PRODUCTION OF SPRAY CHRYSANTHEMUMS IN A HYDROPONIC SYSTEM

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INTRODUCTION

Hydroponics as a propagation tool has come of age due to the lack of good clean soil and the cost of soil sterilization. In Australia, the nursery industry has been using different forms of hydroponics for some time. Propagators generally use a natural or artificial solid medium or a mixture of the two, but some produce bare-rooted plants in either a deep flow system, aeroponics, or nutrient film technique (N.F.T.), as in our case.

There are really only two types of systems—open and closed. In an open system the nutrient solution is not recovered while in a closed system the nutrient solution is recycled. In an ideal closed system, pure water is used and it is only necessary to flush out the system every four months or so. In our nursery, where high salts are present in the main's water, it is necessary to flush out the system every 10 to 14 days in summer and every 3 to 4 weeks in winter. In spring, our water showed a reading of 360 mg/l of chloride (Cl) and 170 mg/l of sodium (Na). Despite these high salt levels, we have found that plant quality is not affected provided that the system is regularly flushed out.

METHOD OF PROPAGATING IN OUR N.F.T. SYSTEM.

Our nursery is divided into two areas—a long-day and a short-day area. The long-day area is used for growing stock plants and propagating cuttings. Stock plants are grown on four elevated tables, 0.75m X 24m, made of Lysaght 305 steel roof decking with the depressions forming the growing channels. These are lined with black PVC damp-proof course which helps to distribute the solution evenly due to its rough surface.

The tables are then covered with black polythene and the plants are planted through holes cut in this polythene at 15cm X 10cm spacings. The tables are fixed at a 2% gradient and the nutrient solution is fed via an in-line filter into the top of each channel through a header pipe. The solution flows down each channel bathing the roots and is collected at the base of each table into a 100 litre reservoir. The solution is constantly recirculated by a submersible fountain pump.

Chrysanthemum cuttings are taken every 7 to 10 days according to the time of year. These are placed onto six similarly designed propagation tables, 1.2m X 6m, at approximately 20mm X 40mm spacings; however no black polythene cover is used. High pressure mist units are used in the early stages and the whole of each table is enclosed in a clear polythene sweat tent.

No heating is used for economy reasons but cuttings will still root within approximately 3 weeks in the depth of winter. In summer, when temperatures can reach 40 °C in the sweat tent, propagation can be as fast as 5 days. Provided good quality cuttings are used and the stock plants are well maintained, we have regularly achieved 100% rooting.

Initially, the reservoir for each propagation table contains only water, which is maintained via a float valve and the surplus water from the misters. Once root initiation takes place, the misters are turned off and the sweat tent is lifted. Cuttings are then supplied with nutrient solution and maintained on the propagation table until they reach the "20-leaf stage" (about 15cm). This takes from 3 to 6 weeks depending on the time of year (Figure 1). Mature cuttings are then transferred to the short-day area.

