Oakes Irrigation Research Site
Field Day Set for Aug. 27

The Oakes Irrigation Research Site field day will be held on Wednesday, Aug. 27. The field day begins with refreshments and rolls at 8:45 a.m. The tour starts at 9 and ends about 11:30 a.m.

The 20-acre irrigation research site, associated with the Carrington Research Extension Center, is 4.5 miles south of Oakes on the west side of North Dakota Highway 1.

The field day will provide the opportunity to present new research-based information and showcase research projects being conducted at Oakes. Topics that will be covered and the presenters are:

• Corn plant development this season and a review of the new nitrogen fertilizer recommendations, Joel Ransom, NDSU Extension agronomist
• Updates on managing white mold (sclerotinia) disease in dry bean and soybean, Michael Wunsch, Carrington REC plant pathologist
• Highlights of soybean production research and recommendations, Greg Endres, Carrington REC Extension agronomist
• Impact of residue removal and nitrogen fertility in strip-till corn, Endres and Mike Ostlie, Carrington REC research agronomist
• Resistant-weed management in soybean and corn, Ostlie

Sulfur fertility research in corn, Jasper Teboh, Carrington REC soil scientist

Results and experiences from a regional energy/industrial beet project, Blaine Schatz, Carrington REC director

Tour participants also will have the opportunity to review the site’s irrigated corn hybrid and soybean performance tests.

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Water Tours – North Dakota
Water Education Foundation

Missouri River Expedition – Aug. 20

This tour begins and ends in Bismarck. Explore the incredible Missouri River and learn about critical Missouri River issues, including bank stabilization, fishing, recreation, water use and management, endangered species, natural resources and water quality. The expedition includes visits to recreation and historic sites in the region, including the Garrison Dam and Fish Hatchery and the Knife River Indian Villages, and ends with an hourlong cruise of the Missouri River aboard the Lewis and Clark Riverboat.

These tours provide a firsthand look at North Dakota’s critical water issues. Registration is $20 per person and includes tour transportation, meals, refreshments, informational materials and a one-year subscription to North Dakota Water magazine.

To register for one or more of these tours, go to www.ndwater.com/programs and click on “Summer Water Tours” in the left-hand menu or send a check to NDWEF, P.O. Box 2254, Bismarck, ND 58502. Please indicate which tour or tours you want to attend and include the number of people who will be attending. For more information, give us a call or send an email.

North Dakota Water Education Foundation,
(701) 223-8332 Fax (701) 223-4645
ndwaterusers@btinet.net
Irrigation Management – Using the Irrigator’s Formula

A simple, effective irrigator’s formula can be used to calculate two important parameters needed for good irrigation water management. This simple formula has been used for more than 100 years, primarily with surface irrigation methods, to determine the average depth of water application or the time needed to apply a certain depth of water to a field.

The formula assumes the entire surface of the soil will receive water, so it works best with surface and sprinkler irrigation. However, with some modifications, it also can be used with drip irrigation. Here is the formula:

\[ \text{Flow rate} \times \text{application Time} = \text{average Depth of application} \times \text{irrigated Area} \]

Using variables:
- \( Q \) – Flow rate in cubic feet per second
- \( D \) – Average depth of water application in inches
- \( T \) – Time of water application in hours
- \( A \) – Area of water application in acres

To use it with flow rate in gallons per minute (gpm), the formula is:

\[ Q = 453DA \]

This formula can be rearranged easily and used with surface irrigation, sprinkler irrigation and drip irrigation water management.

**Surface Irrigation**

The irrigator’s formula, as presented above, works with surface irrigation systems where no or very little runoff (tailwater) occurs, such as level basins or sloping fields with blocked ends. For systems with tailwater, the volume leaving the field has to be measured or accurately estimated and subtracted from the volume applied.

For planning purposes, knowing about how long an irrigation set will take to apply a certain depth of water always is helpful. To use this formula with surface irrigation, the important variable is usually the depth, \( D \), so the formula takes the form:

\[ D = QT/(453A) \]

For example, say you have an alfalfa field where the borders are 60 feet apart and 1,200 feet long, and you want to know the average depth of water applied to the field after two hours. Each border is about 1.65 acres in size (60 x 1,200/43,560). If your pump put out 1,500 gallons per minute (gpm) and this was applied to one border, in two hours, an average of 4 inches would be applied (1,500 x 2/(453 x 1.65)). This assumes the water can flow to near the end of the border in two hours.

