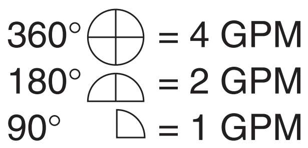
# The Basics of Matched Precipitation

Precipitation rate is the speed at which water is being applied to a specific area. When designing an irrigation system, it is important to ensure that the precipitation is even over each area or zone of coverage. To accomplish this, examine the amount of water falling into each individual area from all sprinklers supplying that area. Then, either select the appropriate nozzles, or zone together sprinklers with the same precipitation rate.

In other words, the criteria to consider are flow rates and arcs of coverage. The following illustration depicts three different sprinkler heads with matched precipitation rates.




At first glance, it may not be apparent that the rates are matched. However, in each case, one gallon per minute (GPM) is applied to each quarter circle (assuming the radius of throw is the same for each head), and thus precipitation is matched.

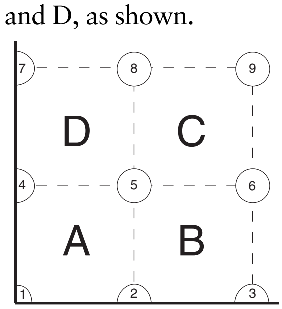
Let's look at the mathematics of this example. If the radius of the full-circle head is 30 feet, which is typical for a mid-range sprinkler, using the formula for finding the area of a circle ($\pi R^2$), we calculate its total area of coverage is 2,827 square feet: $3.1415 \times 30^2 = 2827$. Then, using the precipitation-rate formula (GPM x 96.3 ÷ area), we find the average precipitation rate over the full circle is 0.136 inches per hour: $4 \times 96.3 \div 2827 = 0.136$.

The area covered by the half-circle is exactly half that of the full-circle head. The discharge rate is also half that of the full-circle head or 2 GPM. Therefore, the precipitation rate over the half circle area is 0.136 inches per hour: $2 \times 96.3 \div 1414 = 0.136$.

Similarly, the area covered by the quarter-circle sprinkler is half that of the half-circle head. With a 1 GPM nozzle, the precipitation rate over the quarter-circle is 0.136 inches per hour as well.

If, however, nozzles with the same flow rate (say 4 GPM) were used on all three heads, the precipitation rates would be 0.136, 0.273 and .0545 inches per hour, respectively. In this situation, the corners of an irrigated area covered by quarter-circle heads (0.545 in./hr.), would flood long before enough water could be applied to the areas covered by the full-circle sprinklers (0.136 in./hr.).

To make this clearer, let's examine a nine-head section of an irrigation system, assuming that 4 GPM nozzles are installed on all sprinklers, which are thirty feet apart on a square grid. The area covered by these nine sprinklers can be considered as four subsections, labeled A, B, C, and D, as shown.




Looking first at Area A, you can see it is watered by Sprinklers 1, 2, 4, and 5 – a quarter circle head, two half-circle heads, and one full-circle head, respectively.

Area A receives 100% of the discharge from the quarter-circle head, 50% of each of the two half-circle heads, and 25% of the output of the full-circle head. If each head is supplying 4 GPM, the precipitation rate over Area A is computed as follows:

1. Find the total GPM for area A.

| | | |
|---|---|---|
| 100% of Sprinkler 1 | = | 4 GPM |
| 50% of Sprinkler 2 | = | 2 GPM |
| 50% of Sprinkler 4 | = | 2 GPM |
| 25% of Sprinkler 5 | = | 1 GPM |
| | | 9 GPM |

2. Apply the precipitation-rate formula.

Avg. precip. over Area A =
9 GPM x 96.3 ÷ (30 ft. x 30 ft.)=
0.963 inches per hour.

Next, Area B receives 50% of the discharge of the two half-circle heads (Sprinklers 2 and 3), and 25% of the discharge of Sprinklers 5 and 6, which are full-circle heads (note that the size of Area D is the equivalent of Area B).

1. If each head is supplying 4 GPM, the total GPM for Area B is:

| | | |
|---|---|---|
| 50% of Sprinkler 2 | = | 2 GPM |
| 50% of Sprinkler 3 | = | 2 GPM |
| 25% of Sprinkler 5 | = | 1 GPM |
| 25% of Sprinkler 6 | = | 1 GPM |
| | | 6 GPM |

2. The precipitation rate is:

Avg. precip. over Area B =
6 GPM x 96.3 ÷ (30 ft. x 30 ft.)=
0.642 inches per hour.

