The Importance of Performance

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As preparations are made for the forthcoming dry season, Kenne James looks at all things irrigation, including the importance of placement and nozzle performance.

For a greenkeeper and a golf course business manager, efficiency is a top priority. If they succeed in efficiently maintaining their course, players/customers enjoy outstanding playability and the manager gets to enter the bottom line of the operating budget in black, not red, ink.

For most golf courses, efficiency is optimised not by broad, sweeping changes to the operation, but, rather, by focusing on details, even small ones. How small? As small as the nozzles used throughout the irrigation system because it can be said that the greatest opportunity to improve efficiency lies in the performance, spacing and application of the irrigation system's nozzles. Take a closer look at nozzle operation and you'll see why this is true.

NOZZLE PERFORMANCE

To clarify: When we speak of a 'nozzle', we are actually speaking of the 'nozzling' of a sprinkler, which could mean one, two, three or more nozzles working in unison to distribute water over the sprinkler's entire radius.

Typically, most golf sprinklers have at least two nozzles (a main and an inner nozzle), or three nozzles (a distance or main nozzle, an intermediate nozzle and an inner nozzle). The main or distance nozzle throws the water out as far as possible, usually from the middle of its radius to the end of the radius. A larger stream under higher pressure will tend to go further. If there is an intermediate nozzle, its job is to distribute water over the middle range of the radius, while an inner nozzle distributes water closest to the sprinkler, covering approximately the first one-third of the radius.

Two factors have the greatest effect on nozzles' potential efficiency. First, generally speaking, nozzles with shorter radii (in the 18 to 24 metre range) can achieve higher efficiency than nozzles throwing 25 to 35 metres. Water can be distributed more evenly over a short distance than a long distance, helping us achieve what we call 'uniformity'. The shorter the nozzle radius, the greater the uniformity and, thus, the greater the efficiency of that sprinkler's operation.

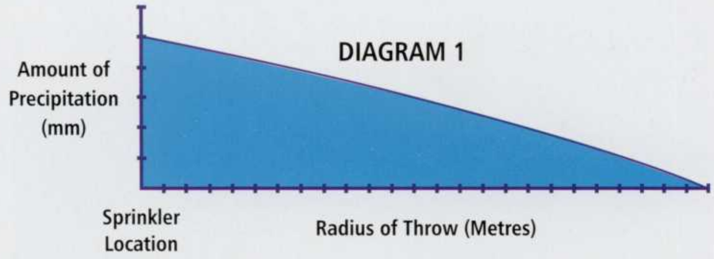
The second factor is the number of nozzles. Imagine the engineer designing a golf sprinkler for a 24 metre radius of throw. If the sprinkler has two nozzles, each will have a broad area to cover. If three nozzles are used, each nozzle can be fine-tuned to distribute water more accurately over a smaller area. The use of three nozzles produces a more even distribution over the entire range of radius and, thus, greater efficiency. This is why sprinklers with three nozzles and a 20 to 24 metre radius are becoming the most desired and common setups used in golf applications, where high efficiencies are beneficial or required.

SPACING

If you understand how a single sprinkler distributes water, as well as the patterns created by groups of sprinklers, you can determine the optimum spacing of sprinklers to deliver the desired effect - efficiently.

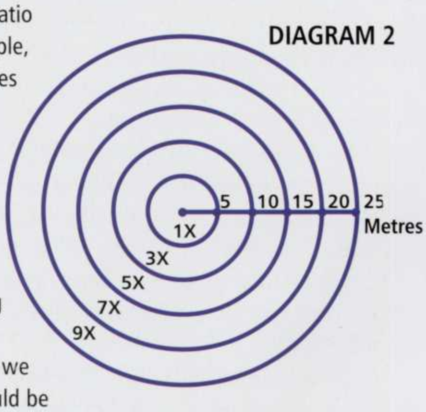
A sprinkler's distribution profile is commonly measured in a test lab where collection cups are spaced every one-third metre, or every foot. After the sprinkler is run for numerous complete revolutions, the volume of water collected in each cup is measured and the water distribution profile is charted in graph form.

A good distribution profile starts highest when closest to the sprinkler, then has a descending line, forming a shape like a triangle, reaching the bottom of the graph at its maximum radius, indicating that water goes no further (see Diagram 1). When you look at a golf sprinkler in use, it typically appears that most of the water is being thrown the furthest distance from the sprinkler. This is actually just an optical illusion, as radius catchment testing (depicted in Diagram 1) proves out.



Here is why: The further from the sprinkler you go, the greater the area over which the water is being spread. Consider a 25 metre radius split in sections of five metres each. The first section is 0 to 5, the second is 5 to 10, and so on. As the sprinkler rotates, each of these sections forms a ring. The area in the first ring (0 to 5 metres) is approximately 78 square metres; the second ring (5 to 10 metres) is approximately 235 square metres; ring three is approximately 393 square metres; four is approximately 549 square metres; and the fifth and furthest ring (20 to 25 metres) covers an area of approximately 706 square metres.

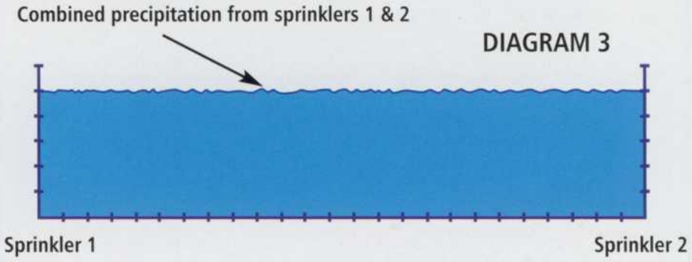
What is significant is the ratio between the areas. For example, the second ring has three times the area of the first ring; the third ring has five times the area of the first ring; the fourth ring has seven times the area of the first ring; and the fifth ring has nine times the area of the first ring (see Diagram 2).



