An inexpensive oscillating irrigation sprayer for nurseries

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An oscillating irrigation sprayer can apply water and fertilizer uniformly and accurately over varying quantities of nursery seedlings at different growth stages. The sprayer is inexpensive and is easily built from off-the-shelf parts.

Nursery workers who grow seedlings in small containers need a way of applying water and fertilizers uniformly. In nurseries using large containers, uniform coverage is provided by overhead traveling sprinklers. These sprinklers cost about $1,200 a unit.' Because of the high cost and the number of species being grown, it would be impractical to use overhead traveling sprinklers in small nurseries.

This paper describes an inexpensive oscillating irrigation sprayer (figure 1) that applies water and fertilizer uniformly and accurately. It is easy to build and can be used to treat varying quantities of seedlings. The area covered by the sprayer can be varied from about 4 by 10 feet to 9 by 30 feet. At a spacing of &1 seedlings per square foot, the number of seedlings sprayed would range from 2,560 to 17,280. Different oscillating sprayers can be connected to the same or different valves. Therefore, the oscillating irrigation sprayer is adaptable to nurseries with a production of several thousand to over 1 million seedlings. The cost of the small unit would be about $40; that of the larger unit would he about $55.

Most components are off-the-shelf items in hardware and plumbing stores. Nozzles are usually available at most greenhouse supply firms The following details about construc provide one approach. Changes in design can be made, depending on availability of materials.

Sprayer requirements

Before building the irrigation sprayer, determine your requirements as to sprinkler, nozzles, and spray patterns (figure 2).

Oscillating lawn sprinklers

Any oscillating lawn sprinkler can he used as the power unit for the irrigation system. However, the more expensive models probably have better gears and therefore, smoother oscillations. Some models tend to bind at low rates of water flow. This problem can sometimes he eliminated by increasing the number of nozzles or the flow rate per nozzle.

Width of spray pattern and height of spray nozzles

The maximum angle of sprinkler oscillation is 90 (figure 21. Therefore, the width of the spray pattern is twice the height of the nozzles above the seedlings. Owing to air friction and wind, the practical maximum nozzle height is 5 feet above the seedlings. This height provides a maximum spray pattern width of 10 feet. However, the bed width should he about 9 feet to allow an overspray of about 6 inches on each side. Because the oscillating sprinklers have full, left, right, and center control, the nursery worker can adjust the spray pattern width to cover only the area desired.

Approximate length of spray pattern

The spray pattern can vary from about 10 feet to 30 feet long. Because nozzles vary in pressure, the spray pattern should be limited to about 30 feet. In my 30-foot model I found a pressure drop of about 2 pounds between the first and last nozzles. A pressure drop greater than 2 pounds would probably result in too much variation in the water pattern. The spray pattern should extend about 1 foot beyond each end of the bed.

Nozzle tip spray angle

The nozzle tips produce a flat spray, tapered edge pattern. The overlapping patterns (25 percent overlap) give uniform coverage of the area sprayed. The most commonly used spray tip angles for pesticide application are 65, 73, and 80°. I have used both the 65° and 80° nozzles with good results. Generally, the 65° spray angle results in a firmer pattern that withstands the effects of air friction and wind better than the wider spray angles-volume and pressure being equal.

Distance between nozzles

The distance between nozzles can be calculated by using the formula:

$$d = 1.5\ h\ \left(\tan \frac{\theta}{2}\right)$$

d = distance between nozzles allowing for the 25 percent spray overlap
h = height of nozzle above plants
θ = nozzle tip spray angle

' Ekbtad, Robert B. 1973. Greenhouses: A survey of design and equipment. USDA, Forest Service Equip. Devel. Center Publ. ED&T 2340. 70 p., illus.

Figure 1.—An easily-built, inexpensive oscillating irrigation sprayer provides for uniform and accurate application of water and fertilizer in small nurseries.