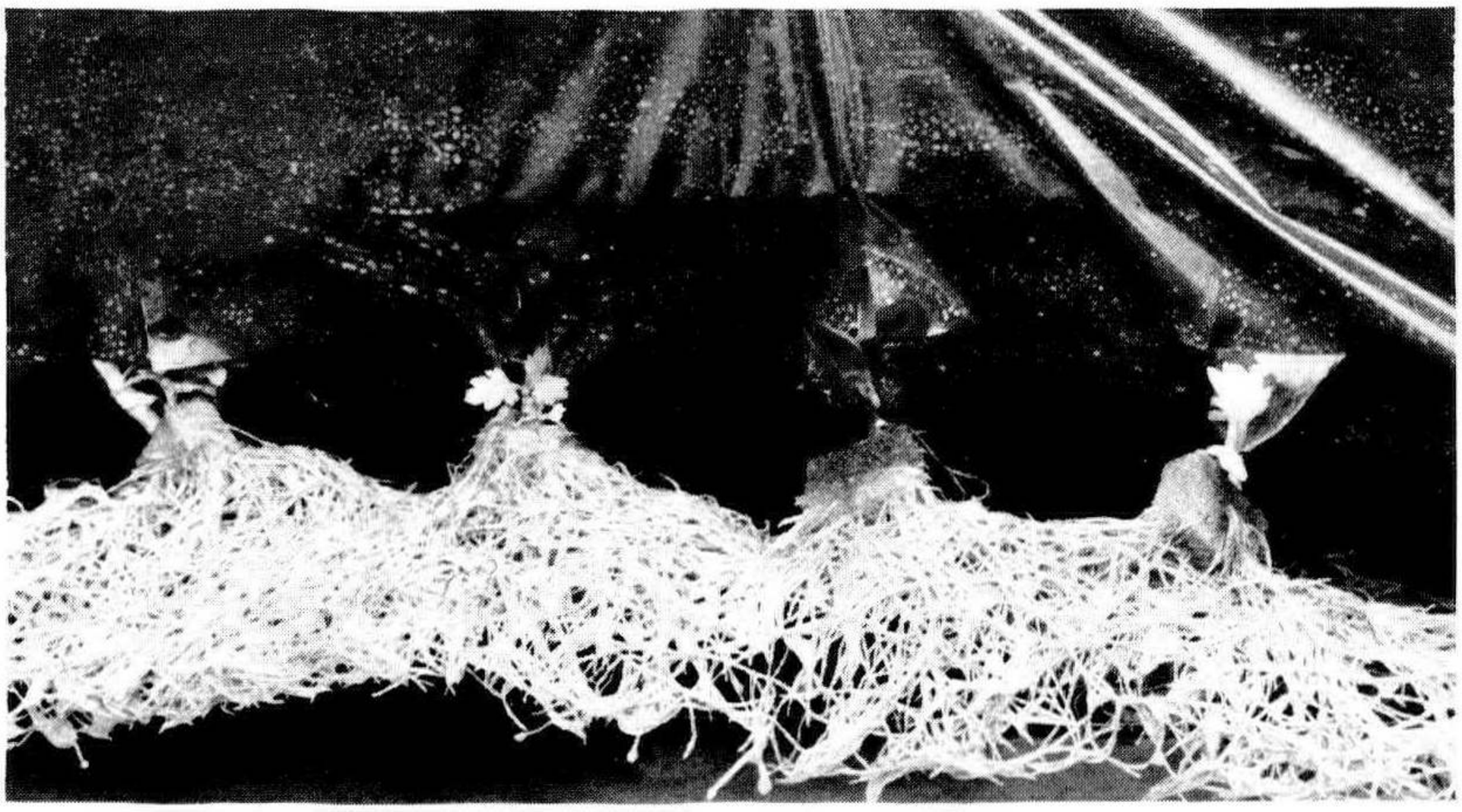

Figure 1. Root development on 9-week-old cuttings in short-day area.

The whole of the long-day area is automatically supplied with nutrient solution from the main supply tank in the pump house. This is fed into each reservoir via a float valve. The whole area is also lit at night to a level of 100 lux at crop height by means of 100 watt incandescent bulbs with reflectors. This is used as night-break

lighting for a period of 2 to 4 hours midway through the hours of darkness to maintain vegetative growth. The length of lighting depends on the time of year.

Both stock plants and cuttings are supported in Oasis Plant-in cubes. These were chosen because they were the only suitable media available when we started the nursery 8 years ago. In addition, the price was right and they were readily available as there is an Oasis factory in South Australia. The cubes are easy to use, clean, light, and above all, they do the job required of them. Of particular benefit to us in our split growing area system, the cubes remain intact when mature cuttings are moved from the propagation tables to the short-day area.

The short day area is the main production area. Mature cuttings are moved here on a weekly basis and planted onto the growing tables at spacings of 15cm X 10cm. These tables are laid out in similar fashion to the stock plant tables but they are only 1.2m X 6m in size and mobile. There are a total of 60 of these tables, each holding 400 plants. Approximately 4 to 8 tables are planted out each week depending on the time of year. In this way, a total of 5 crops per year can be achieved using 9 to 10 week response group spray chrysanthemum cultivars.

