EFFECT OF DIFFERENT HYDROPONIC SYSTEMS AND MEDIA ON GROWTH OF LETTUCE *(Lactuca sativa)* UNDER PROTECTED CULTURE

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ABSTRACT

An experiment was conducted to find out the suitable hydroponic system and rowing media for cultivation of lettuce *(Lactuca sativa)* under protected environment. The treatments included 3 growing systems (nutrient flow system, non circulating system, aggregate system) and six growing media (coir dust, coir dust + tea refuse, tea refuse + partially burnt paddy husk, tea refuse, coir dust + partially burnt paddy husk and partially burnt paddy husk). Results revealed that the aggregate system had better mean values for all measured growth parameters while coir dust and paddy husk proved to be the best growing media for better plant growth and yield. Hence combination of an aggregate system with either coir dust or partially burnt paddy husk or both would be ideal for cultivation of lettuce under protected environments.

KEY WORDS: Hydroponics systems, Growing media, Lettuce, Protected environment

INTRODUCTION

Soil is the natural growth media for cultivation of many crops. However, it has created problems such as soil born diseases, undesirable microbial activities and nematodes, changing acidity levels, salinity, poor drainage, poor nutrient levels and undesirable soil characters.

Therefore to overcome these problems new methods are being (introduced such as soilless culture and cultivation of crops under protected environments. Experiences have shown that these methods have a great potential in Sri Lanka in production and meeting the demands of specific vegetable markets. Lettuce, bell pepper, tomato and salad cucumber are some high valued vegetable crops suited for, soilless culture under protected environments. However, the ideal growing media and other requirements for each crop grown under protected environments in Sri Lanka have not been studied in detail.

The plants absorb nutrients from hydroponics solutions. This solution acts as media and should include all macro and micro nutrients required for plant growth. The commonly used nutrient solution for hydroponics culture in Sri Lanka is Albert's solution. Composition of the Albert solution is given in table 1. It has been claimed that the key to successful hydroponics culture is the nutrient solution (Hedio Ikeda, 2000) and to achieve maximum yield potential, it must be grown under optimum environmental conditions and under sound management practices. Hydroponic is no different from other forms of agriculture and if the correct environmental conditions and management practices are not provided crop output can be drastically reduced (Sutherland, 1986). The nutrient content of a solution is very important, because plants absorb nutrients from hydroponics solutions. This solution act as growing media and should include all macro and micronutrients required for plant growth. For

practical purposes, all essential inorganic nutrients are taken up through the roots. In soilless culture, the growing media must contain all of these nutrients and in amounts which meet the needs of the plants.

Table 1. Composition of Albert's solution (Total fertilizer 2 kg)

Nutrient	NO_3	P	K	Ca	Mg	S	Fe	Mn	B	Zn	Cu	Mo	NH_4
Amount (ppm)	135	70	288	143	30	117	1.5	0.3	0.03	0.03	0.03	0.005	63

The lettuce *(Lactuca sativa)* comes under the family compositae. It is one of the most important vegetable crops in the world. Lettuce is rich in vitamin A, C and minerals like Calcium and Iron. It also contains protein and carbohydrates (Tindall, 1993). There is variation in nutritive values in different types of lettuce, Cos or leaf types being the richest followed by butter heads and crisp heads.

In Sri Lankan context lettuce is not cultivated as a monocrop. It is always mixed with crops like leeks, beet, carrot, cabbage, etc. which ultimately result in low productivity. The quality, too, is poor due to poor management practices.

The hydroponics has paved its way to obtain good quality products as well as increased yields. However the efficiency of hydroponics system depend on factors such as growing methods, media, pest management, variety, nutrient availability etc. Therefore, the objective of this study was to identify the best hydroponic system and growing media for efficient use of nutrients and other growing conditions for increased production of lettuce when cultivated under protected environments.

MATERIALS AND METHODS

The experiment was conducted in a protected house at the Horticultural Crops Research and Development Institute (HORDI), Department of Agriculture, Gannoruwa, Peradeniya from September 2001 to November 2001.

Five hundred lettuce seeds, var. Grand Rapid were sown in plantlet trays using sponge and covered with black polythene and placed in. dark. Two days later black polythene was removed and trays were placed In the protected house. Two week old healthy and vigorous seedlings were transplanted in three different hydroponic systems inside the protected house. The space between two plants was 8 cm for all systems. The protected house was (50 x 25 ft) provided with an insect proof netting on sides and UV treated 1000 gauge polythene roof. It also had temperature control misters and exhaust fans.

