NRCS Natural Resources Conservation Service

Conservation Practice Specification Guide MA-443

Irrigation System, Surface and Subsurface

Greenhouse Zero Runoff System - Ebb & Flow Benches

Introduction

Ebb and Flow Benches are a type of sub-irrigation method that periodically introduces water from the bottom of the root zone, using capillary action in the soil medium to irrigate the crop. This system is suitable for crops grown in pots or flats.

Typically, water and nutrients are pumped to waterproof and level benches to submerge the bottom of the plant containers at a uniform depth of about ¾ to 1 inch. After a predetermined time, a valve is opened and the water rapidly drains and returns by gravity to a recovery tank to be reused. A filter is used to exclude solid matter. If the recovery tank is above ground, then one or more sump tanks may be needed to collect the water which is then pumped to the recovery tank.

Since some water is used by the plants, water must be periodically added to the tank. Adjustments are needed to the nutrient solution, and adjustments to pH and soluble salts may be required.

An irrigation controller can be used to automate the irrigation cycles and promote consistent applications of water and nutrients.

This type of zero runoff irrigation system saves water and protects ground water by eliminating the runoff of water and nutrients. Water and fertilizer inputs are typically 25 to 60% of that needed for top-down irrigation.

General Specifications

Plans and specification for designing and installing a zero runoff system for ebb and flow benches shall be in compliance with this specification guide. The design shall include the size of the benches, the amount of water to be delivered to each irrigation zone, and the method to size the pipelines and recovery tanks. It shall also include the method proposed to dispose of the sediment in the recovery tank when cleanout is needed.

General Criteria

High quality water is required. Because leaching is eliminated, all residues remain in the substrate. Water containing sodium, chloride, or excessive sulfates cannot be used with this system.

If fertilizer will be supplied with the irrigation water, then highly pure fertilizers are needed to eliminate high electrical conductivity and accumulation of residues such as sodium, chloride, and sulfates. An alternative to fertigation is to place all needed fertilizer in soluble or controlled released forms in the substrate and irrigate with clear water.

Benches

The benches are typically aluminum, polyethylene, or fiberglass, 4 to 6 feet wide, installed perfectly level to maintain a uniform depth of liquid. The benches can be stationary or movable depending on the crops to be grown.

The benches shall be capable of submerging the bottom of the plant containers ¾ to 1 inch deep. They shall have channels in the bottom of the bench to allow the water to distribute evenly and to drain rapidly to facilitate drying and reduce algae growth and disease potential.

The benches shall be installed according to the manufacturer to ensure they are level and will function as intended. Bench supports shall have micro-adjustments to facilitate leveling.

Recovery Tank

The recovery tank shall have a minimum capacity of ½ gallon per square foot of bench area served by the tank (zone). The capacity can be reduced if a controller is used to program a pause in the irrigation cycle to allow water to drain back to the tank before pumping to the next bench or set of benches within the zone.

The tank shall be watertight and be of a material to resist all loadings. Tanks installed below ground shall be designed for that use, and shall be installed and used according to the manufacturer's requirements.

Provisions shall be made for periodically adding water to the tank without exceeding its holding capacity. Also, if fertigation is planned, provisions are needed to allow the addition of nutrients to maintain the desired EC and pH.

Include provisions for cleaning the tank to remove accumulated sediments. The design shall include the proposed method of disposal of the liquid and sediment removed.

Sump Tanks, Piping, and Pump

If sump tanks are used, then they shall be watertight and have sufficient capacity (along with the pumping rate of the sump pump) to receive the drain water from the benches and pump to the recovery tank without overflowing. They shall be designed for underground use, and installed according to the manufacturer's requirements.

There shall be separate pipe for delivery and draining of the benches. The sizes of the supply and drain hoses and the type of valve used shall meet the filling and draining requirements of the irrigation system and the management goals of the grower. The pipe and hoses for the delivery and the return flow shall be sized to handle the design flows while minimizing friction losses.

Tanks and piping should be dark in color or painted black to exclude light.

The pump(s) shall be sized to deliver the maximum flows needed for the system. Stainless steel pumps are recommended.

Considerations

An irrigation controller and solenoid valves are recommended to automate the irrigation and provide for consistent delivery and holding time of water and nutrients on the benches. The controller should provide for manual override for starting and stopping of the system.

Sterilization of the feeding solution by heating, ozonation, UV radiation, or hydrogen peroxide may be required to reduce disease potential.

Operation and Maintenance

Zero runoff systems require monitoring and precision management to minimize the risk of crop loss from algae growth, and a buildup of residues.

Maintain all components according to manufacturers' recommendations.

Clean out accumulated sediment in sump tanks and recovery tanks as needed, and properly dispose of the liquid and sediment.

Growing media should be carefully selected to provide capillary action without excess saturation.

Top watering may be needed when plants are young to get nutrients to the crop. Top watering may also be needed to reduce surface salt accumulation.

References

Water and Nutrient Management for Greenhouses, Northeast Regional Agricultural Engineering Service, NRAES-56, May 1996.