The nutrient solution is added to the main supply tank at each initial fill-up stage after flushing. The entire system holds 5000 litres at any one time. The pH is first corrected down to 6.5 by adding sulfuric acid. The required quantities of nutrients are then pre-mixed and added to the circulating water. Our solution is made up by using 80% Top Australia Hydroponic mix (See Table 1) together with 500g/1000 liters of KNO_3 (potassium nitrate) and 20g/1000 liters of iron sequestrene. Further nutrients are added each time

Table 1. Hydroponic mix used in the N.F.T. System

Nutrient element	Range in concentration mg/l (ppm)	Top hydroponic nutrient solution	Langtry nursery solution
Nitrogen (nitrate)	70-200	185	235
Nitrogen (ammonium)	0-31	27	22
Phosphorus	30-90	40	32
Potassium	200-400	208	357
Calcium	150-400	152	122
Magnesium	25-75	55	44
Sulfur	60-333	76	61
Chlorine	to 350	—	360 (in water)
Iron	0 5-5	4.1	6
Boron	0.1-1	0 2	0.15
Zinc	0 02-0 2	0 06	0.05
Copper	0.02-0.2	0.07	0.06
Manganese	0.1-1	0.7	0.56
Moybdenum	0.01-0 1	0.01	0.008

the system is topped up to a maximum of 100% of the initial start-up solution. Initially we tried to monitor and control nutrient levels using sophisticated conductivity and pH probes; however as these were unable to distinguish between "good" and "bad" salts we found it easier to do the job manually. The solution is pumped from the main supply tank into the short-day area to maintain a flow rate of 1.5 to 2 litres per min. Solution is collected into a large common gutter at the end of each group of tables (20 tables per group) and returned to the supply tank by gravity through sealed PVC pipes.

BENEFITS OF THIS N.F.T. SYSTEM

1. As the propagation of plants really begins with stock plant management, this system is ideal as stock plants are never under stress.
2. The nutrient solution can be manipulated to ensure that all plant material at its various stages of growth is at optimum nutrient level to encourage new roots, vegetation, or blooms as the case may be.
3. Stock plants can be easily replaced on a regular basis with little work.
4. Mature cuttings can be moved from the long-day area to the short-day area with minimum root shock.
5. Once blooms have been cut, the stubble can be removed, the growing tables cleaned, and new cuttings planted all within the space of a few hours.
6. Nutrient deficiencies show up quickly and can be quickly remedied.
7. Chrysanthemum blooms tend to be larger and brighter than their soil-grown counterparts and the response time is often shorter than for soil-grown chrysanthemums. This experience has been confirmed by work carried out by the Department of Horticulture, University College, Dublin (1).

DISADVANTAGES OF THE N.F.T. SYSTEM

1. Initially our cuttings were placed in slabs of cubes on the propagation tables but the roots intertwined and damage was caused when the cubes were separated prior to planting-out in the short-day area. This then set them back several weeks. Cubes are now placed in single strips with a space of 30mm between each strip to overcome this.
2. Iron deficiency was a major problem initially. We now add iron sequestrene to the solution to increase the iron content. In addition, immediately after transplanting, cuttings are foliar sprayed with a solution of iron sulfate.

3. Although the system works well, it is only as good as the operator and any failure to maintain correct horticultural practices soon shows up as poor plant growth.

FUTURE PLANS

Although our system has worked well, experience has shown us that some minor modifications will be necessary. These will include improving the water flow from the header pipes by means of directors, replacing the misting units with fogging units, and the use of dilute nutrient solution in the fogging system to prevent leaching. In addition, we will shortly be changing over from rectangular Oasis cubes to the new Oasis Wedge which we will use inverted to form a pyramid. We believe that this will reduce the build up of algae and provide improved root aeration.

LITERATURE CITED

1 Moustafa, A T. and Morgan, J.V. 1981. Root zone warming of spray chrysanthemums in hydroponics *Acta Hortic* 115 217-226