CARIBBEAN FOOD CROPS SOCIETY

PROCEEDINGS

ELEVENTH ANNUAL MEETING

A SIMPLE TECHNIQUE OF CONTINUOUS IRRIGATION FOR HYDROPONIC SAND CULTURE

by

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SUMMARY

A technique of hydroponic sand culture of vegetables has been recently developed in French Guyana with a surface irrigation based on a drip system.

Efforts to simplify this method have led to the use of a porous tubing buried in the sand of the cultivation tank. Two experiments are described for the development of such technique. The choice of a proper water pressure allows it to irrigate continuously. The flow rate of irrigation water through the porous material of the tubing is increased or reduced by the water tension in the sand. Curves of water use compared with the evapotranspiration show a close relation.

INTRODUCTION

Hydroponic sand culture is now widely used in French Guyana, for vegetable production.

Research was continued for helping growers to solve their problems when using such a method, and also for improving this technique of sand culture which has been recently developed in this country. The main purposes are the reduction of investments, further simplications of the management, and higher yields.

Recently large improvements in simplication and reduction of production cost were obtained by the technique of drip or trickle irrigation, (1) which gave very significant reduction in investment (2) because of the possible use of cheap materials such as plastic sheets to build the cultivation tanks. This technique of drip irrigation on sand culture is already used with success by some vegetable growers of French Guyana. Nevertheless in the long run, some problems appeared with clogging; this is mainly due to salt deposits from the nutrient solution which dries up between the daily irrigations; this involves frequent inspection.

Another problem remaining to be solved was the amount of water needed for irrigation. This can change from 1 litre/m2 to 9 litres/m2 for the same crop per 24 hours. Weather conditions in French Guyana change so fast during a short period of time, that irrigation must be adjusted every day, based on the observation of the sand moisture.

Those problems are to be solved, keeping in mind that the main advantage of the drip irrigation system must remain.

These are as follows:

The irrigation water must be rapidly available to the plant.

Water movements in the sand should be extremely reduced for preventing soil borne pest dissemination.

The slope of the tank should not be a critical requirement because of unstable soils.

The cultivation tank and irrigation system must be cheap to build and easy to manage.

This paper will describe two of the trials made to solve those problems with the use of a porous plastic tubing.

TRIAL NO. 1

MATERIAL AND METHOD

Three cultivation tanks under plastic greenhouse with open sides are built in the following way:

A trench is excavated, 1 metre broad, 10 cm deep and 25 metres long. A slope of 0.25% is leveled, in the bottom of the trench. The edges are made with excavated soil and have a 45° angle.

A 200 microns sheet of black plastic is laid in the trench, covering largely the edges.

At the bottom of the tank is laid perforated PVC pipe, as drainage.

A 12 cm layer of beach sand is leveled in the tank (80% of its particule size weight is in the range of 400 to 800 microns). It is washed with water to leach the salt.

A porous irrigation plastic tubing type "VIAFLO"* is buried in the sand, 5 cm deep. One tubing for one row of crop, in one cultivation tank.

The two other cultivation tanks are provided with twin wall hoses for drip irrigation, one per row of crop.

Tomato seed, variety FLORADEL, was sown on November 20th and planted in the cultivation tank on December 20th, spaced by 60 cm between the lines and 30 cm on the row. The plants were pruned and trained. The first harvest was made on February 6th and ended by April 2nd.

Chemicals pest control treatments were made weekly with a mixture of Dicofol and Tetrafidon for aphid control.

* produced by DU PONT DE NEMOURS.

IRRIGATION

The two cultivation tanks irrigated with the twin wall hose system received a daily irrigation of 120 1 of nutrient solution – 4.8 litres/m2.

The porous tubing was fed continuously with a nutrient solution. A float kept a constant water level in a barrel set at one metre over the cultivation tank surface. This one kg pressure was maintained during the whole cycle without any change. The water thus used in the cultivation tank was daily recorded, by measuring the change of level in a large nutrient solution tank, which was feeding this cultivation tank.

As meteorological data, Piche evaporation, maximal and minimal temperature were daily recorded.

RESULTS AND DISCUSSION

Observation

The plants were severely stunted during the early stage by crease stem. This physiological disorder was due to the use of a nutrient solution generally applied during the rainy season. The plants recovered but setting and maturity were delayed. The weather, during this trial, had been exceptionally warm and dry.

