

# Effect of Organic Based Liquid Fertilizers on Growth Performance of Leaf Lettuce (*Lactuca Sativa* L.)

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**Abstract**---The best quality lettuce is assured by adequate fertilizing, steady supply of water and cool temperature. Most of the farmers are using inorganic fertilizers for lettuce in open fields and in hydroponics. However, there is an increasing demand for organically produced fruits and vegetables. Therefore, the present study was conducted to study the plant growth in terms of fresh weight (*FW*, g/plant), dry weight (*DW*, g/plant), total leaf area (*LA*, cm<sup>2</sup>/plant), maximum root length (*RL*, cm), specific leaf weight (*SLW*, g/cm<sup>2</sup>) and number of leaves at harvest (*NL*) in leaf lettuce of variety 'Grand Rapid' in three different organic based liquid fertilizers. The highest *FW* was observed in T<sub>3</sub> (Glliricidia leaf extract) where the average EC and average pH were maintained at 0.43 dS/m and 5.85, respectively throughout the growing period. The highest *NL* and *LA* were also found in T<sub>3</sub>, resulting a higher production of photosynthetic tissues; where the lowest *NL* and *LA* were observed in T<sub>1</sub> (Compost tea liquid). The highest *DW*, partitioned to leaves (*LDW*) and roots (*RDW*) were recorded in T<sub>3</sub>. T<sub>1</sub> and T<sub>2</sub> (Poultry manure liquid) showed significantly lower dry matter partition to leaves and roots eventhough the highest EC (0.77dS/m) during the study period was recorded in T<sub>2</sub>. Although EC is an indirect indication of the strength of nutrient solution, T<sub>2</sub> did not show significant yield advantage due to some reason. The *SLW*, was not significantly different. The highest *RL* was also found in T<sub>3</sub>; owing to its higher dry matter partitioning. But, the highest growth of root hairs was observed in T<sub>1</sub>; which encourages nutrient absorption for plant survival, even at low EC levels. The study revealed that Glliricidia leaf extract as the most favourable organic based liquid fertilizer for best growth performance of leaf lettuce while Compost tea liquid was the lowest. Poultry manure was an intermediate performer in case of vegetative growth in leaf lettuce.

**Keywords**---Leaf Lettuce, Organic fertilizer, Plant growth performance

## I. INTRODUCTION

**L**ETTUCE (*Lactuca sativa* L.) belongs to the family Compositae which is one of the most important vegetable crops in the world. It is cultivated mainly in up country of Sri Lanka in open fields as well as under green house conditions. Simple hydroponics like trough culture and aggregate system are much used in growing lettuce.<sup>1</sup>

The best quality lettuce is assured by adequate fertilizing, steady supply of water and cool temperature. Albert solution and other inorganic fertilizers are heavily used in lettuce

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eventhough there is an increasing consumer demand for organically produced foods because of possible human health hazards due to over usage and environmental degradation caused by inorganic fertilizers [1].

Therefore, it is paramount important to evaluate the performance of lettuce in response to organic liquid fertilizers.

Compost tea is a liquid extract of compost consisting with essential plant nutrients and beneficial microorganisms which recycles organic matter. Compost tea also boosts the plant and soil enhancing activity of soil life. Compost tea has been used as a fertilizer, pesticide and fungicide [2].

Poultry manure is a strong liquid manure. Poultry manure in particular is a rich source of phosphorus and nitrogen, both of which are vital building blocks for plant proteins and thus contributive to plant growth [3].

The foliage of *Glliricidia sepium* is higher in its nutritional composition. Numbers of researches have been conducted on the antifungal and antimicrobial properties of glliricidia extracts, proving its ability to inhibit the growth of some fungi, bacteria and nematodes [4].

Therefore, the objective of this study was to investigate the effect of organic based liquid fertilizers on the vegetative growth of leaf lettuce (*Lactuca sativa* L.)

## II. MATERIALS AND METHODS

### Site Description

The study was carried out in the protected house of Uva Wellassa University, Badulla (IM 1a) during July to October 2014. The location is at 680m above sea level.

TABLE I  
WEATHER DATA FOR THE STUDY PERIOD

Month	Day temperature °C		Average rainfall mm
	Maximum	Minimum	
July	30	25	24
August	30	25	99
September	30	25	142

(Source: <http://www.accuweather.com>)

Mean day temperature of mid day under protected house was 38.5°C, measured daily with thermometers.

