Bottom Watering Irrigation Systems

Bottom watering systems are the most water efficient method of nursery irrigation. There are a number of different systems used, but all have the same principle of water entering the growing media through the drainage holes in the bottom of the container. The following describes the different bottom watering systems.

Ebb and flow benches

Ebb and flow systems can be expensive to set up, but can be considered where water supplies are limited or water losses are a problem. Ebb and flow benches are flooded with water to a depth of approximately 20 mm and then allowed to soak for a pre-determined time, after which, the bench is drained. To minimise leaching and stop root damage, the flood, soak and drain cycle should only be 6 to 8 minutes. In 'Dutch trays" channels allow the water level to increase uniformly along the bench to minimise differences in soaking time. The channels also enable the bench to drain properly so plants are not left sitting in water.

Benches are normally graded level and, depending on the length of the bench, a combined outlet/inlet

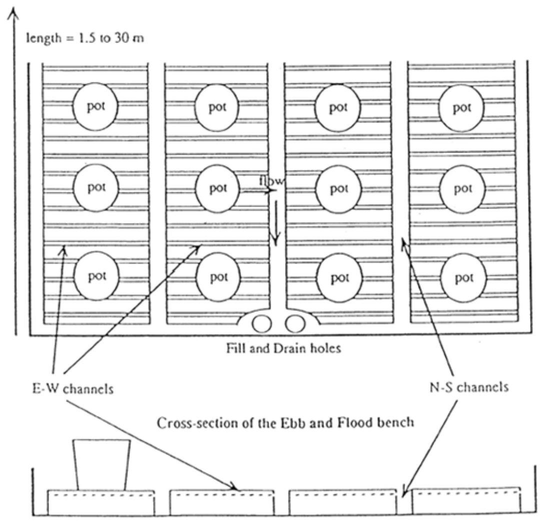

Fig 1. Ebb and flow benches

valve is installed at one or both ends of the bench. For benches longer than 5 m it may be necessary to flood and drain from both ends of the bench. In benches with no drainage channels care needs to be taken when using the same valve for the inlet and outlet, as those plants near the valve will be flooded for a longer time, resulting in uneven watering of the crop. Discharge into the bench should be matched to the flow capacity of the channels so that the water level rises evenly across the whole bench to allow even flood time for all containers. Modular benchtops are available in 1.2, 1.5, 1.8 and 2 m widths, and in various lengths.

Although fully automated systems are available, manual operation may give better control by ensuring plants are not overwatered or allowed to dry out too much. A simple control for the flood level on a manually operated system can be to attach a hose to the bench and have a small piece of polythene pipe that fits into the drainage hole of the bench. The piece of polythene pipe is set at the required water level, and when the depth of water reaches the top of the pipe water flows out, keeping the water in the bench at the pre-determined level. When the irrigation cycle is complete, the polythene pipe is removed allowing the excess water in the bench to drain away.

A water or liquid fertiliser solution can be stored in a tank and pumped to the table valve if required.

When the irrigation cycle is completed, the left over solution is drained from the bench through the fill pipe and back to the tank so it can be used for further irrigation cycles.

Concrete flood floor systems

Concrete flood floor systems are suited to growing large batches of plants. A concrete flood floor consists of a concrete module fitted with underground pipes that enable water to be rapidly pumped into the module and then drained using the same pipe work. Figure 2 shows a schematic of a typical concrete flood floor system. In each of the modules the floor is peaked at the edge and middle of the module, with a grade of 1:100 to 1:150. The grade along the module is flat. Curbing can be used separate sections of modules and can be used to locate the supports for the growing structure. Concrete floors are usually 100 mm thick, reinforced and constructed so they don't leak, and drain with no low areas left. Floor heating can be also be installed in the concrete if necessary.

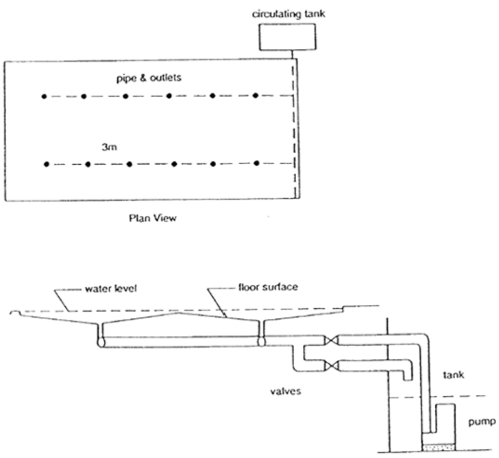

Fig 2. Concrete flood floor

Water comes from a holding tank and is pumped at high flow rates through the underground pipe into the module through the inlet/outlet holes. After the pre-determined soaking time has elapsed, the remaining water is quickly drained out of the module through the same piping, and then through a media filter to remove growing media and plant debris before flowing back to the holding tank.

