home gardens (Weeraratna, 2013). Home garden cultivation has an orientation to adopt ecologically friendly fertilizers.

The objective of this research was to develop a chilli (*Capsicum annuum*) growing domestic model by effectively integrating growth media and fertilizers to achieve higher growth and yield performances.

2. Materials and Methods

This experiment was conducted at the home gardening unit in the Department of Agricultural Engineering, Faculty of Agriculture, University of Ruhuna, February to May 2021.

Experimental crop was the chilli (Capsicum annuum) variety, MICH 3. The experiment was laid out according to a factorial randomized complete block design with two factors; namely, grow bag package and fertilizer type. Grow bag package consisted of two levels, i.e., multilayer gunny bag and commercial coco peat grow bag (control). The fertilizer type consists of two levels, namely, Albert's fertilizer (control) and compost tea. The treatment combinations were replicated four times.

Chilli variety MICH 3 seeds were soaked and sown in nursery trays using a media of coco peat. Watering was done according to the available moisture content of the media to ensure uniform and healthy growth.

A Multilayer gunny bag was made of compost, coco peat substrates and gunny layers surrounded by outer gunny layer. The commercial coco peat grow bag was made of coco peat substrate (Figure 1).

Figure 1 Multilayer gunny bag (a1, a2, a3) and Commercial coco peat grow bag (b)

Four-week-old healthy and vigorous growing seedlings were transplanted in two grow bags types arranged according to the experimental design. Bags were arranged in four blocks with 60 cm spaced between each bag.

According to the experiment, chili plants were fertigated with Albert's solution and compost tea solution. Commercially available Albert's fertilizer packs were used for the solution preparation. A 2 kg of compost was added to a plastic bucket. Then, 20 L of clean water was added to that and mixed well. Then it was kept for 5–7 days and after that it was filtered into the container for use as scheduled. The compost tea was diluted with water 1:2 ratio (Ekanayake et al. 2020) at application. Properties of two fertilizer mixtures are given in Table 1.

Fertilizer was applied two weeks after planting and continued until harvest. Table 2 depicts the amount of Albert's fertilizer and filtered solution of compost tea were applied per plant, according to the plant growing stages (WAT – weeks after transplanting) (Ekanayake et al. 2020). Every three days, liquid fertilizers were added to each grow bag. During the growth stage, fertilizers were applied 50 mL per plant and this rate was continued throughout the vegetative stage and flowering stage from 4 WAT (as indicated by the presence of flowers). During fruit baring stage and up to harvest, fertilizer amount added was increased to 150 mL per plant.

Plant height, number of branches, days to first flowering, days to 50% flowering, and yield per plant (number of pods, pod weight, pod length) were recorded as growth and yield parameters of chilli plant.

Bulk density, true density and porosity, pH, EC, and water holding capacity were tested as potting media parameters. Total nitrogen, pH and EC were assessed as fertilizer properties.

An Analysis of Variance (ANOVA) was used for data analysis, and to compare means, the Least Significant Difference Test (LSD) with a probability of 5% was used.

Table 1: Parameters of fertilizer solutions

Solution	pH	EC (µS/cm)	Total nitrogen (%)
Albert's solution	5.2	1796	10.5
Compost tea	6.46	532	0.7

Table 2: Amount of fertilizer applications (mL) per plant

Fertilizer	Growth stage (2-3 WAT)	Flowering stage (4-6 WAT)	Fruit-baring stage (7 WAT)
Albert's solution	50	50	150
Compost tea	50	50	150

3. Results and discussion

As shown in Table 3, bulk density and true density of multilayer gunny bag media showed significantly high values than commercial coco peat growing media ($p<0.05$). The bulk density of a growing media gives an accurate indication of porosity, which affects the rate at which air and oxygen may transfer through the substrate. Abad et al. (2001) discovered that the bulk density of an ideal substrate should be 0.40 g cm3. In general, bulk density values of both media were within the ideal range. Two growing media particle density values were below the specified ideal particle density range (1.4–2) g cm3 reported by Abad et al. (2001). According to De Boodt and Verdonck (1972), an optimal substrate's total porosity should be larger than 85%. Porosity values of both media were somewhat below the recommended ideal range. The optimal water retention capacity of an ideal substrate should be within the 600-1000 mLL1 range (De Boodt and Verdonck, 1972). Water holding capacity values were within ideal range despite significant differences between the two media. The porosity and water holding capacity of commercial coco peat grow bag media were higher than multilayer gunny bag media, thus could be the ideal depending on media qualities Values are means (n=4) within each raw value followed by different letters are significantly different based on Duncan's test ($p<0.05$). BD: bulk density, TD: true density, PS: porosity, WHC: Water holding capacity. ID: Ideal substrate - (Abad et al. 2001).