Example:

$h = 5$ feet, $\theta = 65°$, $\tan \frac{\theta}{2} = 0.6371$

$d = 1.5\ (5)\ (0.6371)$

$d = 4.8$ feet apart

A wider spray angle will result in a larger distance between nozzles.

Number of nozzles

The number of nozzles required to cover the length of bed desired can be calculated from the formula:

$n = \frac{s_p}{d}$ where:

n = number of nozzles (rounded upward to next whole number)

s_p = approximate length of spray pattern, including the overspray on the ends of the bed

d = distance between nozzles

Example:

s_p = requires approximately 25 feet

$d = 4.8$ feet

$n = \frac{25}{4.8} = 5.2$ or 6 nozzles required

The spray pattern length would therefore equal

$s_p = n(d) = 6(4.8) = 28.8$ feet

Allowing 1 foot on each end as overspray, the actual bed length would equal 26.8 feet.

Spray bar length

The spray bar length required to cover the spray pattern length can be calculated from the formula:

$s_b = (n-1)\ (d) + 1$

s_b = spray bar length in feet

n = number of nozzles

d = distance between nozzles

Example:

$n = 6$, $d = 4.8$ feet

$s_b = (6-1)\ (4.8) + 1 = 25$ feet

The extra 1 foot is required to provide 6 inches at the inlet end for insertion into the power unit and 6 inches at the outer end for the pressure gage (figure 1).

Flow rate per nozzle

Most oscillating lawn sprinklers function well on a water flow rate of

2.5 to 4.5 gpm at 40 psi. The product of the number of nozzles and flow rate per nozzle should equal about 3.5 gpm. The flow rate per nozzle can range from 0.067 to 2.00 gpm at 40 *psi*. The flow rate per nozzle can be calculated from the formula:

$$F_r = \frac{3.5}{n}$$ where:

F_r = flow rate per nozzle at 40 psi
n = number of nozzles

Example:

n = 6

$$F_r = \frac{3.5}{6} = 0.58 \text{ gpm or } 0.60 \text{ gpm tips}$$

Materials

Materials required for this oscillating irrigation sprayer are:

Item	*Number*
Power Unit	1
Block of wood	1
Metal strap for 1-inch pipe	1
TeeJet nozzle assembly including body, strainer, cap, and tip	*
PVC pipe ½ inch diameter	1**
Pulley, 1-inch diameter	***
Shower curtain hook	***
Nylon line	***
Pressure gage with ¼-inch NPT external thread	1
Bushing ½ inch with ¼-inch NPT internal thread	1
Reducing coupling ⅞ by ⅜ inch	1
PVC female adapter (slip x thread) ½ inch	1
PVC plug ½ inch	1
PVC 90° elbow 1 inch	2
Galvanized pipe ¾ inch	**
Metal collar with set screw to fit over ¾-inch pipe	2
Aluminum tubing, 1¼ inch	2**
Galvanized pipe, 1 inch	1**
Garden hose	1**

* Number will depend upon the spray pattern length and nozzle spray angle.

** Cut to length desired.

*** Use 1 per 5 feet of spray bar.

Construction

Oscillating lawn sprinkler alteration

The only part of the lawn sprinkler used is the power unit. Therefore, before cutting the arched water ejection bar, mark the spray direction on the power unit. Screw a wood block to the power unit base. Attach a metal strap to the opposite side of the block to bind the power unit to the support pipe. The strap should he arched in such a way that the support pipe and spray bar will be parallel.

Spray bar

The spray bar, made of ?-inch PVC pipe, should be made the desired length, either by cutting some off or by joining pieces. Starting about 6 inches from the power unit end, mark off the location of each TeeJet nozzle, making sure that all marks are in line. Using a 9/32-inch bit, drill a hole at each mark and attach the TeeJet nozzle bodies.

About 6 inches beyond the last nozzle, glue a female PVC adapter (SXT) to the end of the spray bar. Screw a .5 by .25 inch bushing into the adapter. Attach a pressure gage 1/4inch external thread) to the bushing.

