The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

PROCEEDINGS

OF THE

CARIBBEAN FOOD CROPS SOCIETY

TENTH ANNUAL MEETING
PUERTO RICO

1972

VOLUME X

A SIMPLIFIED METHOD OF GROWING VEGETABLES UNDER HYDROPONIC SAND CULTURE

J. F. Brochier
Institut de Recherches Agronomiques Tropicales et de Cultures Vivriéres (IRAT) - Cayenne - French Guyana

INTRODUCTION

The production of some vegetable species (tomatoes, lettuces, cucumbers, muskmelons) was found to be technically and economically difficult under French Guyana conditions. One of the main problems is the very long (nine months) rain season (annual rain fall average of 3,106 mm or 122.2 inches in Cayenne. These heavy rains mechanically destroy the vegetables and the superficial structure of the soil. Cultivation under shelter is a necessity. Sheds being expensive, high yields must be produced to make them economically feasible. Another tough problem are the soil born pests, specially root knot nematodes, and bacterian wilt (pseudomonas solanacearum) which are virulent on all the cultivated soil of French Guyana.

The fertility of those leached soils is not very suitable for vegetable production and the lack of farm manure and other economical sources of organic matter is a problem in this area. The high cost of labor is also to be considered as a draw-back for a regular economical production of vegetables besides all the technical problems.

With the purpose of producing the most current vegetables at a reasonable price and with more profit and security for the growers, hydroponic techniques of production were developed allowing high yield of vegetables of good quality, and an easy control of soil born pests.

The simplest and most suitable method was found to be the sand culture, with irrigation by capillarity from a non returned solution flowing across a thin layer of fine gravel at the bottom of the cultivation tank; the slope of the tank is of about 2%. Spectacular results have been made with this technique which became popular among the vegetable growers. Nevertheless, in the long run, some problems appeared.

The ideal sand was difficult to find: if too fine, aeration of the roots was sometimes deficient, if too coarse, the capillarity is reduced and the plants are not properly irrigated. After a few crops, the sand was often mixed up with the gravel in the bottom of the tank plugging the pass way of the water or nutrient solution. The 2% slope of the tank was difficult to maintain on the highly unstable soils of French Guyana often watersaturated. The construction of expensive, heavy concrete tanks was found to be necessary. This irrigation system in the long run appeared to be not always satisfactory, mainly because it was too slow. Water has to run in the bottom of the tank and then go up by capillarity to the roots. This is a draw-back in this area where weather conditions change extremely fast, producing some very big differences in water consumption during a same day.

Under such conditions, water has sometimes to be superficially added, specially for the small plants, to prevent wilting. Another disadvantage of this irrigation system is that water or nutrient solution is moving from one end of the tank to the other, making the propagation of the soil born diseases very rapid, specially for bacterian wilt and the nematodes, when they are accidentally introduced.

DEVELOPMENT OF A METHOD OF SAND CULTURE MORE ADAPTED TO THE LOCAL CONDITIONS, BASED ON THE EXPERIENCE OF COMMERCIAL VEGETABLE PRODUCTION IN FRENCH GUYANA

In the light of the past experience, an ideal sand culture technique of production under those equatorial conditions was defined. The main requirements are:

- The irrigation water must be rapidly available to the plant, and precise in its amount.

- Sand particle size should be a secondary factor, large variation must be possible.
- Water movement in the tank should be extremely reduced for preventing soil born pest dissemination.
- The slope of the tank should not be a critical requirement because of instable soils.
- The system must be cheap to build and easy to manage.

The use of drip or trickle irrigation appeared to be the best approach. The water is brought directly at the right place, on the sand surface, so it is immediatly available to the plant in a precise amount. With small plants or young planting, only a small volume of water is necessary. On the contrary in the former technique the whole bulk of the tank had to be wetted. The water movements are limited to lateral capillarity around the plants; that limits, consequently, the soil born pest dissemination, and also the sand particule size problems. The slope of the tank becomes a secondary factor, and the construction of expensive concrete tanks is not necessary, a simple plastic sheet will be enough.

DETERMINATION OF THE VARIOUS DATA CONCERNING THIS SYSTEM OF SAND CULTURE WITH TRICKLE IRRIGATION

Shape of the Tank

Trials were made on the differents tanks shapes. Large sized square of 10 m x 10 m (32 x 32 feet) or rectangular of 4 m x 10 m (13 x 10 feet) were tested. In all the cases, drainage problems were encountered with large broad tanks. Under this very wet climate, storms can sometimes partially flood the tanks even with a good shed, so drainage must be very efficient to prevent any yield reduction. This was verified with lettuces, tomatoes and muskmelons A narrow strip of 1 m (3.2 feet) broad and up to 25 m (82 feet) long gave the best results, with a very efficient drainage. This is important also for washing the tanks. The narrow type can readily be planted after this essentia operation.