The different systems used were,

1. Nutrient flow system

10 cm diameter and 500 cm length P.V.C. pipes and small net pot (as container) were used for the nutrient flow system. Fertigation unit was connected with this system (Figure 1). The nutrient solution (Albert's solution, with 1500 Electro Conductivity (E.C.) and 6.5 pH) was circulated twice a day.

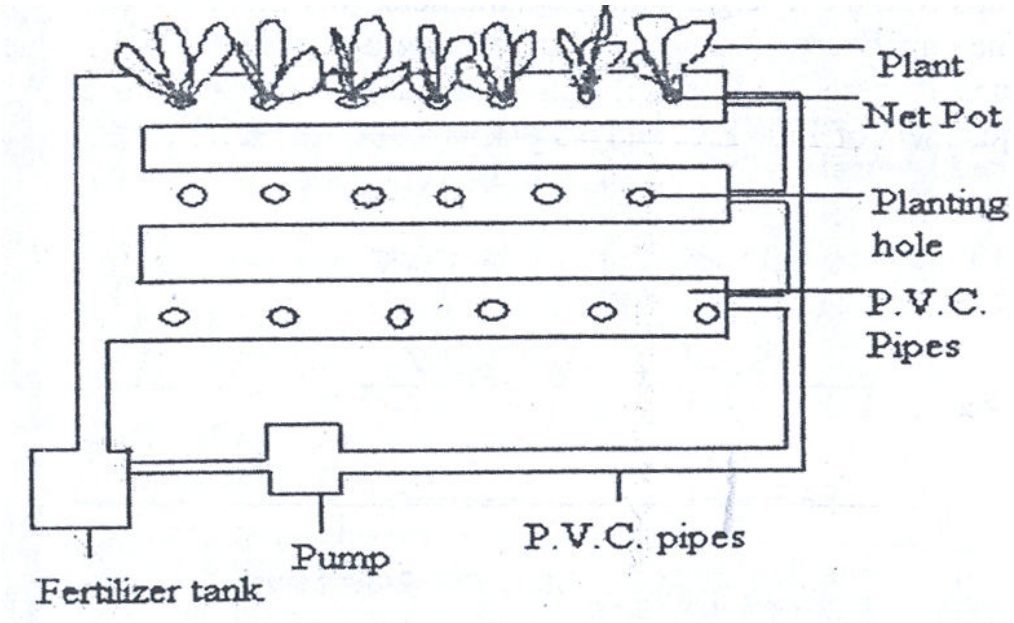


Figure 1. Nutrient flow system

2. Non circulating system

15 cm width and 15 cm height gutters were used for the non circulating system. It was covered with ridgiform plates and net pots were placed on them. The gutters were filled with Albert's solution up to 10 cm in height leaving of about 5 cm gaps between the nutrient solution and the ridgiform plate (Figure 2). The E.C. and pH of the solution were maintained as 1500 and 6.5 respectively in weekly basis.

