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Lower your pumping costs with better sprinkler spacing

By Dave Snell

IT'S BEEN A CHALLENGE to get the nursery industry interested in water conservation in past years, even though the dwindling water supply is possibly our most important resource. It seems this is because water is either free or very inexpensive for us in the Pacific Northwest. Now, with electricity costs on the rise, there is a more direct economic impact coming into the picture that should encourage us to review our water usage.

A recent 9th Circuit Court of Appeals ruling has removed Bonneville Power's residential exchange payments to private utilities. That means a lot of nurseries that receive their power from Portland General Electric, Pacific Corp and Idaho Power will no longer see the "credits" on their electrical bills. These utilities have announced this will amount to a 13 percent increase for residential and small farm customers. Even though this does not affect all nurseries, it still is an indication of where power costs are headed.

Most ornamental nurseries need to irrigate. The extent of the irrigation depends, of course, on the type of plant material and the process by which it is grown. Regardless, most all nurseries use electrical pumps. This is a good time to examine irrigation practices that can save water and — more economically relevant — the escalating pumping costs. This article will focus on how correct overhead sprinkler spacing can possibly reduce pumping costs. If you know your pumping costs, then you can determine if and when there is a payback to making sprinkler layout improvements.

Calculating pumping costs

To calculate how much electricity your pumps consume you need to know the power input to the pump (in kilowatts). You can get this information from your pump dealer or, for more accuracy, use the formula in Figure 1. If you know the volts and amps simply use the multiplication formula to figure the kilowatts. For example a single-phase, one-half horsepower, 230-volt pump that consumes 5 amps uses 920 watts

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Pump Cost Calculation

For single phase pumps
volts X amps X .8* X 1** X power rate

For three phase pumps
volt X amps X .9** X 1.73** X power rate

* Ratio of real power (inductive load) to apparent power (source)
** The square root of the phase

Figure 1

or .92 kilowatts. If you irrigated with this pump for 12 hours at the current rate of $.055 per kilowatt hour, that's a measly $.61 for one night's irrigation. Not bad! Cheap power, you say. But guess what: The pump in this example is good for one or two sprinklers. Do you have more than two sprinklers? Do you need more than 30 PSI? Do you need more than 5 gallons per minute? Do you need more than 12 hours of watering a day? I thought so!

Plug in the data (volts and amps) from your pump to find your pumping costs per hour, and multiply that by the estimated yearly hours you are irrigating (and don't forget that 13 percent rate increase) to calculate your yearly pumping costs. Of course, if you have a separate meter for your irrigation pumps, all you need to do is add 13 percent to last year's total bill to find out how much more you'll be paying.

We can create a long checklist of irrigation system improvements that provide potential ways to save pumping costs. But since most nurseries irrigate with various forms of overhead rotating sprinklers I will focus this article on improving sprinkler system uniformity as a way to decrease pumping costs.

When the irrigation system has low uniformity, run times must be increased to get the needed amount of water applied to the driest plants. The excess water applied to the plants that already have enough is wasted, and the extra pumping time translates to higher electrical bills.

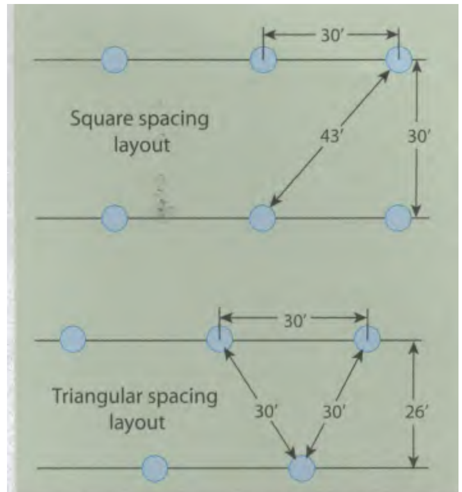

Figure 2

Figure 3

For 25 years I have been evaluating overhead sprinkler systems in landscapes and nurseries. I've concluded there are three prominent factors that make or break a system's uniformity: system layout (sprinkler head location), sprinkler nozzle pressure and sprinkler spacing.