Gravel flood floor systems

Gravel flood floor systems can be simply constructed with timber edges, 200 micron plastic, 50 mm slotted PVC pipe, 20 mm gravel and two hydraulic valves. The floor is sloped at a 1:100 grade as shown in Figure 3. Water is supplied through slotted PVC pipe and controlled by hydraulically operated butterfly valves normally closed (for the inlet) and normally opened (for the outlet) and located at one end of the bed. This system is supplied with low-pressure high volume water delivery and can also recycle the unused water.

Pipe and valve sizing depends on the size of the module and the flow rate required. A full watering and dewatering cycle should take about 15 minutes. To calculate the volume of water that needs to be pump and the flow rate required it is assumed the gravel will hold 50% of its volume as water.

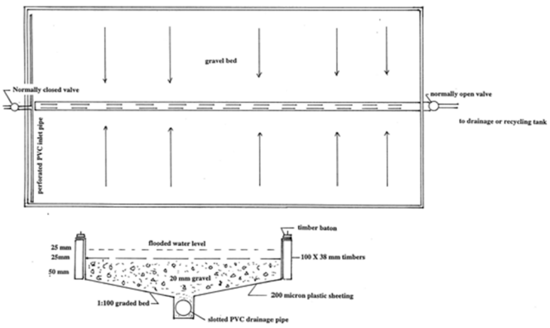

Fig 3. Gravel flood floor

To initiate an irrigation cycle the inlet valve is opened and the outlet valve closed and the bed flooded. After the bed has been flooded to the pre -determined height the inlet valve is closed and the outlet valve opens which then empties the module.

The outlet valve must remain open when not irrigating to allow any rainfall to drain from the gravel. Because of the 50 mm – 100 mm depth of gravel used in these systems, and the exceptional drainage of this gives, sufficient air space is always maintained below the containers to suppress disease and limit root growth.

Trough systems

In trough systems, containers are placed in a trough sized to suit the container. The containers slow the flow of water down along the trough which then allows capillary movement of water into the containers through the pot's drainage holes. The slow flow rate into each trough has a low velocity which stops the growing media from washing from the containers. Trough systems generally allow good airflow between the spaced troughs thus reducing the humidity which can cause problems with other bottom watering systems.

Troughs can be made of aluminium, Colorbond® or PVC. Steel roofing is used extensively, particularly when growing potted colour. However, the lack of spacing between troughs means this system does not have the same airflow around the containers as other trough system designs.

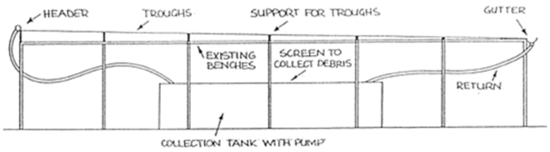

Fig. 4 Trough system

Troughs are installed with a grade of about 1:600 to 1:750, and the troughs and containers are spaced to suit the plant being grown and the container size. Water is supplied at a low rate (an 8L/hr dripper or 1.5 to 2 mm microtubing) to one or both ends of the trough, with the water draining to the other end or the centre, and then returned to a holding tank for reuse.

As a guide, for each irrigation, 150 mm containers are irrigated for about 20 minutes, and 200 mm containers for about 40 minutes. The interval between irrigations will be dependant on the crop grown and the evapotranspiration rate.

Capillary matting systems

Capillary matting systems are efficient where light levels and temperatures are low and humidity is high, and are suited to growing plants with short crop cycles, e.g. potted colour. As the plants only take up the water they need, plants of different water requirements can be laid out in the same area.

The matting material for capillary systems is usually a synthetic fibrous material like geotextile fabric from 2 to 6 mm thick. In these systems a common construction method is to place a layer of black polythene film on a flat bench, on top of which a layer of matting is placed and covered with weed mat or a perforated plastic sheet. The container is placed on the capillary matting and the water moves from the mat into the growing media through the drainage holes.

There are also products available that are supplied as the completed mat with the 3 layers. These products only require the capillary mat to be rolled out and connected to the water delivery system.