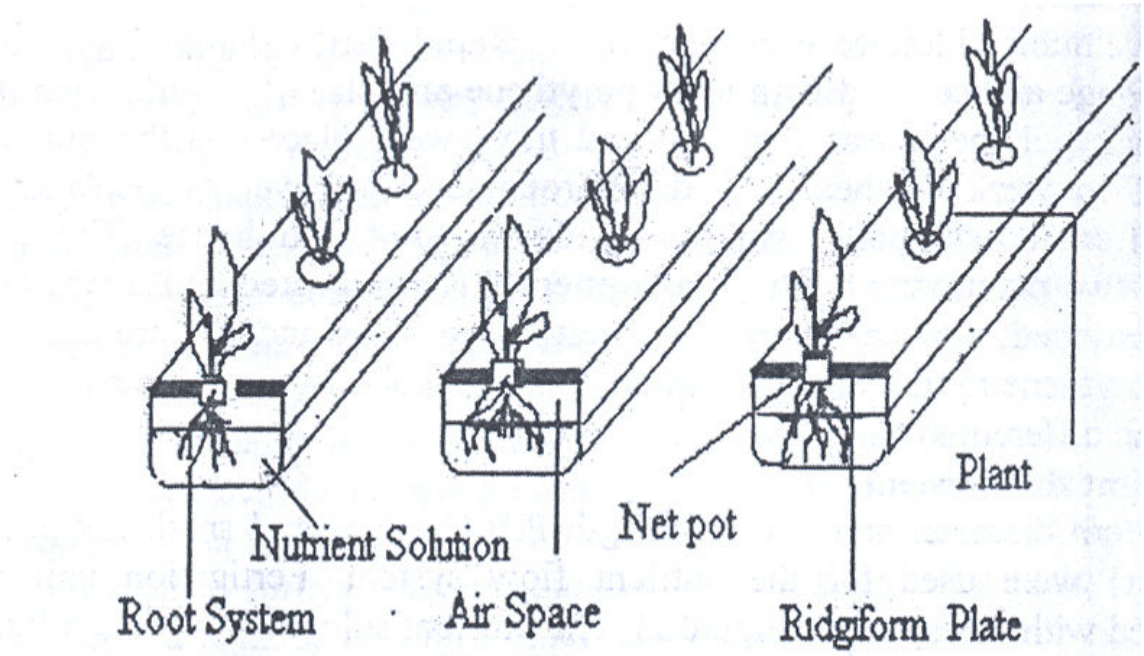


Figure 2. Non circulating system

3. Aggregate system

Cups with 8 cm height and 12 cm diameter (0.5 1iter ice cream cup) were used. The cups were filed with six different growing media and it placed on the ground (Figure 3). 20 ml of nutrient solution per plant was added daily with adjustment of 1500 E.C. and 6.5 pH.

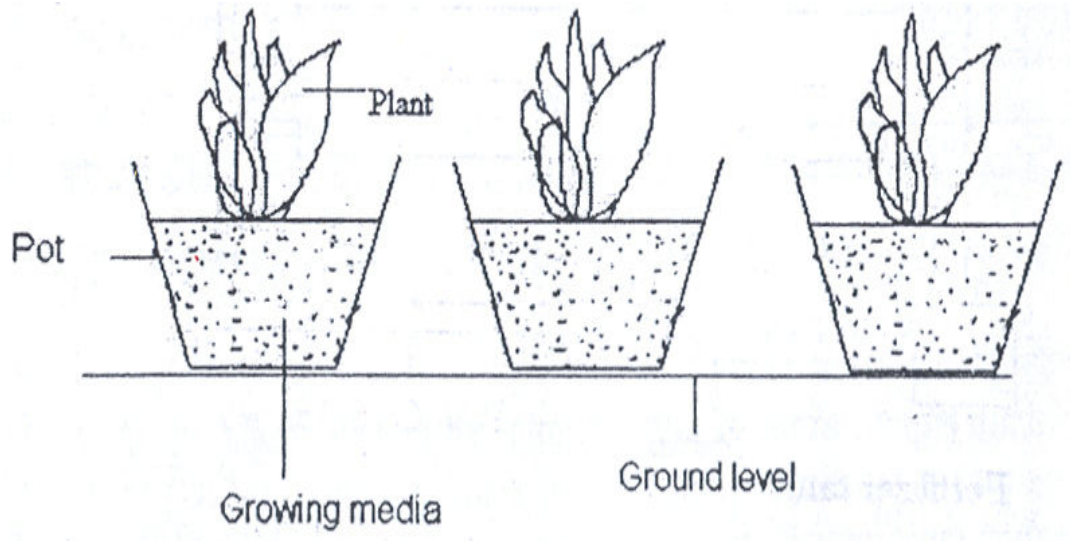


Figure 3. Aggregate system

For each system six growing media were used. They were,

1: Coir dust (T_1)
2: Coir dust + tea refuse (T_2)
3: Tea refuse + partially burnt paddy husk (T_3)
4: Tea refuse (T_4)
5: Coir dust + partially burnt paddy husk (T_5)
6: Partially burnt paddy husk (T_6)

Each block consisted of 72 plants (all have 216 plant) and 108 randomly selected plants were used for the purpose of data recording. Data on following parameters were recorded.

1. pH and E.C. m the nutrient solution.
   pH and E.C. of nutrient solution were measured on weekly basis from transplanting to harvesting and maintained the pH at 6.5 and E.C. at 1500 in all methods and treatments.
2. Number of leaves per plant.
   Number of leaves per plant was taken on weekly basis from transplanting to harvesting stage.
3. Length and width of the leaves. (cm)
   Maximum length and width of each leaf were recorded, on weekly basis up to harvesting.
4. Fresh plant weight at harvest (g)
5. Root length at harvest (cm)
6. Leaf area per plant at harvesting. (cm^2)
   Using leaf area meter (model DELTA - T) total leaf area was taken in each plant.
7. Leaf dry weight after harvesting. (g)

The experiment was laid down as CRD design with three replicates and the data gathered were analyzed statistically as two factor- factorial experiment using SAS computer programmed package. All continuous data (leaf length and width, fresh weight, dry weight) were analyzed using GLM procedure while the number of leaves was analyzed by using CATMOD procedure.