Table 4 depicts the key chemical parameters of substrates. The pH values and EC values of two growing media were significantly different and the highest values obtained from commercial coco peat grow bag media. The pH of the substrates was within the acceptable range (5.2–6.5) for an ideal substrate as recommended by various studies (Abad et al. 1993; Noguera et al. 2003). The pH values value of commercial coco peat grow bag media was within ideal range, while EC exceeded from the ideal value recommended by Noguera et al. (2003).

Growth and yield parameters

The results showed that the grow bag packages significantly affected the plant height, days to first flowering, days to 50 % flowering, while no significant impact was observed for number of branches, number of pods per plant, pod weight per plant and pod length per plant. Analogously, results resulted significant impacts of fertilizer types on plant height, days to first flowering, days to 50 % flowering, while no significant impacts were reported for number of branches, number of pods per plant, pod length per plant and pod weight per plant.

Plant height

The average plant height of two grow bag packages were shown in Table 5. Plant height was significantly different between two grow bags. Significantly the highest plant height was observed in Multilayer gunny bag package.

The average plant height of different grow bags applied to both fertilizers was significantly different and significantly high plant height was observed from Albert's fertilizer (Table 6).

Number of branches

The average number of branches of two grow bag packages were similar ($p>0.05$) at 10 weeks after transplanting. However, during the initial stage of the cultivation (5–6 weeks after transplanting) branch number was illustrated certain significant number differences between two grow bag packages (Table 7).

The average number of branches of chilli was not significantly different due to fertilizers since 7th week onwards after transplanting. However, at earlier stages of the cultivation (5–6 weeks after transplanting); the branch number was significantly different among two fertilizers (Table 8).

Days to first flowering

The number of days taken to first flowering was significantly different among two types of grow bags and the lowest days taken were recorded in multilayer gunny bag. The number of days taken to first flowering was significantly lower in Albert's fertilizer application, while a significantly higher number was taken in in compost tea solution (Table 9).

Days taken to 50% flowering

According to the Table 09, number of days taken to 50% flowering was significantly different between two grow bag packages and the lowest number of days taken to 50% flowering were observed in multilayer gunny bag. The number of days taken to 50% flowering data was significantly different between two fertilizers and the lowest days taken to 50% flowering were recorded in Albert's fertilizer application.

Number of pods, pod length and pod weight per plant

The number of pods per plant were similar among the two types of grow bags, yet the highest average number of pods was obtained from multilayer gunny bag. A similar experiment conducted by Ekanayake et al. (2020) using compost tea and Albert's solution for Capsicum annuum and found that Albert's solution gave the highest values for number of fresh pods per plant and fresh weight of the pods per plant. According to Abid et al. (2014), using organic fertilizer increases the fresh weights of the fruit per plant. Although the pod length per plant at first harvest of two types of grow bags was not significantly different. Pod length per plant was significantly similar in both two fertilizer types at first harvest (Table 10).

Table 3: Physical properties of two media

	Media		ID
	Commercial coco peat grow bag	Multilayer gunny bag	
BD (gcm−3)	0.13 b	0.23 a	<0.4
TD (gcm−3)	0.90 b	1.15 a	1.4-2
PS (%)	85 a	80 b	>85
WHC (mLL−1)	899 a	876 b	600-1000

Values are means (n=4) within each raw value followed by different letters are significantly different based on Duncan's test ($p<0.05$).

BD: bulk density, TD: true density, PS: porosity, WHC: Water holding capacity. ID: Ideal substrate - (Abad et al. 2001).

Table 4: Chemical properties of two media

parameter	Media		ID
	Commercial coco peat grow bag	Multilayer gunny bag	
pH	6 a	5.5 b	5.2-6.5
EC (dSm^{-1})	0.62 a	0.48 b	<0.5

Means followed by the different letter in the same row differed significantly according to Duncan's multiple range test ($p < 0.05$).

EC: Electric conductivity. ID: Ideal substrate - (Abad et al. 2001).