Capillary matting uses a low application rate system such as drip tape spaced about 60-70 cm apart to keep the matting wet. The spacing of the emitters along the tape needs to be sufficient to achieve a uniform moisture level across the whole mat.

In these systems growing media salt levels, runoff salt levels and nitrate concentrations tend to be higher than with other systems. However, the

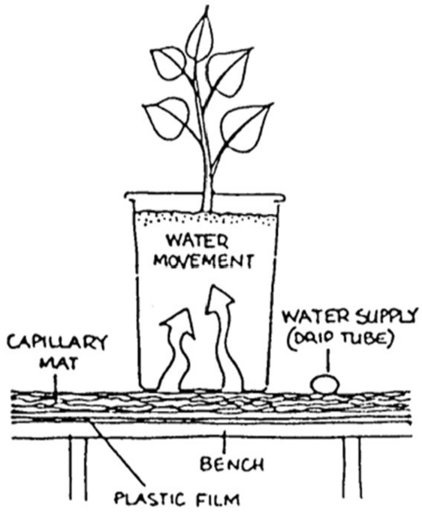

Fig 5. Capillary mat

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consistent moisture levels in the growing media help to reduce the effect of higher salt levels. Salt build-up can also be reduced by top watering every 3-4 weeks. In outdoor growing systems light rain can push the accumulated salt from the top of the container into the rootzone.

Water use in capillary systems is higher than other bottom watering systems. This is partly due to the higher evaporation loses from the mat surface due to the mat being constantly wet. Water losses due to evaporation from the mat decrease as plants grow and shade the mat.

Black perforated cover sheets will better give better algal growth control, but liquid feeding can increase algal problems. For the water to move from the matting into the growing media the containers must have adequate holes in the bottom to allow the water to move into the container through capillary action.

Irrigation scheduling of capillary mats needs to take into consideration the management of algae on the mat, e.g. watering cycles of 3 or 4 thirty-minute irrigations per day to enable the mat to dry between applications and reduce algal growth. This scheduling is better suited to small containers.

There are also risks that the excess water around the containers may result in the spread of fungal root diseases. Use of fungicides and good hygiene practices will help to minimise these problems.

Sandbed capillary systems

Sandbed capillary systems have the containers placed in a moist sandbed. A typical system comprises a bed lined with 0.2 mm UV-resistant plastic film to make the bench waterproof. Plastic drainage pipes are installed to remove excess irrigation water, with an overflow pipe to remove rainwater. The plastic and drainage pipes are covered with a 100 mm layer of sand (minimum 25 mm) with typical grain sizes as follows:

- *>2 mm 25 %*
- *0.6 to 2 mm 30 %*
- *0.2 to 0.6 mm 30 %*
- *0.6 to 0.2 mm 15 %*

Forty to fifty percent of the sand by weight should be between 0.2 and 0.5 mm. A coarser sand may be needed in high rainfall areas to help drainage and stop surface saturation. "Growing Media for Ornamental Plants and Turf " contains a testing method for sand to determine its suitability for capillary systems. Sand should be thoroughly disinfested to ensure it is disease free before use, and hygiene practices put in place to minimise contamination of the sand bed.

The surface of sand beds needs to be level but the bottom can be sloped, e.g. 1-in-70, which will help to remove excess water. The surface of the sand should remain moist but not saturated. This is achieved by an automated system maintaining the water level within the sand bed—see figure 6.

The following are some limitations of sandbed systems:

- *Containers larger than 9 L are not suitable for sandbeds as the containers are too deep.*
- *If plants are grown on the sandbeds for more than two months the growth of roots into the sand bed must be addressed. A perforated plastic cover such as weedmat can be used for this, but the containers need to be pressed well into the sand to maintain capillary action.*
- *Using liquid fertilisers can increase slime on the sand.*
- *Washing out of the sandbed in high rainfall events may be a problem in outdoor systems.*

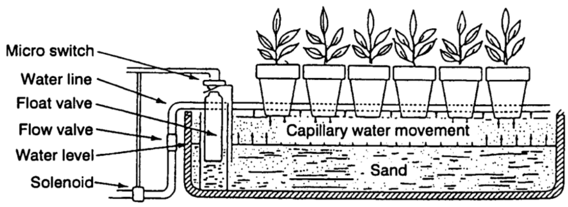

Fig. 6 Sandbed capillary system

For more information refer to "Nursery Industry Water Management Best Practice Guidelines 2010" and "Growing Media for Ornamental Plants and Turf".

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