Square, rectangular or triangular?

In square or rectangular spacing the sprinkler rows are at a consistent distance and the sprinklers are also at a consistent distance along each row. The sprinklers are located at every 90- and 100-degree direction from each other as shown in Figure 2. In this example, the rows are 30 feet apart and the heads are spaced every 30 feet along the row. You'll notice, however, the 45 degree diagonal distance is more like 43 feet.

Triangular spacing offsets the heads to be 45 degrees and 180 degrees from each other. In the triangular example in Figure 2, the heads are still spaced 30 feet along the rows, but the rows are 26 feet apart (30 feet X .87). The offset heads and the closer row spacing provide heads 30 feet apart in *every* direction. If an open field or container yard is being irrigated, the triangle spacing scheme will achieve better uniformity (more even water application), which equates to less pumping time to get the nursery stock adequately watered.

If you have no choice but to use a square spacing scheme, the radius of the sprinkler should be capable of covering the diagonal distance, which, in this case, means a sprinkler spaced at 30 feet should have a radius over 40 feet. The photo on the left in Figure 3 has heads spaced along the rows correctly but the rows are spaced too far apart. The photo on the right in Figure 3 has heads and rows spaced correctly.

Nozzle pressure

Correct nozzle pressure is critical with overhead sprinklers. When the pressure is too high, water is lost from misting and evaporation. The sprinkler radius also decreases with increased rotation speed, and the sprinkler's distribution profile becomes more erratic. The same also applies when the pressure is too low. Either way, incorrect nozzle pressure can result in low uniformity. The correct nozzle pressure range for a particular sprinkler can be found in the manufacturer's specifications.

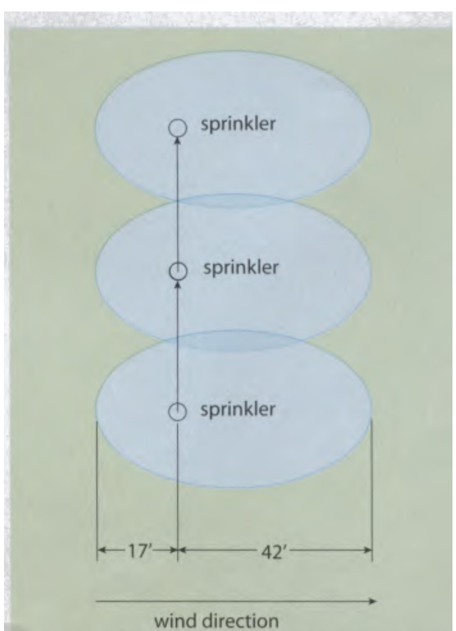

Figure 4

Sprinkler spacing

This is probably the most critical factor for good sprinkler uniformity. You may have heard the term "head-to-head" sprinkler spacing. This means the distance between each sprinkler should be no more than the sprinkler's radius published in the manufacturer's specifications. The triangular spacing in Figure 2 is an example of head-to-head spacing. For example, if the manufacturer states a 30-foot radius at 40 PSI, the sprinklers should be no farther than 30 feet apart. While this rule seems to work fairly well in turf and landscape situations, it may not work as well in nurseries. There's more at stake than spots of brown grass in a landscape when we're talking about nursery stock and escalating pumping costs.

If you use the manufacturer's listed radius from their performance specification table to determine the sprinkler spacing distance, there are a couple things to keep in mind. First, you want to make sure your system can provide the required GPM and correct PSI to duplicate the listed performance. Second, you need to be aware of the

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effect wind has on a sprinkler's distribution. If you are irrigating in a windy area or windy time of day, a slight breeze can drastically change the wetted pattern of a sprinkler. Figure 4 is a graphic illustration of what a 7 mph wind can do to sprinklers that are square-spaced head-to-head at their 30-foot radius. There is very little overlap inside the wetted patterns, and areas outside the wetted pattern will receive little or no water. To compensate for this loss of uniformity, the system will have to run longer to make sure all the plants get the required amount of water.

