Eight Steps to a Successful Watering System

John W. Bartok, Jr.
Extension Agricultural Engineer

Do you spend much of your day holding the end of a water hose? An automatic watering system may be your answer to more uniform watering and less labor input. When setting up a watering system, consider the following:

How much water is needed?

Plants require an adequate supply of moisture for optimum growth. For each ounce of dry matter produced by the plant, as much as two gallons of water move through the plant. A first step in planning a new greenhouse operation or in automating an existing one is to estimate the maximum water requirements. This varies with the type and size of crop and the local climate. Besides transpiration from the plants, evaporation from soil surfaces must also be considered.

Table 1 gives an estimate of the maximum daily water requirements for most types of crops. This maximum usage usually occurs on the hot days during the summer. The water needs for your operation can be calculated by multiplying the square feet of growing area for each crop times the daily water requirement. For example, a 20' x 250' bed of container plants may use up to 2,500 gallons per day (5,000 sq ft x 0.5 gal/sq ft/day).

Table 1. Estimated Maximum Daily Water Requirements

Crop	*Gallons of Water*	*Remarks*
Bench Crops	.4 gal/ft^2	Based on twice-a-day watering
Bedding Plants	.5 gal/ft^2	
Pot Plants	.5 gal/ft^2	
Mums, Hydrangias	1.5 gal/ft^2	Based on three-times-a-day watering
Roses	.7 gal/ft^2 of bed	
Tomatoes	.25 gal/ft^2 of bed	Water every other day

Is there adequate water available?

The water system should be able to supply the total daily needs in about a six-hour period. This allows the plants to be watered during the morning and early afternoon and still have time for the foliage to dry before sunset. The peak use rate is the maximum flow rate needed during this six hour period.

Peak use rates are needed to determine pump capacity, pipe size, type of distribution system and storage tank size. In the above example if the 2,500 gallons were applied over the six hours, you would need 415 gallons per hour (gph) or seven gallons per minute (gpm). If the water was applied over a 60-minute period, as might be the case with an overhead sprinkler system, then a supply rate of 42 gpm is needed. Although streams, ponds and municipal systems can supply this rate, most wells cannot. Under these conditions, an intermediate storage tank may have to be used.

How will the water be applied?

There are many devices for watering plants. These can be classified as low-pressure, trickle systems that operate on less than 15 pounds per square inch (psi) and high pressure sprinklers that operate on presures above 15 psi. Because the application rate is much slower with a low-pressure system, it works well where a well supply rate is limited. High-pressure systems, on the other hand, can give good coverage over a larger area in a shorter time period. A low pressure emitter may have a flow rate of one gallon per hour, whereas a typical sprinkler applies several gallons per minute.

Low-pressure devices include drip tubes, emitters and perforated hoses. Drip tubes are widely used for watering containers and hanging baskets. The system consists of small diameter plastic capillary tubes connected to a supply line. "Drop in" weights are attached to the other end. Some weights are available with a shut-off so that the water to individual containers can be stopped when the plant is removed. The diameter of the tube and its length determine the water flow.

Emitters are devices usually placed in a supply line at intervals that correspond to the container or plant spacing. They are designed to dissipate the energy in the flow of water so that it emerges as drops at a rate of 1/2 to 1 gph. Some emitters accomplish this by creating a long flow path, while others develop a turbulent flow condition.

Low-flow porous or perforated hoses are designed for watering greenhouse benches, beds and capillary MAT systems. Under low pressure, water dribbles from the seams or tiny holes. A hose within a hose is sometimes used to give more uniform pressure along its length and, therefore, more uniform flow.

High-pressure sprinkler devices are available in many designs, capacities and patterns.

Fixed spray heads, originally developed for lawn irrigation have been successfully used to irrigate bedding plants and for propagation of cuttings in small pots. Heads with various patterns—square, full circle, part circle and rectangular—are available.

Rotating impact sprinklers revolve about one to two times per minute. Rotation is caused by an arm that oscillates in and out of the nozzle jet stream. For field-grown plants and containers in large beds, impact sprinklers are the most common irrigation system. Nozzles can be interchanged to vary flow rate and coverage.

Whirling, rotating sprinklers rotate by the reaction of the jet of water discharging from the nozzle. Sprinklers with single or double arms work well on small, closely-spaced containers. Discharge rate and droplet size can be varied.

Sprinkler head spacing is usually 50 to 75 percent of the spray diameter to allow for more uniform coverage. Spray diameters from three to 80 feet are available.

With the shift to plugs, cell packs and closely spaced containers, there is need for a system that will provide very uniform coverage. The watering boom supported over the plants by either a track system or a cart that travels along a central aisle works well. These can be purchased from several suppliers in both manually pulled and motorized models. A fact sheet on how to build your own is available from the Natural Resources Management and Engineering Department, 1376 Storrs Road, University of Connecticut, Storrs, CT 06269-4087.

Develop a system layout.

A plan should be developed on paper that shows the location of the water supply and growing areas. Accurate measurement of distances are important to aid in sizing pipe. Things to consider include:

1. Available flow and pressure influence the type of system that can be used. Dividing the area into smaller zones allows low gallonage supplies to be used.

2. Smaller lateral pipes can be used if the supply line is brought to the middle of the bench or bed.

3. For sprinkler systems, select a nozzle pattern and lateral spacing to give uniform coverage of the plant area.

4. For trickle systems, locate emitters to get water to each plant root zone.

Figure 1 shows two possible system layouts to water our 20' x 250' bed filled with containers.