Depth of the Sand

The depth of the sand was tested on tomatoes with 8 cm (3in), 12 cm (4.7 in) and 16 cm (6.2 in) of sand without showing any significant difference The depth of 12 cm (4.7 in.) was retained.

Material of Trickle Irrigation

Different materials were tested in consideration of the cost and simplification. Capillary hoses were tested. The precision was good, but some clogging problems were encountered, mainly caused by salt deposits of the nutrient solution. Different kinds of low pressure punched hoses were tested. Finally, the most efficient was a twin-wall hose, because it secure a low water discharge rate and minimize flow variations due to both friction loss and variations in elevation. There were little problems of clogging when a 23 AFNOR filter (400 mesh) was used.

Injecting the Concentred Nutrient Solution in the Irrigation Water

Trickle irrigation working with a low pressure (below 1.40 meter (4.5 feet) injecting a concentred solution is an easy operation. One or two small tanks of nutrient solution are connected to the main feeding pipe at a slightly higher level above the working pressure. When irrigation is working, the solution tanks are allowed to flow in the irrigation system.

Timing and Regulating the Amount of Water to be Applied

A section of cultivated tank of 65 x 65 cm (25.5 x 25.5 inch.) is made in a wooden box filled with sand, just as the cultivation tank, and managed in the same way, irrigation, drainage, planting etc. The box or "part of tank" is put on a cushion, made of polyamide tarpaulin, polyvinylchloride coated, filled with water. The cushion, compressed by the box pushes the water in a vertical pipe to a small expansion tank. There a device of float can open or close the irrigation, with the changing level of water, due to the weight of the "part of tank" should be maintained at a constant weight which has been determinated at the field capacity. The needs of water are consequently directly and exactly transmitted as they vary with the evapo-transpiration. This device still at the experiment stage is promising.

DESCRIPTION OF THE TECHNIQUE OF SAND CULTURE WITH TRICKLE IRRIGATION

Construction of the Tanks

The construction of the tank is very simple and cheap. A furrow of about 12 cm (4.7 in.) deep and 1 m (3.9 in.) broad is made, with a deeper transversal side of 16 cm (6.2 in.). Longitudinally, the slope can be from 0 to 1%. The excavated soil is put on the border side and well compacted. The border cut should make a 45° angle. A plastic sheet of 200 microns is then unrolled on the furrow, largely covering the side. A punched plastic pipe is put in the deeper side of the tank running from one end of the tank to the other. The tank is then filled with 12 cm (4.7 in.) of chemically inert sand with a particle size in the range of 200 to 700 microns. All those operations can be mechanically made for a large installation. A trickle irrigation system is laid on the sand surface. The most practicle and efficient is a twin-wall hose with 12" outlet spacing for row crops.

For lettuce, three twin-wall of 4 inch outlet spacing hoses are spaced by 33 cm (12.9 inch).

Management

Before planting, the sand should be washed for leaching the deposited salt and taking off all the crop residues. When necessary, the sand is treated with a 2% solution of formol (if bacterian wilt has been observed) and with dazomet against fusarium sp. nematodes and other soil born pests.

Water consumption is very variable. Also the amount of water to apply will vary from 1 to 4 liters per m2 with an average of 1.5 liters for lettuces to 3.5 liters /m2 for tomatoes at the fruit maturing stage. Plant symptoms and observation of the sand are the best guides for estimating how much water is needed. Automatic irrigation as described above will nevertheless give good results.

Concentred nutrient solution are added to the water. Two stock solutions are injected separately:. The stock solution A, with magnesium sulfate (fertilizer), potassium nitrate (fertilizer), ammonium phosphate monoammonic (technical) and the stock solution B, with calcium nitrate (fertilizer). Microelements are applied once a week. Care should be taken with nutrient solutions applications, to prevent salt build up in the sand, pure water and nutrient solution have to be alternated.

The plants are managed just as regular vegetable croping as for as pruning and treatments are concerned. The yield so far obtained per square meter are:

2.5 kg (0.51 lb/sq. Ft.) of butterhead lettuce (variety Noran)
10 kg (2.2 lb/sq. Ft.) of tomatoes (variety Floradel)
20 kg (4.4 lb/sq. Ft.) of hybrid cucumbers (Gemini 7)

S U M M A R Y

After several years of research and development for commercial hydroponic production of vegetables in French Guyana, an approach was made to improve the adaptation of hydroponics to the local conditions and to reduce significantly the cost of production. This led to the development of a very simplified method of sand culture which will be described in this paper.