### Plant Description

Seeds of lettuce variety 'Grand rapid' were used as the planting material. Three treatments (TRT) were used for the experiment, namely; Compost tea solution (T<sub>1</sub>), Poultry manure liquid (T<sub>2</sub>) and Glliricidia leaf extract (T<sub>3</sub>). Three

plants (03 replicates) per each treatment were used for data collection. Complete Randomized Design (CRD) was used.

Seeds were sown in nursery medium of coir dust in seedling trays and two week old lettuce seedlings were transplanted to poly bags filled with a medium of coir dust. Bags were placed at 8 cm distance in protected house.

The fertilizer application was started three days after transplanting. Compost tea solution and Poultry manure liquid were prepared one week prior to each application. Glliricidia leaf extract was prepared just before each application.

#### Preparation of fertilizer solutions

In case of compost tea, 800g of commercially available compost was placed in a water container having 4 L using a cotton cloth sack, 01 week prior to application. Tea-bag (the sac) was securely tightened and immersed in water. Liquid was aerated by manual agitation twice a day. In case of poultry manure extract, 800g of dried poultry manure was placed in a water container having 4 L and the fertilizer liquid was prepared in the same manner as in case of compost tea liquid. Glliricidia leaves were collected from the plants grown naturally. Leaves were ground while mixing 1 L of water to 100 g of leaves to form the Glliricidia leaf extract [5].

Properly, filtered solutions were applied for plants once in two days. Application the amount applied was varied depending on the desirable EC values to be maintained in the hydroponics solutions (Table. II)

TABLE II  
APPLICATION AMOUNT OF FERTILIZER SOLUTIONS (ML)

Fertilizer	1 <sup>st</sup> – 5 <sup>th</sup> application	6 <sup>th</sup> – 10 <sup>th</sup> application	11 <sup>th</sup> – 15 <sup>th</sup> application	16 <sup>th</sup> – 20 <sup>th</sup> application
Compost tea (T <sub>1</sub> )	40	50	60	70
Poultry manure (T <sub>2</sub> )	40	50	60	70
Glliricidia leaf extract (T <sub>3</sub> )	40	50	60	70

Note: Each amount was applied to individual poly bags with 200mL of H<sub>2</sub>O

#### Dry Weight and Leaf Area Measurements

During the first week of October 2014, the plants were separated in to roots and leaves and fresh weights at harvest were obtained. Number of new leaves, developed after the treatments was counted. Root length of each plant at harvest was recorded. Then the samples were separately oven dried and dry weights after harvesting were recorded.

#### EC and pH of fertilizer solutions

EC and pH of fertilizer solutions were measured prior to application and pH was maintained in the range of 5.5 - 6.5 by adding 0.1 M phosphoric acid.

TABLE III  
EC AND PH VALUES OF FERTILIZER SOLUTIONS

	EC				pH			
	40 mL	50 mL	60 mL	70 mL	40 mL	50 mL	60 mL	70 mL
T1	0.21	0.23	0.25	0.27	6.45	6.49	6.48	6.47
T2	0.6	0.76	0.82	0.88	6.52	6.51	6.49	6.5
T3	0.38	0.42	0.43	0.47	5.86	5.91	5.8	5.81

Note: EC and pH were measured after mixing respective volume of fertilizer solutions in 200 mL of H<sub>2</sub>O

#### Climatic Parameters under Protected House Data Analysis

Results were analyzed by one-way ANOVA using Minitab 15 statistical package. Comparisons were made between mean values of morphological parameters using Tukey method.

### III. RESULTS AND DISCUSSION

#### Effect of Light Levels on Physiological Parameters

The effect of organic liquid fertilizers on the average fresh weight of leaves (*LFW*) and roots (*RFW*), average dry weight of leaves (*LDW*) and roots (*RDW*), average maximum root length (*RL*) and average leaf area (*LA*) of lettuce grown in grow bags (hydroponics) were statistically significant (Table IV).

Mean *LFW* at T<sub>3</sub> was significantly higher than T<sub>1</sub> and T<sub>2</sub>. This is due to higher number of leaves and larger leaf area per plant observed in T<sub>3</sub> at harvest (Figure 1 and Figure 2); where the average electrical conductivity (EC) and average pH were maintained at 0.43 dS/m and 5.85, respectively throughout the growing period.

EC is an indirect indication of the strength of the nutrient (hydroponic) solution. Higher EC more than 2.5 dS/m; hinders nutrient absorption due to increase in osmotic pressure whereas lower EC may severely affects the plant health and yield [6]. The latter may be the reason for the significant reduction of fresh weight of lettuce in T<sub>1</sub> where EC was much lower compared to T<sub>3</sub> (Table 2). Eventhough EC was higher in T<sub>2</sub> compared to T<sub>3</sub> and lesser than 2.5dS/m, there was no significant yield increase because higher EC creates higher nutrient concentration of the solution which may lead to toxicities in plant nutrition [7].