RESULTS AND DISCUSSION

1. Effect of hydroponic systems

Table 2 gives the mean results of root length, leaf area, fresh plant weight, dry weight and yield obtained from plants grown under 3 different hydroponic systems. It is clear that the aggregate system has shown the most promising results. Results obtained for above parameters were significantly higher than the other two systems. Longer root (17.5 cm) and heavier root mass would have absorbed more nutrients resulting larger leaf area (752.3 cm^2) and higher plant weight (46.8 g). The highest yield was also recorded in the aggregate system (2340 g/m^2).

The nutrient supply in the aggregate system was much better than the other two systems and absorption of nutrients was quick. Further, this system had a good aeration than the other two. Further it had wider spacing and provided dark condition for root development.

Table 2. Growth parameters of lettuce in relation to 3 hydroponic systems

System	Growth parameters				
	Root length (cm)	Total leaf area (cm^2)	Fresh weight (g)	Dry weight (g)	Yield (g/m^2)
Nutrient flow system	15.4b	551.8b	29.2c	0.7b	1460
Non circulating system	14.2b	648.1b	35.8b	0.9b	1790
Aggregate system	17.5a	752.3a	46.8a	1.1a	2340
LSD (0.05)	2.0	116.0	4.9	0.2	
CV	19.2	26.55	19.5	29.31	

System means in a column having a common letters are not significantly different by LSD test at 5% level

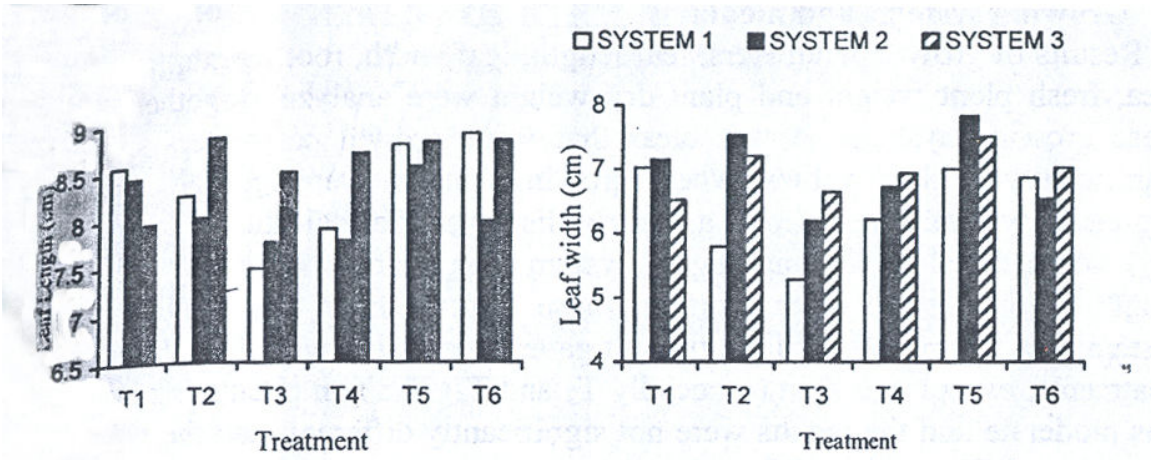
2. Effect of growing media

Table 3 indicates that growing media have shown significantly variable results for growth parameters. The coir dust (T_1) showed the most effective results giving higher values for root length (16.9 cm) and total leaf area (727.05 cm^2) while it was placed second in fresh weight (40.2 g) and dry weight (1 g) which were not significantly different from the treatments which showed the highest values. On the other hand, all other treatments which were blended with coir dust and partially burnt paddy husk and partially burnt paddy husk alone showed higher values. However, the treatments with tea refuse (T_4) and its mixture gave the lowest values. .This clearly shows that tea refuse is not suitable as a growing media, while coir dust alone or mixed with partially burnt paddy husk or burnt paddy husk alone make good growing media for lettuce cultivation under control environments.

Table3. Growth parameters of lettuce in relation to 6 treatments (growth media)

