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Study on The Use of Rectangular and Triangular Models in Hydroponics for the Culture of *Anubias barteri* Var "Broad Leaf"

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Abstract Hydroponics is a method of culturing plants without the use of soil. *Anubias barteri* var "Broad Leaf" is an aquatic plant being cultured as a decorative plant in aquaria. It is in demand and is expensive. This research was conducted to compare the use of rectangular and triangular models for the culture of *Anubias barteri* var "Broad Leaf". Specifically, to compare the leaf width, leaf length, leaf thickness, number of leaves per plant, chlorophyll content and fresh weight at 120 days after planting. Results revealed that no significant difference was observed among plants in terms of all the parameters studied within each model except for number of leaves per plant in the triangular model. In comparing the two models, no significant difference was observed in all parameters except for plant height wherein plants grown in triangular model were taller than plants grown in the rectangular model.

Keywords: hydroponics, anubias, model

Introduction

Hydroponics is a method of growing plants using nutrient solutions in water without soil. Plants be grown with their roots soaked or dipped into the nutrient solution only (Itthisutorn, 2014). There are several types of Hydroponics systems being used to culture plants such as: Nutrient Film Technique (NFT), Dynamic Root Floating Technique (DRFT), Aeroponics, Substrate culture and Deep Flow Technique system (DFT). The kind of system to be used depends on the plants to be grown as well as the characteristics of the system itself. Salad vegetables (Green Oak, Red Oak, Green cos, Red coral lettuce) can be grown using NFT and DRFT systems whereas tomatoes and Melons can be grown using Substrate culture system.

Growing greenhouse vegetables is one of the most exacting and intense forms of all agricultural enterprises. In combination with greenhouses,

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hydroponics is becoming increasingly popular, especially in the United States, Canada, Western Europe, and Japan. It is high technology and capital intensive. It is highly productive, conservative of water and land and protective of the environment. For production of leafy vegetables and herbs, deep flow hydroponics is common. For growing row crops such as tomato, cucumber, and pepper, the two most popular artificial growing media are rockwool and perlite. Computers today operate hundreds of devices within a greenhouse by utilizing dozens of input parameters, to maintain the most desired growing environment. The technology of greenhouse food production is changing rapidly with systems today producing yields never before realized. The future for hydroponic/soilless cultured systems appears more positive today than any time over the last 50 years.

Anubias (*Anubias* sp.) belongs to Araceae (Sukanya, 2005). It is annual, dicotyledon plant with thick and durable leaf. Anubias have slow growth and 8-10 leaf in the year (Nongnuch, 2549). This plant originated in Western Africa (Rataj and Horeman, 1997; Muhlberg, 1982),

At present, the demand for anubias is high and the cost per plant ranges from 1-2 US dollars.

Objective

The study aimed to compare the use of rectangular and triangular models for hydroponics in the culture of Anubias barteri var "Broad Leaf".

Specifically to: 1. measure the leaf width; 2. Measure the Leaf length; 3. Measure the height plant; 4. Measure the Leaf thickness; 5. Measure the Number of leaf; 6. Measure the chlorophyll content; and 7. Measure the fresh weight

Materials and methods

Preparation of the structure experiment

The structure has ½ Inches pipes, 3.5 meters length and 1.6 meters heightuse for table. The PVC have 2 inches size and 4 meters length, that the hole within PVC have 39 holes. and the diameter size of the hole is 5 centimeter.

Figure 1. The structure of experiment

Preparation of plants

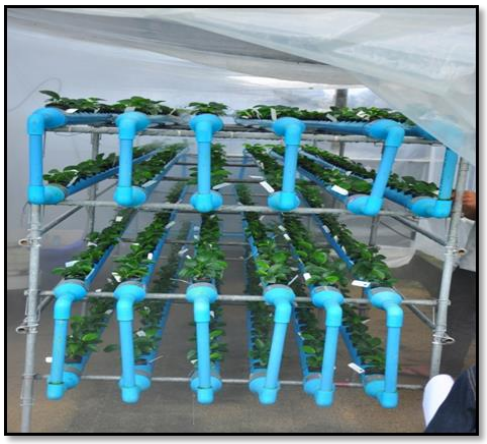
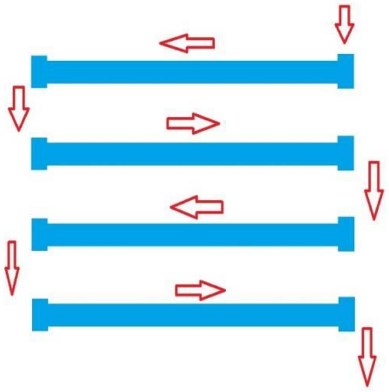


