THE CAPILLARY BED METHOD OF IRRIGATING NURSERY STOCK

JOHN JOE COSTIN

Costins Nursery, Portgloriam
Kilcock, Co. Kildare
Republic of Ireland

Capillary watering of plants was first developed as a research tool to eliminate uneven watering as a factor in experimental work. The National Institute of Agricultural Engineering (1) in England published in 1964, a paper on the results of that work showing how a bench system could be used for the watering of house plants. In Ireland in 1975 Lamb, Kelly and Bowbrick (2) described how capillary beds could be used for the production of outdoor nursery stocks. Margaret Scott at Efford in England was making similar modifications for outdoor use. This paper describes the further modifications and adaptations of the system in a commercial nursery.

The principle of the system is that water flows upwards from the water level into small soil spaces or pores by capillary attraction. The rise in water obtained increases as the size of pore decreases. There are a range of pore sizes in compost. The capillary rise will vary with these. The smaller spaces will be filled with water while air will remain in the larger ones. Hence the water/air ratio and the moisture content can be controlled by the composition of the compost and by the level of the water below the surface. Within the compost it varies at different levels within the pot. The compost at the top being drier than that at the bottom.

Once capillary action has been established the water loss by transpiration and evaporation from the pot is replaced by water taken up by capillary action by the compost from the substrate below.

In theory it is the ideal watering system and under experimental conditions it consistently proves to be the best method of producing uniform crops. However, it has not been widely adopted in the nursery trade for a number of reasons;

1. Lack of understanding of the simplicity of the system.
2. Capital costs.
3. Difficult to build on sloping sites.

The capillary bed is a *sealed* system laid on *level ground* and supplied with water (controlled by ball-cock) via a header tank. The water in the bed can be replenished as it is used throughout the 24 hours via the ball-cock. Therefore there is no peak demand. We pump water directly from the borehole, which has a capacity of 2,400 gal./hr (12,000L/hr). This is sufficient for our 5 acres of capillary beds.

There is no need for reservoirs, electronic controls, or powerful pumps with this system.

The savings on the water distribution network however, are lost in the construction costs. The ground must be levelled with a zero fall in all directions. We do this by machine. Our bed sizes are determined by the polythene sheets available, our largest is 250 ft. × 42 ft. wide (80m × 13m). Next we kerb with concrete garden edges, 1000 × 20 × 50mm. These form the sides and are laid absolutely level with a spirit level. Next we dig shallow trenches 50mm deep to accommodate the water supply and drainage pipes. If the ground has to be levelled to sub-soil we spread finer sand over the ground before laying the polythene to protect it from sharp edges or stones. Then we roll out the sheets of polythene and align it with the kerbs. Having done that we re-roll the polythene to one end. We bring in the grit and sand using a bobcat loader.

Originally we made the bed with 100mm of sand but as the bottom 50mm is permanently under water during the growing season we have now changed the specification to a bottom layer of 50mm of grit and a layer of capillary sand 50mm on top of this. The grit more or less coincides with the water level and the sand gives us good capillary action. In winter time and during periods of heavy rain the grit gives us excellent winter drainage.

Once the sand is in, the bed is flooded and allowed to settle for a few days. Then using the water as a level the sand is moved around until a perfect level is obtained. This normally takes about 2 days work for 2 people on a large bed. The water supply, header tank and ball-cock are fitted as well as the drainage overflow. This work takes about 1 day.

The construction cost for a capillary bed on this scale is approximately £2.50 per sq. metre. Starting with level ground 2 men can make a bed of this size in 1 week approximately. Levelling ground is a major cost. The most economical way is to level the total proposed capillary bed area with heavy machinery initially and then to obtain a finer level with smaller machines as areas are required for construction.

The capillary bed system gives the following advantages;

a) There is no labour requirement whatsoever with the system.

b) It is completely automatic.

c) There is no week-end or holiday work.

d) Should a breakdown occur each bed contains a buffer capacity of 3 to 4 days water before plants show signs of water stress.

