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EVALUATING PERFORMANCE OF THREE LETTUCE VARIETIES USING A NON-CIRCULATING HYDROPONIC SYSTEM

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RESUME

L'expérimentation préliminaire a indiqué que les substrats pour cultures sans sol à base de matériau local au Suriname sont à des coûts accessibles pour la production de laitues lorsque qu'on utilise un système hydroponique à solution perdue. De plus, l'utilisation de parches de riz comme substrat avec des solutions nutritives soit de "Miracle Growth" (18-18-21) soit de "Pokon" (6-3-6) a accru la production de laitue sous abri.

Dans cette étude trois variétés de laitue furent évaluées sur parche de riz en utilisant soit « Miracle Growth » soit « Pokon » comme solution nutritive dans un système hydroponique à solution perdue. Les résultats ont révélé que le poids moyen de la plante de la variété Trinity Star était significativement, plus élévé ($p < 0{,}05$) en comparaison du poids moyen par pied de Black Seeded, Simpson, et Great Lakes 366. Les chiffres ont montré que le poids moyen par pied des trois variétés de laitues était significativement plus élevé ($p < 0{,}05$) quand Miracle Growth était utilisé. Le pH de la solution de Miracle Growth était significativement plus élevé que le pH de Pokon alors que la capacité d'échange (EC) de Miracle Growth était légèrement plus élevée que celle de la solution de Pokon.

ABSTRACT

Preliminary experimentation has indicated that soilless culture media made of local materials in Suriname are cost effective in lettuce production when using a non-circulating hydroponic system. Furthermore, the use of rice hulls as a soilless media with mineral solutions of either Miracle Growth (18-18-21) or Pokon (6-3-6) as nutrient solution has enhanced lettuce production under greenhouse conditions.

In this study three lettuce varieties were evaluated on rice hulls utilizing either Miracle Grow or Pokon as a mineral solution in a non-circulating hydroponic system. Results revealed that the average plant weight of Trinity Star was significant higher ($p < 0.05$) in comparison to the average plant weight of Black Seeded Simpson and Great Lakes 366. Data also showed that the average plant weight of all three lettuce varieties was significantly higher ($p < 0.05$) when Miracle Grow was used. The pH of the Miracle Grow solution was significantly higher than the pH of Pokon while the EC of Miracle Grow was slightly higher than the EC of the Pokon solution.

INTRODUCTION

Soilless culture or hydroponics is a technology for growing plants in nutrient solutions. In this system plants are supplied with a complete nutrient formula. Furthermore, an inert growing medium can be used for the attachment of plant roots.

Culture of plants through hydroponics in comparison with culture of plants in the soil has the advantage that incidences of pest and diseases seldom or never occur. A major advantage is that weed control, the most important problem to many crop system Sis not needed.

Other important advantages of hydroponics include high productivity and more efficient use of water and fertilizer.

Hydroponics systems can be divided into two distinct types and are usual referred to as passive and active systems.

A passive hydroponic system is one in which the nutrients are supplied to the plant periodically, usually manually, and is allowed to sit in a reservoir to be used by the plant as needed. The simplest passive system is the pot culture, which is the simplest and safest way of growing hydroponics. This system is ideal for beginners but also favored by experienced growers. It is suitable for a lot of plant types and almost all growing situations. It is very cheap to set up and it is hard to fault as an effective growing system.

An active hydroponic system is one in which a pump is used to supply the solution to the plants on a regular basis. The solution is usually recirculated which is the most significant difference between the systems in terms of management.

Active systems can be divided into several types: rockwool, Nutrient Film Technique (NFT), and Flood and Drain. All these systems have their advantages and disadvantages, and the choice of the individual grower will depend very much on their specific requirement.

A major disadvantage of active hydroponics is the high costs of capital and energy inputs compared to the convential soil culture.

There has been an increasing interest in the use of hydroponics for producing greenhouse horticultural crops.

In Suriname, the introduction of an energy-saving hydroponics system could be of great potential to the small farmers in Suriname. Especially, if several types of local materials could be used as soilless culture media which would cut down on production costs. In order to provide farmers with information an technology on soilless culture using a non-circulating hydroponics system, a project was set up to evaluate the growth of lettuce using several local materials as soilless culture media.

PURPOSE OF THE STUDY

To evaluate the growth of lettuce on a non-circulating hydroponic system.

SPECIFIC OBJECTIVES

- ✓ To evaluate lettuce growth on a non-circulating system
- ✓ To test various inert media
- ✓ To evaluate greenhouse conditions (T, RH, sunlight)
- ✓ To monitor pH and EC
- ✓ To evaluate various liquid fertilizers.

METHODOLOGY

In November 2000 until January 2002, a series of preliminary investigations were conducted at one of the greenhouse facilities at the Center for Agricultural and Forestry Research in Suriname (Celos) using a non-circulating hydroponic system as described by Asian Vegetable Research and Development Center.

Experiment 1

In November 2000-January 2001, a preliminary study was conducted at one of the greenhouse facilities at Celos. For this experiment a Completely Randomized Design was used with two types of fertilizer (liquid and fixed) and three types of growing media (vermiculite, smoked rice husk, and rice husk).

The interior of 50 L polystyrene boxes will lined with black plastic and then filled with 46 1/2 L. water. To three of these boxes 100 ml. of a liquid NPK (6-3-6) was added to each box, while 56 gr. Of a fixed NPK fertilizer (12-12-12-17) was added to the remainder of these boxes. Each lid of the polystyrene box contained fifteen plastic pots with a volume of 300 ml.