Finally, Area C is affected by four full-circle heads (Sprinklers 5, 6, 8, and 9).

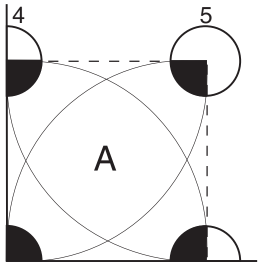
Each contributes 25% of its output to this area, so each head contributes 1 GPM to this area, for a total of 4 GPM. Thus, the precipitation rate for Area C is:

Avg. precip. over Area C =
4 GPM x 96.3 ÷ (30 ft. x 30 ft.)=
0.428 inches per hour.

These precipitation rates are quite different – if you are going to use nozzles with the same flow rate on quarter-circle, half-circle and full-circle heads, it will be necessary to zone each type of head separately. And further, you will have to run the heads for different periods of time to achieve matched precipitation, or areas of flooding or stress will result. (See Hunter's LIT-088 for information on scheduling.)

Now let's look at the same nine-head section of a system set up for matched precipitation. Assume that 4 GPM nozzles are installed in the full-circle heads, 2 GPM nozzles in the half-circle heads, and 1 GPM nozzles are in the quarter-circle heads. Remember, when examining precipitation rates, we are looking at the amount of water coming from each sprinkler into the area in between the sprinklers.

Let's start with Area A again.



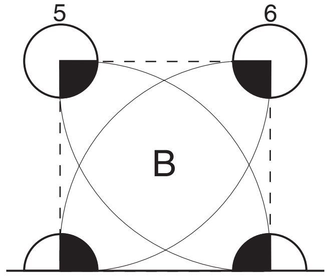

Sprinklers 1, 2, 4, and 5 are a quarter-circle head, two half-circle heads, and one full-circle head, respectively. The total GPM for the area is:

| | |
|---|---|
| 100% of Sprinkler 1 (1 GPM) = | 1 GPM |
| 50% of Sprinkler 2 (2 GPM) = | 1 GPM |
| 50% of Sprinkler 4 (2 GPM) = | 1 GPM |
| 25% of Sprinkler 5 (4 GPM) = | 1 GPM |
| | 4 GPM |

and the precipitation rate is:

Avg. precip. over Area A =
4 GPM x 96.3 ÷ (30 ft. x 30 ft.)=
0.428 inches per hour.

Area B is affected by Sprinklers 2, 3, 5, and 6.




These are two half-circle heads with 2 GPM nozzles, and two full-circle heads with 4 GPM nozzles. The total GPM is:

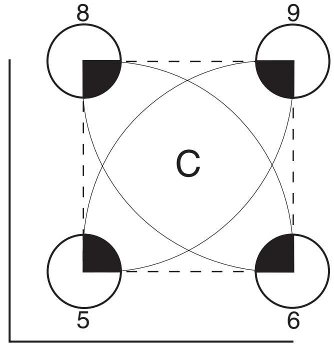
| | |
|---|---|
| 50% of Sprinkler 2 (2 GPM) = | 1 GPM |
| 50% of Sprinkler 3 (2 GPM) = | 1 GPM |
| 25% of Sprinkler 5 (4 GPM) = | 1 GPM |
| 25% of Sprinkler 6 (4 GPM) = | 1 GPM |
| | 4 GPM |

and the precipitation rate is:

Avg. precip. over Area B (and D) =
4 GPM x 96.3 ÷ (30 ft. x 30 ft.)=
0.428 inches per hour.

Finally, Area C is unchanged.

With four full-circle heads (Sprinklers 5, 6, 8, and 9) each contributing 25% of its 4 GPM




output to this area, the total for the area is 4 GPM.

Avg. precip. over Area C =
4 GPM x 96.3 ÷ (30 ft. x 30 ft.)=
0.428 inches per hour.

Thus, the four areas will be receiving the same amount of water per hour, and the different patterns (quarter-circle, half-circle, and full-circle) can be zoned together. If the sprinklers are assigned to more than one zone, the zones can be set to run the same amount of time, depending on the needs of the landscape.

As you can see, it is important that sprinklers are nozzled and zoned in a manner that provides even coverage. Designing and installing systems with matched precipitation in mind will reduce flooding and stress problems, as well as save water.

*For additional information, refer to the following Hunter publications: LIT-087, "Sprinkler Spacing" and LIT-088, "Scheduling Irrigation."*

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