



## THE EFFECT OF FERTILIZER PACKAGES ON THE GROWTH AND YIELD PERFORMANCES OF ICEBERG LETTUCE (*Lactuca sativa*) IN THE HORIZONTAL GROW-BAG SYSTEM

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### INTRODUCTION

Modern high-tech protected houses are equipped with favorable environments for the crops as discussed by Stanghellini, (2014). High-value crops such as lettuce play a significant role in the protected agricultural sector. In the controlled environment, plant nutrition requirement is mainly supplied by inorganic fertilizers. They play a significant role in triggering growth and boosting the yield of high-value crops grown under controlled environmental conditions.

In Sri Lanka, lettuce varieties are mainly grown in the upcountry zone, mostly in open fields. Nevertheless, some varieties such as Iceberg, Cos, and Rocket are grown in protected houses. In Sri Lanka, considerable negative consequences have occurred due to the inappropriate use of fertilizers for vegetable production - even under controlled environmental conditions. This is owing to the fact that the growth and yield of containerized crops mainly depended on the adequate supply of fertilizers (Dorais *et al*, 2004).

The average head weight of Iceberg lettuce in the world is about 850 g/head, In Sri Lanka however it is about 250 g/head in commercial-scale farming; which indicates a significant gap between the existent production of the Iceberg in Sri Lanka and other countries. Various types of fertilizers are available in the market for lettuce production. Yet, there is no crop-specific fertilization schedule to produce these types of high-value crops in a controlled environment. Due to limited root systems in the application of correct amounts of nutrients, it is necessary to promote growth (Kumara *et al*, 2015). It has captured the growing attention of the scientific community to introduce fertilizer packages for hydroponically grown crops.

To enhance the performance of the Iceberg, it is important to combine the commercially available fertilizers according to crop growth requirement, availability, easiness to use and cost-effectiveness. The reliability of fertilizer packages is significantly important to boost the crop production. On the other hand, the application of this fertilizer package should be more cost-effective than other combinations, for the farmers to gain a higher profit.

Therefore, a strategic combination of commercially available fertilizers is vital to produce a reliable and cost-effective fertilizer package for Iceberg. Therefore, this research study is conducted to evaluate the growth and yield performances of Iceberg lettuce (*Lactuca sativa*) in a hydroponic system and to assess the cost-effectiveness of the application of fertilizer packages.

### METHODOLOGY

The study was carried out in Nuwara Eliya under-protected house conditions. Horizontal grow bags were used to plant the experimental crop. The horizontal grow bags were filled with cocopeat and each grow bag had four planting holes with 25 cm spacing. The iceberg variety 'Tropical' was used. Treatments were prepared using different combinations of commercially available fertilizers. They were N: P: K- 30:10:10 (A), N: P: K- 10:52:10 (B), Albert's solution (C), Calcium nitrate (D), K44 (E) and Calmax (F) fertilizers. Four fertilizer packages (treatments) were prepared using these six fertilizers. These six fertilizers were assigned to different treatments according to the plant nutrient requirement in different growth stages. Treatment combinations were treatment 1 (T1- A, B, C, D), treatment 2 (T2 - A, C, D), treatment 3 (T3 - C, F) and treatment 4 (T4 - A, C, E). T3 (existing farmers' practice) was used as the control. Treatment application started after 21 days of the nursery period. Thereafter, treatment application was continued for 8 weeks. The treatment application interval was 6 days. The



treatment application schedule is given in Table 1. Treatments were applied in liquid form (500ml/plant/day).

**Table 1.** Treatment application

	T1	T2	T3 (Control)	T4
1 <sup>st</sup> week	A (0.8 g/plant)	A (0.8 g/plant)	C (0.5 g/plant) + F (1 ml/l)	A (0.8 g/plant)
2 <sup>nd</sup> week	B (0.8 g/plant)	C (0.8 g/plant)	C (0.5 g/plant) + F (1 ml/l)	C (0.8 g/plant)
3 <sup>rd</sup> week	A (0.8 g/plant)	A (0.8 g/plant)	C (0.8 g/plant) + F (1 ml/l)	A (0.8 g/plant)
4 <sup>th</sup> week	B (0.8 g/plant)	C (0.8 g/plant)	C (0.8 g/plant) + F (1 ml/l)	C (0.8 g/plant)
5 <sup>th</sup> week	C (1.0 g/plant)	C (1.0 g/plant)	C (1.0 g/plant) + F (1 ml/l)	E (0.8 g/plant)
6 <sup>th</sup> week	D + A (0.8 g/plant)	D (1.0 g/plant)	C (1.0 g/plant) + F (1 ml/l)	C (0.8 g/plant)
7 <sup>th</sup> week	C (1.0 g/plant)	C (1.0 g/plant)	C (1.5 g/plant) + F (1 ml/l)	E (0.8 g/plant)
8 <sup>th</sup> week	D + A (0.8 g/plant)	D (1.0 g/plant)	C (1.5 g/plant) + F (1 ml/l)	C (0.8 g/plant)

A common irrigation schedule was practiced for all the treatments. The watering interval was 4 days. Also, a common insecticide and fungicide package was applied to all treatments to prevent pests and diseases. Harvesting was done after 60 days of transplanting.