Each growing media was randomized assigned to boxes each. The level of nutrient solution was kept at the 2 cm, level above the bottom of the lids to ensure that the seeds got adequate moisture for generations. In each pot one seed (variety Black Seeded Simpson) was placed.

Variables which were studied included plant weight, plant height, T, RH, pH, and EC.

RESULTS AND DISCUSSION

The daily temperature in the greenhouse ranged from 24^0C (8:00 am) – 30^0C (12:00 am).
In general it was observed that the lettuce growth was much better in liquid fertilizer in comparison to the lettuce plants growing on the fixed fertilizer.

It was also noted that lettuce growth which used smoked rice hulls as a soilless media revealed the poorest growth.

The lettuce growth on rice hulls and vermiculite was good. The results showed that there were no significant differences in growth ($P< 0.05$) between the vermiculite plants and the rice hulls plants who were fertilized with the liquid fertilizer until the fifth week. After the fifth week there were significant differences in height and water usage between vermiculite and rice hulls plants (see figure 1 and 2).

The average length per plant of the rice hulls treatment in the liquid fertilizer was after seven weeks 54 cm. and was 64.2 cm. for the vermiculite treatment (see figure 3).
The results of the study also revealed that the vermiculite treatment showed the best root development.

RECOMMENDATIONS

(1). Liquid fertilizers performed much better than fixed fertilizers in the non-circulating hydroponic system.
(2). Rice hulls and vermiculite are both suitable soilless media for the production of lettuce in a non-circulating hydroponic system.
(3). Additional research is needed on lettuce growth and lettuce quality using vermiculite and rice hulls as soilless media.

EXPERIMENT 2-6

Since February 2000 the preliminary experimentation continued some modifications.
Experiment 2

In November 2000-January 2001, the preliminary investigations were continued at one of the greenhouse facilities at Celos. For the experiment a Completely Randomized Design was used with two types of liquid fertilizers and three types of growing media (vermiculite, coconut fibre, and rice husk).

The interior of 50 L polystyrene boxes will lined with black plastic and then filled with 46 1/2 L. water. To three of these boxes 100 ml. of a liquid NPK (6-3-6) was added to each box, while 34 gr. Of Miracle Growth was used (18-18-21) was added to the remainder of these boxes. Each lid of the polystyrene box contained fifteen plastic pots with a volume of 300 ml.

Each growing media was randomized assigned to boxes each. The level of nutrient solution was kept at the 2 cm. level above the bottom of the lids to ensure that the seeds got adequate moisture for generations. In each pot one seed (variety Black Seeded Simpson, Trinity Star, and Great Lakes 366) was placed.

Variables which were studied included plant weight, plant height, T, RH, pH, and EC.

RESULTS AND DISCUSSION

The observations show indicated monitoring environmental factors such as T, RH, pH, EC, evaporation, and greenhouse construction are of eminent importance in the hydroponic production of lettuce.

The daily average T varied from 25^0C-30^0 C between 6:00 am. and 9:00 am. The corresponding RH ranged from 80-100% . The daily average T ranged from 25^0 C-38^0 C with a corresponding RH which ranged from 60-50% between 9:00 am-17:00 pm. Between 18:00 pm and 6:00 am, the averaged daily T averaged about 25^0C with a RH from 80-100%.

In general it can be stated that the temperature of the plant environment need to be optimal during the growth season. Many plants are known to grow optimal at a T between 20^0 C-28^0 C. The results of the investigation showed that at certain times during the day the temperature in the greenhouse is to high. To assure optimal plant growth in the greenhouse, peak temperatures need to be lowered in the greenhouse.

A high relative humidity in the greenhouse in general causes plants to evaporate less, and as a result lesser nutrient transport occurs from the roots to the leaves and also causes lesser evaporation of the leaf surface.
In some cases a high relative humidity can also cause plant diseases.

The average pH ranged between 6.0-6.5 for Miracle growth while the average pH for Pokon was 6.6.
Results showed that in the sixth week he average pH of the Pokon solution dropped to 5.9 in week six.
These results indicate that throughout the lettuce growing season optimal nutrient availability and uptake could take place. Literature research findings report that in hydroponic cultivation of lettuce, a pH of 5.8 allows optimal nutrient availability, but in general, a pH range of 5.6-6.0 is also acceptable.

The average EC for the Pokon solution remained the same and was about 2.2 mS throughout the lettuce growth. The average EC for Miracle Growth was 2.5 mS.
Research by Lorentz & Maynard (1980) have indicated that de EC for optimal lettuce growth is less than 2mS.

Water addition varied from 2-6 liters every other day. In the fourth week of lettuce growth water addition varied from 4-6 liters every day.

In comparison to Black Seeded Simpson and Great Lakes 366, Trinity Star performed the best on the non-circulating hydroponic solution when rice hulls, vermiculite or cocunut fibre was used as soilless media.

RECOMMENDATIONS

(1). Monitoring T, RH, pH, and EC are very important in hydroponics.
(2). Not all lettuce varieties are suitable for hydroponics.
(3). Nutrient management in hydroponics varies from fertilizer to fertilizer.
(4). Monitoring of light intensity, O_2 , CO_2, and greenhouse construction are also of importance to hydroponics and need to be considered in future experimentation.

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Figures 1,2, and 3