On the power unit end of the spray bar, glue a copper reducing coupling (c by q inch), using epoxy glue. The -inch end of the coupling slips over the outside of the PVC spray bar. Roughen both the inside of the coupling and the outside of the spray bar before gluing.

The -inch end of the coupling fits into the power unit. Usually some reaming is required to make the two fit together. Roughen both contact surfaces. Use epoxy glue to join these pieces. Make sure that the nozzles on the spray bar line up with the mark made earlier on the power unit.

Irrigation system support

The irrigation system must be supported so that the spray bar can still oscillate while the system can be moved up and down. A 1-inch galvanized pipe forms the basis for the support system: the spray bar and power unit are suspended under it.

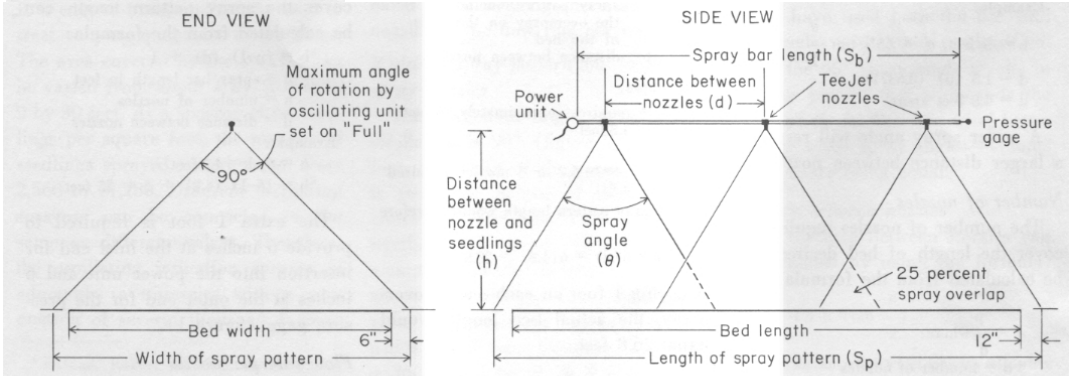

Figure 2.—Sprayer and spray pattern requirement must be determined by the nursery worker before construction can begin.