Table 5: Changes of weekly average plant heights depending on factor grow bags package

Grow bag package	TH	2 WAT	3 WAT	4 WAT	5 WAT	6 WAT	7 WAT	8 WAT	9 WAT	10 WAT
Commercial coco peat grow bag	13.13 a	15.31 a	20.12 b	22.37 b	24.25 b	28.25 b	32.87 b	34.87 b	37.37 b	39.37 b
Multilayer gunny bag	13.13 a	15.37 a	21.62 a	26.5 a	28.75 a	32.5 a	36.5 a	38.62 a	40.62 a	42.62 a

TH= Transplanting height, WAT= weeks after transplanting

Means followed by same letter along columns for each grow bag packages not significantly different at 5% level. Mean separation by LSD.

Table 6: Changes of weekly average plant height depending on fertilizer type

Fertilizer type	TH	2 WAT	3 WAT	4 WAT	5 WAT	6 WAT	7 WAT	8 WAT	9 WAT	10 WAT
Albert's solution	13 a	15.25 a	21.75 a	25.75 a	27.25 a	32 a	36.13 a	38 a	40 a	42.25 a
Compost tea	13.25 a	15.42 a	20.5 b	23.25 b	25.5 b	29.25 b	35.5 b	35.25 b	38 b	39.75 b

TH= Transplanting height, WAT= weeks after transplanting

Means followed by same letter along columns for each fertilizer not significantly different at 5% level. Mean separation by LSD.

Table 7: Changes of weekly average number of branches depending on grow bag package

Grow bag package	4 WAT	5 WAT	6 WAT	7 WAT	8 WAT	9 WAT	10 WAT
Commercial coco peat grow bag	2 a	2.25 a	2.87 a	3.25 a	3.62 a	3.87 a	4.12 a
Multilayer gunny bag	3.5 a	3.37 b	3.87 b	4.25 a	4.62 a	4.62 a	5.12 a

WAT= weeks after transplanting

Means followed by same letter along columns for each grow bag packages not significantly different at 5% level. Mean separation by LSD.

Table 8: Changes of weekly average number of branches depending on fertilizer type

Grow bag package	4 WAT	5 WAT	6 WAT	7 WAT	8 WAT	9 WAT	10 WAT
Albert's solution	2.75 a	3.12 a	3.75 a	4.12 a	4. 5 a	4.62 a	5 a
Compost tea	2.75 a	2.5 b	3 b	3.37a	3.75 a	3.87 a	4.25 a

WAT= weeks after transplanting

Means followed by same letter along columns for each fertilizer not significantly different at 5% level. Mean separation by LSD.

Table 9: Differences of days taken to first flowering and 50% flowering

		Days taken to first flowering	**Days taken to 50% flowering**
Grow bag package	Commercial coco peat grow bag	26.37 a	25.5 a
	Multilayer gunny bag	22.65 b	21.5 b
Fertilizer type	Albert's solution	23.5 a	21.5 a
	Compost tea	25.5 b	23.35 b

Means followed by same letter along columns for each grow bag package and fertilizer not significantly different at 5% level. Mean separation by LSD.

Table 10: Differences of treatments on yield parameters of chilli at significance level of α = 0.05 (n=4)

	Number of pods/ plant		**Pod length (cm)**		**Pod weight/plant (g)**	
Grow bag type	Commercial coco peat grow bag	Multilayer gunny bag	Commercial coco peat grow bag	Multilayer gunny bag	Commercial coco peat grow bag	Multilayer gunny bag
	4 a	7.6 a	11.91 a	19.42 a	6.1 a	6.1 a
Fertilizer type	Albert's solution	Compost tea	Albert's solution	Compost tea	Albert's solution	Compost tea
	6.75 a	4.87 a	22.16 a	14.65 a	6.1 a	6 a

Means followed by same letter along rows for each grow bag type and fertilizer not significantly different at 5% level. Mean separation by LSD

4. Conclusions

According to the results, chilli grown in multilayer gunny bag was performed comparatively better during the vegetative growth. Higher effective growth performance was observed Albert's solution treated chilli crop compared to organic compost tea treated crop Yet, yield parameters were not significantly different between two fertilizer types. Considering the growth performances of the crop, multilayer gunny bags with organic compost tea can be recommended for growing domestic model for chilli.

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Conflicts of Interest: The authors declare that there are no conflicts of interest regarding the publication of this paper.

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