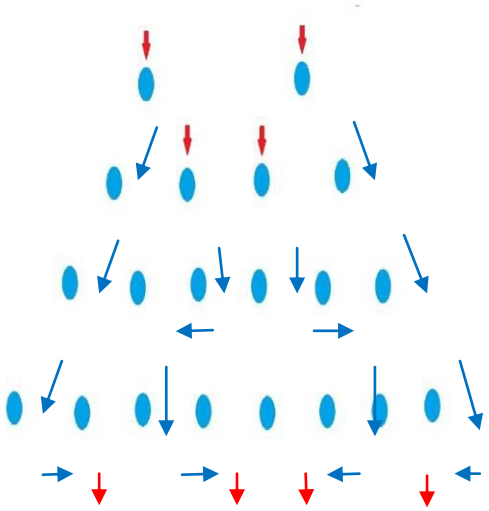
Figure 2. Rectangular models



Circulating water system

Rectangular structure was the assembled eight 2-inch diameters PVC tubes into four layers, total of 32 tubes. Total of rectangular structure had 1,248 holes.

Figure 3. Triangular models



Circulating water system

Triangular structure was the assembled eight 2-inch diameters PVC tubes into four layers, total of 20 tubes. Total of rectangular structure had 780 hole.

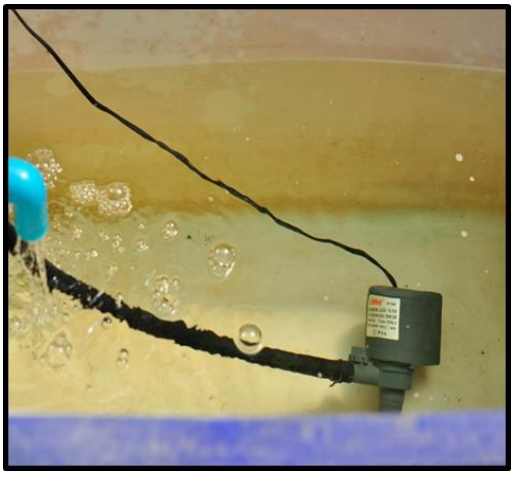


Figure 4. A: Pump

B: fogger machine

The size of nutrient solution tank had 100 liters. The nutrient is pumped into the PVC and flows through to the root of plant and drains back into the tank, and the fogger machine use for reduce temperature within greenhouse.

Preparation of Anubias barteri var "Broad Leaf"

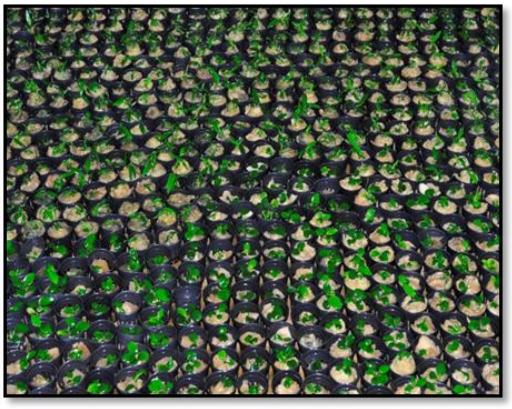


Figure 5. Anubias barteri ver "broad Leaf" Sprout Anubias barteri ver "broad Leaf"

This experimental have used Anubias barteri ver "broad Leaf" from tissue culture. Rock wool is used going media. And then 1 month move into the PVC.

Nutrients

Solution	Volume
Solution A	
$(Ca(NO_3)_2.4H_2O$ (Kg.)	3.767
Fe-EDDHA (Kg.)	0.303
Solution B	
KNO_3 (Kg.)	1.769
KH_2PO_4 (Kg.)	0.653
$MgSO_4.7H_2O$ (Kg.)	1.037
$ZnSO_4$ (g)	4.756
$CuSO_4.5H_2O$ (g.)	1.016
$MnSO_4.H_2O$ (g.)	14.194
H_3BO_3 (g.)	8.894
$(NH_4)_2MoO_4$ (g.)	0.343

The research was conducted for four months from 27 April 2013 to 29 August 2013.

Results and discussion

Using the rectangular models ,it was found out that the leaf width ranged from1.98-2.19 cm, leaf length from 3.25-3.57 cm, leaf thickness from 0.44-0.47 cm, height plant from 5.22-5.68 cm, number of leaf/plant from 8.83-9.11 , chlorophyll content from 45.71-50.33 , fresh weight from 2.61-3.21(g/plant) Statistical test indicated that there was no significantly difference among number of leaves/plant, leaf width, leaf length, height plant, leaf thickness, number of leaf and fresh weight but there were statistically different in chlorophyll content ($p<0.05$).