There is no wastage, it is a sealed system and all the water is used by the plants. It is an efficient system using approximately half the water of overhead irrigating systems. It provides better working conditions and better controls. Neither the surface of the compost nor the foliage is ever wet. Surfaces are never waterlogged, so it provides nicer working conditions.

There is no leaching of nutrients as with overhead irrigation. So ferilizer rates can be reduced by one third. The top of the pot is driest so there is less weed seed germination.

Plants on capillary beds are remarkably stable. There is a capillary bonding between the bottom of the pot and the sand. Secondly, the compost in the bottom of the pot is heaviest and at the surface is lightest, this gives extra stability. Conventional stabilizers stuck into the ground can not be used because they would break the polythene sheet.

Capillary bed systems have their greatest influence on the root systems of plants. The compost is always at field capacity, therefore the plant does not have to produce excessive roots to search for water and the roots stay in a nice juvenile condition.

There is a very fine spread of roots throughout the compost. Root curl, common in overhead systems for taproot plants, is not as pronounced. Plants such as *Quercus* and *Eucalyptus* develop excellent fibrous roots that do not wind-blow when planted out. The roots do not go into the substrate. Since the water level is constant, they do not have to search for water.

In winter the substrate is critical in determining the drainage of the compost. A pot standing on gravel has no downward pull. It develops a capillary fringe in the bottom of the compost where the water stagnates and root death results. However, capillary beds, on the other hand, suck the water from the bottom of the pot and the capillary fringe is transferred to the sand. Therefore, with a good drainage system winter root deaths can be eliminated.

DISEASES

The foliage is never wetted except by rain, therefore, there is no washing off of fungicides and so the foliage is protected longer. It is quite noticeable that the occurrences of leaf diseases lessen under these conditions (3).

Water is necessary for spore germination in *Phytophthora* species. Water is even of greater importance since it is essential for the production and motility of the zoospores which swim or are carried around in water in contact with the host roots where they germinate and infect. To control this disease surplus water must be immediately removed and surface flow must be avoided. The effect of surplus water on the spread of *Phytophthora* root rot has been confirmed in experimental work by Smith (3). Sub-irrigated capillary beds gave the best control of this disease. This was only achieved, however, where the roots were not allowed to root into the bed material. American researchers have shown that the water regime affects not only the pathogen but also the host. Under drought conditions they reported that cracking of the roots can occur and these become loci for infection.

Species of *Pestalotiopsis* and *Monochaetia* cause leaf petiole diseases. *Pestalotiopsis* thrive under wet conditions and is spread in water droplets. In experimental work by Dr. Smith she proved that very little infection occurred on capillary beds as against the same crop irrigated by overhead sprays.

Peculiarly, there is also evidence to suggest that *Phytophthora* does not spread from pot to pot. That the upward action of the capillary prevents the downward movement of zoospores. The final advantage of capillary beds where disease does occur is that as the bed is a sealed system and with the network of drainage pipes they can be effectively sterilized.

LITERATURE CITED

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MONROVIA NURSERY COMPANY: PROUD OF OUR PAST—BUT LOOKING TO THE FUTURE

DENNIS M. CONNOR

Monrovia Nursery Company
P.O. Box Q
Azusa, California 91702, U.S.A.

SUMMARY

Monrovia Nursery Company was founded in 1926 by Henry E. Rosedale on a ten acre site in Monrovia, California. In 1952 the nursery moved to Azusa to allow for expansion.

Today Monrovia Nursery produces 55 to 60 million plants annually on two 500 acre nurseries in Azusa, California and Dayton, Oregon. Both nursery sites have been selected because of their microclimate and the readily available source of high quality water. At each nursery fertiliser is put into the growing medium and this is supplemented by nutrients in the irrigation water, which is recycled. The water treatment plant adds fertilisers and herbicide to the water before it is reused. The health of plants is regularly monitored by the Research and Development Department.