So, what's the solution? If you are installing a new underground system, shorten the distance between sprinklers to less than the listed radius of the sprinkler you want to use. If you are laying out portable hand lines, lay your rows of pipe closer than the radius of the sprinklers. If you are upgrading or retrofitting an existing system, look for a sprinkler that may be able to increase your radius or distribution uniformity without changing your pump or sprinkler layout. It's almost safe to say you can't get enough overlap. Tighter overlap means better uniformity. Better uniformity means less pumping time and cost.

Here is an example of this solution on a small scale at our nursery. During the summer months, we move our ferns into shade houses that are 14 feet wide by 96 feet long with open ends as shown in Figure 5. Inverted drop spinners are not an option for these houses because of height and space restrictions, as well as wind blowing through. So, we installed fixed spray heads on risers down both sides spaced at 13 feet, 9 inches (almost perfect square spacing). A "no-wind catch can test," similar to the one shown in Figure 6, produced 53 percent uniformity. This meant that we had to add about 40 percent to our run times to make sure all the plants got adequate water.

Figure 5

But this resulted in some of the plants receiving too much water (dead plants just don't seem to sell very well).

Two years ago we removed the fixed spray nozzles and replaced them with a new, short-radius, low-volume rotor. The retrofit was a simple 30-minute project that cost $80 in materials. A subsequent catch can test showed the uniformity increased to 78 percent. Another huge benefit of this changeover was that the total gallons per minute decreased from 28 GPM to 14 GPM. We anticipated the run times would have to double because die new heads with the lower GPM had half the application rate. We found, however, the increased uniformity almost made up for the difference in run time, and we could now irrigate two houses at a time with nearly the same volume of water. That cut our pumping time almost in half for those houses. The electricity savings last year amounted to $68. The payback took just over one irrigation season. We were impressed enough with this retrofit to trade out the rotors in the can yard to similar but larger radius heads.

This year our pumping costs were 17 percent lower in May than they

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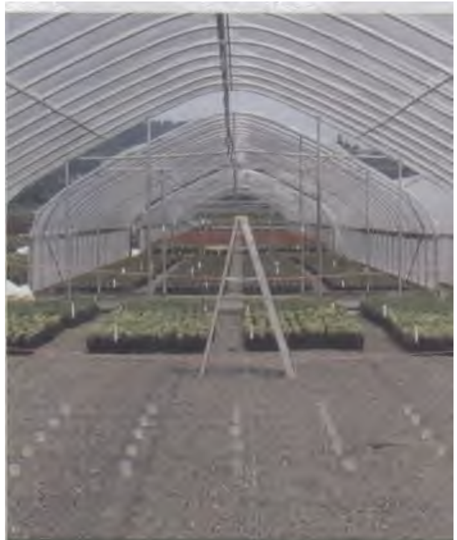
Figure 6

were for the same month last year, even though the local weather data showed evapotranspiration (water lost through evaporation and plant transpiration) to be higher in May 2007 than in May 2006. Plus, we have increased the square footage of can yard space. With improved uniformity we have been able to reduce the hours of irrigation without going to a bigger pump. To verify the plants are getting enough water, we randomly check a sample of the containers for moisture content following the irrigation cycle.

There are many other elements within a nursery irrigation system we could examine to improve efficiency and lower pumping costs, including pumps and the control mechanisms. However, I've observed over the years that money invested in pump stations and control systems has limited payback unless the sprinklers are properly spaced and located.

Dave Snell is the owner of Gales Creek Nursery in Gales Creek, Ore. He has been involved in the irrigation industry for 30 years. Snell is a certified irrigation designer and certified irrigation auditor with the Irrigation Association, a licensed irrigation contractor with the Oregon Landscape Contractors Board and a certified hackflow tester with the Oregon Health Department. He has also taught the irrigation design courses at Clackamas Community College for the past 20 years.