This data shows us that if we had only one sprinkler, it would be very difficult to distribute water evenly over the sprinkler's entire coverage area. Thus, sprinkler distribution profiles are designed to take the shape of a triangle (highest near the sprinkler and lowest at the end of its radius). This is why most manufacturers recommend that the space between sprinklers be equal to their radius. This locating - or spacing - is commonly called 'head-to-head' spacing and it offers a significant benefit.

'HEAD-TO-HEAD' SPACING

If two sprinklers have the same distribution pattern, and are placed opposite each other, separated by the distance of their radii, the result is greatly improved distribution over the area between them. Both sprinklers contribute to the total watering between the sprinklers, and where one distributes less water, the other distributes more water. This complementary distribution continues over the entire distance between the sprinklers, producing an even and beneficial water distribution pattern (see Diagram 3).



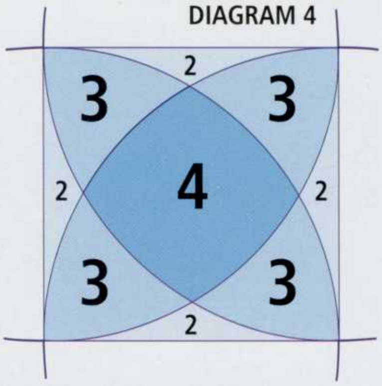
This is usually the ideal spacing, as opposed to sprinklers being over-spaced - too far apart from one another - or under-spaced - too close together, both of which produce less-than-optimum efficiency. A common symptom of sprinklers that are over-spaced appears during the hottest season of the year, when dry rings of grass tend to form within the first two to eight metres around the sprinklers. The only way to overcome this is to operate the sprinklers for much longer run times. While this may reduce these dry rings, it can also create wet spots in the centre of the patterns between the sprinklers.

A symptom caused by under-spacing sprinklers is wet spots in approximately the first five metres around each sprinkler. Greenkeepers commonly have to reduce sprinkler run times in this situation, which can result in dry spots in the centre of the patterns.

Golf courses with sandy soils may not display these symptoms as much, but the result will be the same, and a greenkeeper will use and waste more water than is necessary. This improper spacing reduces efficiency, resulting in higher than necessary costs and possible turf damage.

APPLICATION UNIFORMITY

We begin by noting that when we discuss 'pattern uniformity,' we are considering the area included between all of the sprinklers that create the pattern. This is important because any area that is not an 'included' area - 'included' meaning 'surrounded by sprinklers', will not receive the same 'effective' coverage. For instance, if you looked at a two row system, double row of sprinklers down the fairways, the grass in the area between the sprinklers will receive much better watering than the grass on the outside of either row of sprinklers. You can certainly still grow grass outside the rows of sprinklers, but you cannot water it as efficiently as the grass inside. Because of this, it is highly recommended that important turf areas are irrigated as parts of the 'included areas' between patterns of sprinklers.



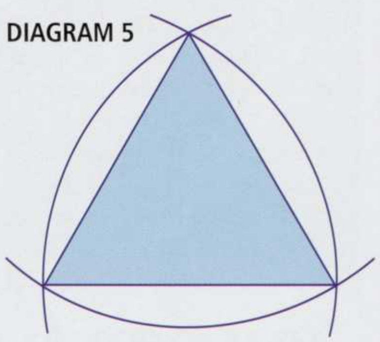
In a Square pattern, with a sprinkler at each corner, this is the effect of how many sprinklers are applying coverage to the various areas of the entire pattern.

Now let's focus on the affects of various types of sprinkler patterns. The two most common pattern types are square, sometimes called 'rectangular', and triangular, sometimes called 'equilateral triangular'.

Square patterns are very simple and until about 10 years ago, they were the most commonly used patterns worldwide. The biggest drawback of square or rectangular spacing is the fact that each of the four sprinklers, even when spaced at head-to-head distances, cannot spray across the entire pattern. As a result, some areas within the pattern receive water from four sprinklers, other areas receive water from three sprinklers and some receive water from only two sprinklers (see Diagram 4).

This can cause problems and these types of patterns tend to be less efficient than triangular patterns of the same distance with the same sprinklers. Square spacing is also more susceptible to suffer from the adverse effects of wind. The pattern is made by four sprinklers, none of which throws completely across the pattern, and wind tends to shorten the radius throw even more. This causes greater variance throughout the pattern. This is why professional consultants commonly recommend triangular spacing in windy areas.

Another advantage of triangular spacing, particularly equilateral triangular spacing, is that all three sprinklers throw across the entire 'included' pattern (see Diagram 5). This usually creates the highest pattern uniformities, and thus is the most efficient in terms of water usage and application uniformity.



In a Triangular pattern, each of the 3 sprinklers contributes to coverage across the entire pattern

ADJUSTING FOR WIND

Another design technique commonly used in known windy areas is to use shorter-radius sprinklers and closer spacing. Instead of using 24-25 metre spacing, spacing of 19-21 metres might be used in a windy area. There are two main reasons for the short radius approach:

1. Water particles that have to travel further, say 25 metres instead of 20 metres, spend more time in the air, and thus are more prone to be affected by the wind.

2. To travel the further distance, the water droplets go higher and are again more susceptible to the effects of the wind. The shorter radius lowers the maximum height of the distribution.