The yield was severely reduced as compared with what we get generally (around 10 kg/m2 for trickle irrigation with the twin wall hose). The porous tubing gave a somewhat smaller yield than the drip irrigation with the twin wall hose, considering the crease stem incidence, this difference will not be considered as meaningful.

Nevertheless our main purpose was to study this irrigation'and water consumption.

The yields are as following:

	Twin wall hose		*Porous tubing*
Yield per tank (g)	90 300	59 350	63 050
Yield per m2 (g)	3 612	2 374	2 522
Yield per plant (g)	516	361	370
Average yield per m2 (g)	2993		2522

The water consumption is recorded from *January 28th*. The first of April shows a total amount of 320 mm per m2. The compared evapotranspiration (ETP) calculated by HOUCHET formula*, for the same period of time shows a total of 316 mm. Penman formula would be better but all the data were not available for its calculation.

Graph No. 1 shows the variations given by the daily average of water consumption and ETP of five day periods.

The two curves show some similarities, nevertheless the lower water consumption at the end of the cycle as compared with the ETP remains unexplained. It may be that ETP calculated by BOUCHET formula during this period with comparatively dry and windy weather was higher than in the reality.

The most spectacular result is in the great variation in the rate of water released from the porous tubing, as shown in graph No. 2. The water

*ETP = Ep (0)

ETP = evapotranspiration in mm/day

EP = Piche evaporation in 24 h(mm)

= 0.37

= coefficient related to temperature 0 (table)

$= o\,m + \frac{OM - Om}{4}$

flow can change from 2 to 7 and sometimes up to 10 mm per m2, as water is needed in the cultivation tank. Water daily consumption curve generally follows ETP curve. The water released from the porous tubing is increased as the suction increases in the sand. An attempt to get some suction data with tensiometers did not succeed because the sand was too coarse.

CONCLUSION

This system of continuous irrigation does work. Under the conditions of this experiment, other yield data show similar yield performances as compared with other drip irrigation systems. It is a great improvement as far as management is concerned. It is simple, safe, and without clogging problems. It saves time, since no care is needed as long as nutrient solution is available to feed the irrigation system.

Other trials remain to be done to control the water needed with more accuracy and to compare it with water provided by the porous tubing, as well as to know more exactly the performances of this material.

TRIAL NO. 2

The purpose of this trial is to test the porous tubing irrigation system with a long size tank: 100 metres long.

MATERIAL AND METHOD

The cultivation tanks are built with the same material and the same method as in the first trial, but the cultivation tank is 100m long with 1 m broad.

The lettuce variety *NORAN* was sewn in a germination flat on April 17th then transplanted in the nursery and was planted in the cultivation tank on May 12th with a plant spacing of 20 cm x 20 cm. The lettuce was harvested on June 7th.

IRRIGATION

A water pressure of 3 kg was empirically determined. The first ten days 300 litres of nutrient solution or 3 l/m2 were applied; then 500 litres were daily applied until harvest. No pesticide treatment was made. The water outflow was 100 l/hour.

RESULTS AND DISCUSSION

Observation:

The row of lettuce in the centre of the tank was not sufficiently irrigated, showing a very poor development owing to lack of water and nutrients.

The other rows were correctly irrigated and produced lettuce of good quality.

Yield

The total yield was 92,600 kg or 926 g/m2 – this is low as compared with the yield obtained with the variety NORAN grown with sand culture capilarity or trickle irrigated, which produced 1.5 kg/m2. This was mainly due to the poor irrigation of the central row of the cultivation tank. This could be corrected by a higher water pressure.

The yield along the tank appeared very irregular and showed a lower production at the lower part of the cultivation tank (graph 3). This could also be corrected by a higher water pressure.

CONCLUSION

This trial shows that irrigation with the porous tubing system may be promising for cultivation tanks as long as 100 metres. Nevertheless a rather high water pressure must be used, up to 4 kg. With such water pressure this irrigation system cannot be used continuously, its management must be based on daily observations of the sand moisture level.

The porous tubing irrigation has the advantage over the other trickle irrigation systems in avoiding clogging and consequently in simplifying the management.

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