Table 1. The growth of *A. barteri*"broad leaf" of rectangular models for hydroponics

Level	1	2	3	4	F-test
leaf width (cm.)	1.98 ±0.05	2.10 ±0.16	2.16 ±0.07	2.19 ±0.07	ns
Leaf length (cm.)	3.25 ±0.10	3.40 ±0.12	3.43 ±0.11	3.57 ±0.12	ns
leaf thickness (cm.)	0.44 ±0.02	0.47 ±0.02	0.45 ±0.01	0.45 ±0.01	ns
height plant (cm.)	5.22 ±0.20	5.56 ±0.21	5.58 ±0.22	5.68 ±0.22	ns
number of leaf/plant	8.69 ±0.26	8.81 ±0.20	8.83 ±0.23	9.11 ±0.23	ns
chlorophyll content	46.18 ±0.94^{b}	46.06 ±1.14^{b}	45.71 ±1.13^{b}	50.33 ±1.02^{a}	*
fresh weight(g/plant)	2.96 ±0.40	3.21 ±0.43	2.91 ±0.34	3.12 ±0.41	ns

*Means with the same letter superscript do no vary significantly at $p>0.05$

Figure 6. The growth of *A. barteri*"broad leaf" of rectangular models for hydroponics

Using the triangular models ,it was found out that the leaf width ranged from1.86-2.12 cm, leaf length from 3.10-3.66 cm, leaf thickness from 0.40-0.45 cm, height plant from 5.81-6.41 cm, number of leaf/plant from 8.56-9.33 , chlorophyll content from 46.88-49.33 , fresh weight from 2.70-3.70)g/plant(Statistical test indicated that there was no significantly difference among number of leaves/plant, leaf width, leaf length, height plant, leaf thickness, number of leaf fresh weight and chlorophyll content)p>0.05(.

Table 2. The growth of *A. barteri*"broad leaf" of triangular models for hydroponics

Level	1	2	3	4	F-test
leaf width (cm.)	1.86±0.04	2.12±0.05	2.07±0.08	1.96±0.12	ns
Leaf length (cm.)	3.17±0.09	3.10±0.13	3.62±0.31	3.66±0.21	ns
leaf thickness (cm.)	0.40±0.01	0.41±0.01	0.45±0.02	0.44±0.03	ns
height plant (cm.)	5.81±0.16	5.77±0.21	6.41±0.28	6.24±0.37	ns
number of leaf/plant	8.56±0.20	8.94±0.19	9.17±0.34	9.33±0.47	ns
chlorophyll content	46.88±0.76	48.46±0.95	48.43±1.52	49.75±1.96	ns
fresh weight (g/plant)	2.70±0.19	2.86±0.22	3.50±0.31	3.70±0.52	ns

Figure 7. The growth of *A. barteri*"broad leaf" of triangular models for hydroponics

The result showed that comparing the two models, no significant difference was observed in all parameters except for plant height wherein plants grown in triangular model were taller than plants grown in the rectangular model.

Table 3. The result showed that comparing the rectangular models and triangular

Growth	rectangular	Triangular	t-test
leaf width (cm.)	2.13±0.03	2.00±0.05	Ns
Leaf length (cm.)	3.46±0.04	3.39±0.15	Ns
leaf thickness (cm.)	0.45±0.01	0.42±0.01	Ns
height plant (cm.)	5.51 ± 0.10^{b}	6.06 ± 0.16^{a}	*
number of leaf/plant	8.86±0.09	9.00±0.17	Ns
chlorophyll content	47.07±1.09	48.38±0.59	Ns
fresh weight(g/plant)	3.01±0.04	3.19±0.24	Ns

*means with the same letter superscript do no vary significantly at p>0.05; Study on the use of rectangular and triangular models for hydroponics in the culture of

Anubias barteri var "Broad Leaf" indicated that can grow since The Anubias plants as plants need light for growth 3,000-7,500 lux (Nongnuch, 2006) So, it have not problem with the shade inside the level. This is consistent with (Preedaporn, 2013) which reported that growing plants can thrive in vertical. The market needs 3 size of Anubias which consider the height of plant and number of leaves as the standard distribution. S size has a height of not more than 4 inches. M size have a height of not more than 6 inches and L size have a height of more than 6 inches. The three size must be at least 6 leaves per plant (Somkiat, 2013) When the consider from structure showed that Structural rectangular have amount more than triangular at 468 plants.

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