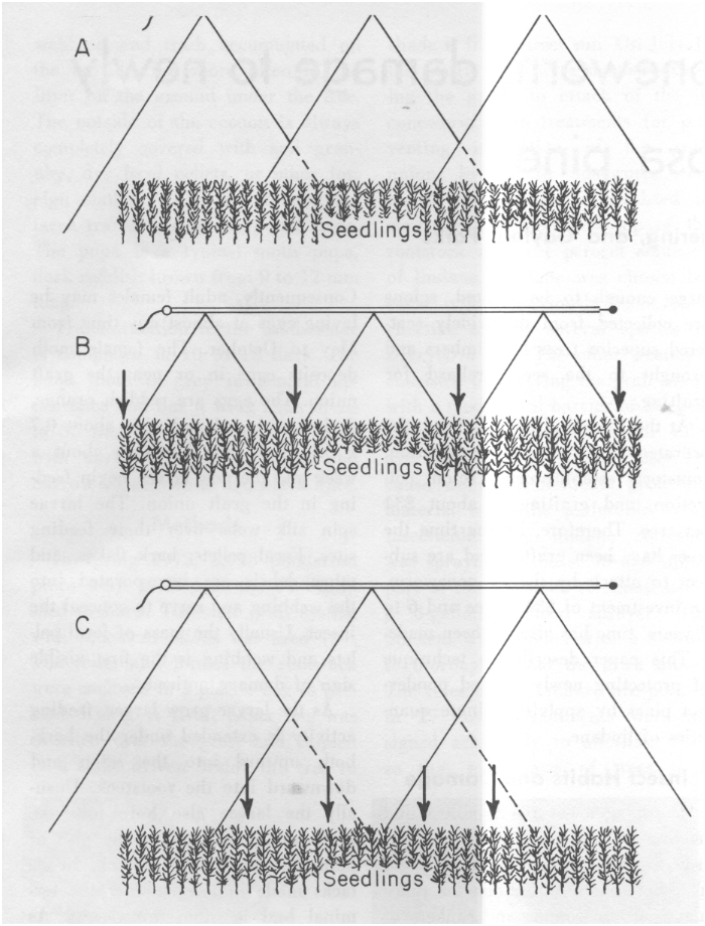

Figure 3.-Side view shows proper and improper spray patterns: (A) proper height of spray nozzles results in uniform water distribution; (B) nozzles too close to seedlings result in too little water in spray overlap areas and at edges; (C) nozzles too far above seedlings result in too much water in the spray overlap area and at edges. Arrows show areas where water distribution is not uniform.

Attach the irrigation system and the vertical supports to the pipe. If the pipe exceeds 15 feet, it will sag in the middle. Correct this by using a truss system.

Attach the spray bar to the support pipe by pullies (figure 1) . Attach 1-inch single pullies at about 5-foot intervals to the support pipe by stainless steel shower curtain hooks. Tie nylon lines through each pulley and then around the spray bar. As the spray bar turns, the nylon line moves freely up and down because the pulley turns in the same direction and amount as the spray bar. When tying the nylon lines, make sure that the spray bar and the support pipe are parallel.

The vertical supports can he attached to the support pipe from above or below. Either way, the whole irrigation sprayer must be movable up and down so that the distance between the nozzle and the seedlings remains constant. This distance must be maintained to insure uniform irrigation. If the distance is too little, the seedlings at the ends of the spray pattern and those in the spray overlap area will not receive as much water as adjacent seedlings (figure 31. If the distance between the nozzles and seedlings is too great, the seedlings in the spray overlap areas receive more water than adjacent seedlings (figure 3).

The irrigation sprayer must be raised as the seedlings grow. It must then be lowered for the new crop. For most tree seedling crops, a vertical movement of the irrigation sprayer of about 2 feet should be adequate.

We have used both types of support i.e., from above and below. Sup. port from above is simple if the irrigation sprayer is to he installed in a greenhouse. Greenhouses generally have beams or other structures from which the vertical supports can be suspended. Two 26-inch lengths of 2- by 2-inch dimension stock, each with hooks screwed in at 4-inch intervals and properly braced, make adequate supports. Suspend the stock in a vertical position, and at the same level. As the seedlings grow, raise the irrigation sprayer by placing the support pipe on higher hooks.

The irrigation sprayer can be supported from below, indoors or out, by a telescoping pipe. Two 5-foot sections of aluminum tubing ($1^1/_4$inch diameter) provide support, one at each end of the irrigation sprayer. Slide a 6-foot length of 3/4-inch galvanized pipe into the tubing. Place a metal collar, with a set screw, over the pipe. The collar rests on top of the $1^1/4$-inch aluminum tubing. Attach the vertical $^3/4$-inch pipe to the 1-inch support pipe by a 1-inch 90° elbow. The loose fit on

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the vertical pipe is necessary to allow one end of the irrigation sprayer to he raised at a time without pipe binding occurring. The base pipe must be braced in the vertical position.

Water supply connection

The power unit should be connected to the water supply line by a section of garden hose. The hose, at least 1/2, inch in diameter, must be long enough to allow the irrigation system to be raised to its maximum height. It must also be flexible enough to allow the lowering of the irrigation sprayer without kinking.

Water control

The schedule and quantity of water applied can be controlled manually or automatically. Manual control requires one gate valve: automatic control requires a clock and a solenoid valve. One clock can control more than one irrigation unit.

Fertilizer injection

Fertilizer can be applied through the irrigation sprayer. A wateroperated proportioning pump designed to add a preset amount of water-soluble fertilizer works well. A siphon-mixer type will not work because the back pressure created in the irrigation sprayer prevents the uptake of the fertilizer solution.