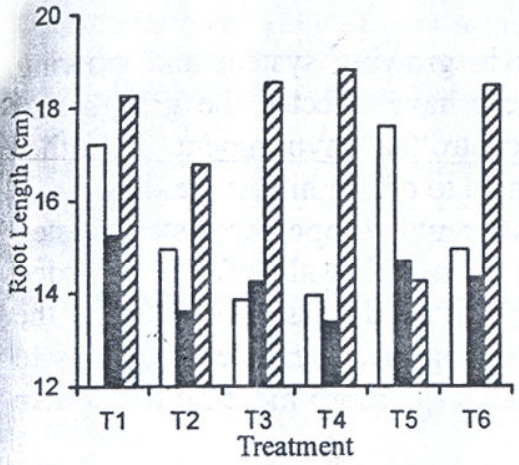
Treatment	Growth Parameters			
	Root length(cm)	Total leaf area(cm^2)	Fresh weight(g)	Dry weight(g)
1	16.9 a	727.6 a	40.2 a	1.0a
2	15.1a	693.8 a	38.5 ab	0.8ab
3	15.5 a	606.7 ab	32.5bc	0.9ab
4	15.3 a	521.7 b	31.6 c	0.7b
5	15.5 a	671.9ab	39.5 a	1.0a
6	15.9 a	682.8 ab	41.3 a	1.1 a
LSD (0.05)	2.86	163.98	6.91	0.25

Treatment means in a column having a common letters are not significantly different by LSD test at 5% level.

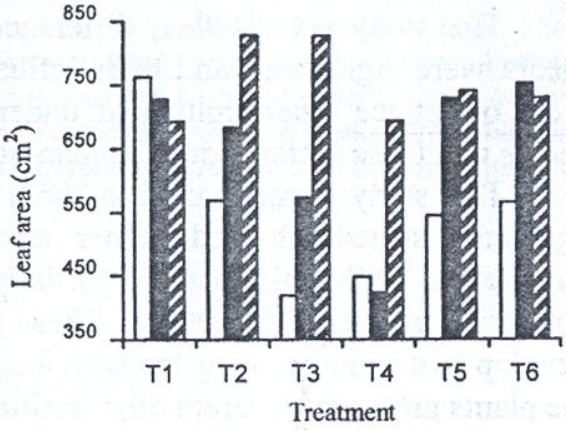


a. Leaf length

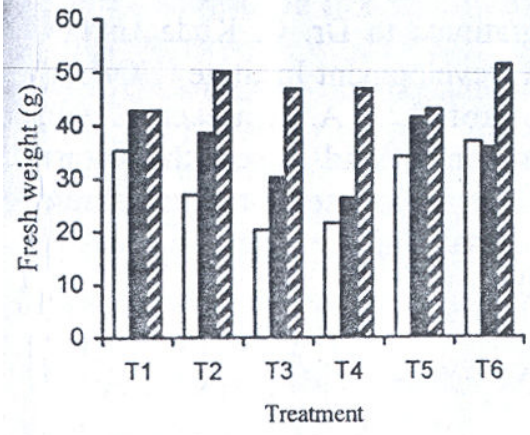
b. Leaf width



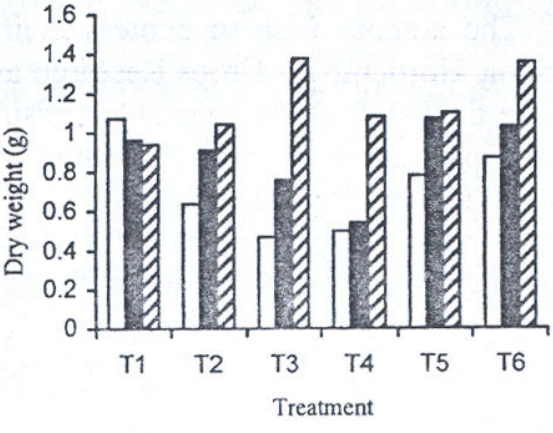
c. Root length



d. Total leaf area



e. Fresh weight



f. Dry weight

3. Growing systems and media

Results of growth parameters, leaf length, leaf width, root length, total leaf area, fresh plant weight and plant dry weight were analyzed together with these growing systems, it was clear that some growth parameters showed significantly higher values when growing media were combined with aggregate system. The figure 4 a, clearly displayed that coir dust + tea refuse (T_2) when coupled with aggregate system significantly increased the leaf length of the lettuce plant. Further, these figures show that nutrient f1ow system as a failure. Most of the time, it gave lower value with growing media treatments, except coir dust (especially T_3 T_4). The non circulating system was moderate and the results were not significantly different than the nutrient flow system (Figure 4 a - 4 f).

CONCLUSIONS

The study reveals that, differences in growing system and growing media were significant and their influences have affected the growth and yield of lettuce when cultivated under controlled environment. It further shows that these factors could be manipulated to obtain higher yields.

This study shows that out of three different hydroponics systems tested aggregate system showed higher mean values for all of the recorded parameters, while coir dust and partially burnt paddy husk proved to be the best growing media for lettuce. These growing media enabled the roots to develop better thus paving the way for plants to absorb more nutrients than the plants grown in different other media.

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