For this example, an application rate of 0.3 gal/sq ft/day will be used. The amount of water needed is 1,500 gallons (0.3 gal/sq ft/day x 5,000 sq ft)/

Sizing pipe is important.

Polyethylene, polyvinyl chloride (PVC) and aluminum pipe are most commonly used for supply and distribution lines. The cost is low, the installation is easy and the service life good. Schedule 40 is commonly used for 1/2- and 3/4-inch pipe sizes and Schedule 80 for larger sizes.

Supply lines and laterals should be sized to carry the flow needed without excess friction loss. Friction loss is created when water flows through pipes, valves, fittings and sprinklers or emitters. Because friction loss is cumulative between the source and the nozzles, allowances have to be made to ensure that each nozzle has an adequate supply, or the coverage will be uneven. Tables are available that help you determine what size pipe is needed.

Select good quality equipment.

Pumps should supply water under sufficient pressure to provide the required flow rate and coverage. The total pressure against which a pump must work is composed of four parts. They are: 1) suction lift or the vertical distance water is lifted to the pump by suction, 2) the vertical distance from the pump to the point where water is to be delivered, 3) the required pressure at the outlet or nozzles and 4) the friction in the piping system. These values can be given in feet of water or psi. Multiply psi by 2.31 to obtain feet of water. For example, 40 psi is equal to 92 feet of water or a column of water 92 feet high.

Valves are needed in a water system to control the flow of water. Ball valves should be used for shut-off purposes where possible because they have less friction loss and allow a greater flow than gate or globe valves.

All municipal and domestic water sources must be protected against contamination caused by backflow. The most commonly used backflow preventer is the vacuum breaker. If you are connected to a municipal system, check with the water company to see what is required.

Make the system automatic.

Automatic control is desirable where several zones are used. It requires a controller and solenoid valves to turn each zone on or off. Controllers are available that will meet almost unlimited combinations of watering duration per zone, watering frequency per zone per day, override if more water is needed or skip if there are no plants in that zone. With recent advances in solid state technology and the increased use of computer control, more precise watering should be possible with lower fertilizer usage and less potential pollution.

No water system is any better than its installation.

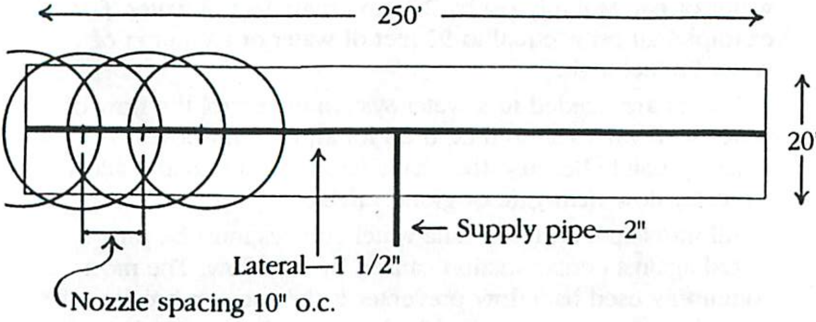
If the system is to be used during the winter, supply pipes should be buried below the frost line. In areas of heavy traffic, pipes should be protected by placing in a culvert or drain pipe. To avoid stress on connections, allow for expansion of the pipe.

Provide adequate power to the pump. A common cause of failure on electric pumps is a low voltage condition caused by too small a wire size.

Design the system to keep the number of fittings and valves to a minimum to reduce the friction loss.

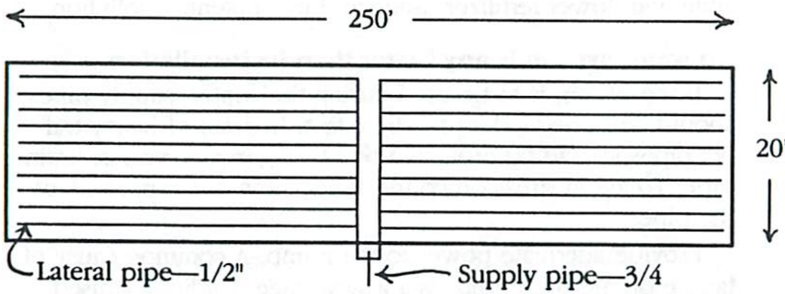
A good installation is one where the pump and other components are easily accessible, making inspection and maintenance easy. Also make provisions for expansion by installing extra tees at critical locations.

Figure 1



Design using 2 gpm nozzles—whole bed watered at one time.

Nozzle spacing - 10' o.c.
Coverage—25' diameter, double overlap
No. of nozzles—26
Supply pipe size—2"
Water supply needs—26 nozzles x 2 gpm = 52 gpm
Lateral pipe size (each lateral supplies 26 gpm)—1 1/2"
Time needed to apply water—$\frac{1{,}500 \text{ gal}}{52 \text{ gpm}}$ = 30 minutes



Design using 1 gph drippers—1/2 of bed watered at one time.

Dripper spacing—2' o.c. in row
No. of drippers—1,250
Water supply needs—$\frac{1{,}250}{2}$ @ 1 gph = $\frac{625}{60}$ gal/hr = 10 gpm
Lateral size—1/2"
Time needed to apply water—75 min/section
Controllers and solenoid used to sequence sections of bed.