TABLE IV  
MEAN VALUES OF *LFW* (G/PLANT), *RFW* (G/PLANT), *LDW* (G/PLANT), *RDW* (G/PLANT), *RL* (CM), *LA* (CM<sup>2</sup>) FOR LEAVES UNDER DIFFERENT ORGANIC LIQUID FERTILIZERS

	<i>LFW</i>	<i>LDW</i>	<i>RFW</i>	<i>RDW</i>	<i>RL</i>	<i>LA</i>
T <sub>1</sub>	33.13 <sup>c</sup>	0.87 <sup>b</sup>	1.68 <sup>c</sup>	0.23 <sup>bc</sup>	9.13 <sup>c</sup>	580.43 <sup>c</sup>
T <sub>2</sub>	41.5 <sup>b</sup>	1.10 <sup>ab</sup>	1.77 <sup>b</sup>	0.24 <sup>ab</sup>	10.00 <sup>b</sup>	685.53 <sup>b</sup>
T <sub>3</sub>	45.4 <sup>a</sup>	1.27 <sup>a</sup>	1.92 <sup>a</sup>	0.26 <sup>a</sup>	10.83 <sup>a</sup>	725.87 <sup>a</sup>

For each variable, means followed by the same letter are not significantly different at p=0.05 level

Mean *LDW* at T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> were not significantly different from each other (Table 1). Significant proportion of the weight reduction after drying may be due to higher moisture content of lettuce leaves.

Average *LA* at T<sub>3</sub> was significantly higher compared to T<sub>1</sub> and T<sub>2</sub> (Figure 1); resulting a higher production of photosynthetic tissues; where lowest average *LA* were observed in T<sub>1</sub>.

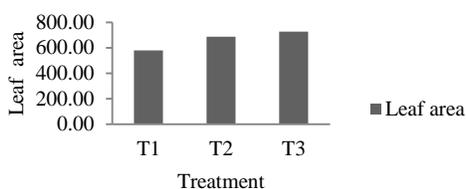


Fig. 1 Mean leaf area produced under each type of liquid fertilizer

The mean *RL* was highest in T<sub>3</sub> compared to T<sub>1</sub> and T<sub>2</sub>, owing to its higher dry matter partitioning. But, the highest growth of root hairs was observed in the plants in T<sub>1</sub> (Not proven statistically); which encourages nutrient absorption for plant survival, even at low EC levels.

Number of leaves (*NL*) was significantly different among treatments while it was higher in T<sub>3</sub> than T<sub>1</sub> and T<sub>2</sub> (Figure 2).

Specific leaf weight (*SLW*) was not significantly affected by different organic liquid fertilizers. *SLW* indicates dry matter produced per unit area of leaf tissue.

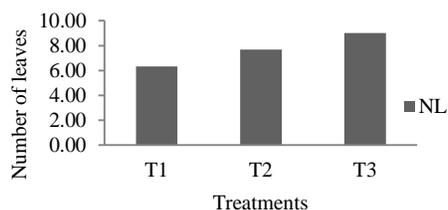


Fig. 2 Mean number of leaves produced under each type of liquid fertilizer

When compare the results with reports as in [8], lettuce plants grown in coir dust medium which were fertilized with Albert's solution (EC was 1.5 and pH was 6.5) have performed their vegetative growth more or less similar to the plants grown with organic liquid fertilizers in the present study (Table 4).

TABLE V  
MEAN VALUES OF *LFW* (G/PLANT), *LDW* (G/PLANT), *RL* (CM), *LA* (CM<sup>2</sup>) FOR LEAVES UNDER DIFFERENT ORGANIC BASED LIQUID FERTILIZERS AND ALBERT SOLUTION

Treatment	<i>LFW</i>	<i>LDW</i>	<i>RL</i>	<i>LA</i>
T1	33.13	0.87	15.93	580.43
T2	41.5	1.10	15.13	685.53
T3	45.4	1.27	14.93	725.87
Albert's	42.5	0.93	18.5	690.00

#### IV. CONCLUSION

The present study identified the most favourable organic based liquid fertilizer for best growth performance of leaf lettuce. All the growth paramaters determined; were higher in the plants grown with *Gliricidia* leaf extract whereas the lowest performance was found in plants grown with Compost tea liquid. Poultry manure was an intermediate performer in

case of vegetative growth in leaf lettuce. Comparatively low cost of *Gliricidia* extract, justifies the results, economically.

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