The total fresh weight of the plant, the weight of shoots/plant, the weight of roots/plant, the head weight, and the diameter of the head were measured at the harvest. The experimental design was a Completely Randomized Design with four replicates. Data were subjected to ANOVA. Duncan Multiple Range Test ( $\alpha = 0.05$ ) was used to compare the treatment means.

## RESULTS AND DISCUSSION

### Effect of fertilizer packages on growth and yield parameters

The application of fertilizer packages had a significant effect on the growth and yield attributes of Iceberg lettuce (Table 2).

**Table 2.** Growth and yield parameters of Iceberg as influenced by fertilizer packages

Treatment	Total fresh weight of the plant (g)	Weight of shoots/plant (g)	Weight of roots/plant (g)	Head weight (g)	Diameter of head (cm)
T1	484.81 <sup>a</sup>	85.49 <sup>a</sup>	25.15 <sup>a</sup>	374.16 <sup>a</sup>	11.94 <sup>a</sup>
T2	294.80 <sup>d</sup>	56.78 <sup>d</sup>	18.42 <sup>c</sup>	219.59 <sup>d</sup>	10.75 <sup>c</sup>
T3 (Control)	349.89 <sup>c</sup>	71.28 <sup>c</sup>	21.05 <sup>b</sup>	257.56 <sup>c</sup>	11.28 <sup>b</sup>
T4	424.75 <sup>b</sup>	81.25 <sup>b</sup>	26.05 <sup>a</sup>	317.45 <sup>b</sup>	11.69 <sup>ab</sup>

The highest total fresh weight of the plant (484.81 g), mature shoot weight per plant (85.49 g/plant), the head weight (374.16 g) and the head diameter (11.94 cm) were obtained from treatment T1 where the application of fertilizer package 1 (N: P: K- 30:10:10, N: P: K- 10:52:10, Albert's solution and Calcium nitrate). The lowest values of total fresh weight of the plant (249.80 g), mature shoot weight/plant (56.78 g/plant), the head weight (219.59 g) and the



diameter of the head (10.75 cm) were gained from treatment T2 (N: P: K- 30:10:10, Albert’s solution and Calcium nitrate). The results of the experiment are in accordance with Baker (1979), because NPK nutrient combination stimulates the head formation and development during the last three weeks of growth in head lettuce. According to Abdel (1996), the treatment with higher nitrogen and phosphorus at the early stage of head lettuce gave the highest head size and the highest yield. All these conditions agreed with the fertilizer combination of fertilizer package 1. Therefore, the highest growth and yield attributes were obtained from fertilizer package 1. However, no significant difference in root weight was observed between T1 and T4.

**Cost analysis for fertilizer packages**

The lowest cost was obtained from the application of T1 (Rs. 155.20 / 100 plants) where N: P: K- 30:10:10, N: P: K- 10:52:10, Albert’s solution and Calcium nitrate fertilizer combination, while the application of T3 generated the highest cost (Rs. 359.18 / 100 plants) with the combination of Albert’s solution and Calmax (Table 3).

**Table 3.** Cost analysis for fertilizer packages

Treatment	Fertilizers	Price/kg	Quantity (kg)	Cost (Rs/100plants)
T1	N: P: K-30:10:10	80.00	0.320	25.60
	N: P: K-10:52:10	100.00	0.160	16.00
	Albert's solution	440.00	0.200	88.00
	Calcium nitrate	160.00	0.160	25.60
	Total Cost			
T2	N: P: K-30:10:10	80.00	0.159	12.75
	Albert's solution	440.00	0.360	158.58
	Calcium nitrate	160.00	0.200	32.00
	Total Cost			
T3	Albert's solution	440.00	0.767	337.51
	Calmax	1300.00	0.016	21.67
	Total Cost			
T4	N:P:K-30:10:10	80.00	0.162	13.00
	Albert's solution	440.00	0.316	140.71
	K44	560.00	0.160	89.83
	Total Cost			

**CONCLUSIONS/RECOMMENDATIONS**

This study suggests that fertilizer package 1 (N: P: K- 30:10:10, N: P: K- 10:52:10, Albert’s solution and Calcium nitrate) can be used as a reliable and cost-effective fertilizer package to produce Iceberg lettuce in the horizontal grow-bag system.

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