If you did two 1.65-acre borders with this flow at the same time, then applying 4 inches to both borders would take about four hours. However, if the field had not been leveled in a few years and reaching the end of the field took the water five hours, then an average depth of about 10 inches of water would be applied to a single irrigated border and about 5 inches would be applied if two borders were irrigated at the same time.

**Sprinkler Irrigation**

For sprinkler irrigation systems, quite often the time to apply a certain depth of water is the necessary variable to calculate. For this situation, the formula takes the following form:

\[ T = 453 DA/Q \]

For example, you have a center pivot that covers about 128 acres and a well and pump that produce 800 gpm, and you want to determine the number of hours to pump 1 inch of water to the field. Using the formula above, this would take about 73 hours (453 x 1 x 128/800).

Of course, with sprinkler systems, the pumped amount of water that actually gets into the soil is less than 1 inch. The average sprinkler application efficiency for center pivots is about 85 percent, so that means putting about 0.85 inch of water into the soil for the plants to use takes 73 hours.

Let’s look at another example, this time using the irrigator’s formula with a traveling big-gun sprinkler system. If you have a big gun on a field with 400-foot spacing between travel lanes 1,300 feet long and are supplying 400 gpm to the big gun, how long does applying 1.5 inches of water take?

The area covered is about 12 acres (400 x 1,300/43,560). The formula shows the travel time down the length of the lane will be about 20 hours (453 x 1.5 x 12/400). However, the average application efficiency of big-gun sprinklers is about 70 percent, so only a little more than an inch of the pumped water gets into the soil.

**Drip Irrigation**

To use the irrigator’s formula with drip systems, you have to make some adjustment to the area term (A) in the formula. Drip irrigation, sometimes called trickle irrigation, often is used in situations where the rows of plants are spaced far apart and water need not be applied to the entire surface area. For example, on grape vines, the drip lines may be 8 feet apart but water is needed only in a 4-foot-wide band near the roots. In this case, the area covered is a half an acre out of one acre of grape vines.

Drip irrigation is designed with zones, and often the length of time to apply a certain depth of water is needed...
to program the controller. With smaller drip systems, the depth of water applied needs to be calculated.

For example, you have a row of raspberries 800 feet long being irrigated from a farm hydrant that produces around 10 gpm, and during a dry period, you want to apply 1 inch of water. Assuming the root width is about 4 feet, the area covered is about 0.075 acre (4 x 800/43,560). The time you need to apply 1 inch at 10 gpm is 3.4 hours (453 x 1 x 0.075/10).

In a situation like this where the raspberries shade the ground, the drip irrigation system has an application efficiency around 98 percent, so just about all the pumped water gets into the soil for the raspberries to use.

These are just a few examples, but you can see the irrigator’s formula is very useful and can be manipulated easily to help manage irrigation water efficiently.

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**Wheel Tracks Under Center Pivots**

Every irrigator with a center pivot knows that the wheel tracks under some towers can turn into deep ruts in parts of their fields. Variations in soil texture and slope cause ruts to vary in depth across a field. Finding wheel tracks up to 6 inches deep, even on very sandy soil, is common, but when the wheel track is 12 inches or deeper, that is a time for concern.

Deep wheel tracks are caused by saturated conditions that reduce the weight-bearing capacity of soil. The deepest wheel tracks usually are found where water collects in low spots or under the first and second towers from the pivot point. Deep wheel tracks can cause drive wheels on towers to get stuck and trip the safety circuit on a center pivot. They also interfere with tillage and harvest operations.

**Major factors that affect the depth of pivot wheel tracks are:**

- **The soil type** – Usually locations in the field with heavier soils (clay, clay loams) have deeper tracks because they remain wet longer due to higher water-holding capacity and slower drainage. Deep wheel tracks commonly form in the low spots where water accumulates. Often the wheel track acts like a drainage canal, where rain and irrigation water runs down the wheel track to the low spot.

- **The number of revolutions the pivot makes in the tracks before tillage levels them**

- **The weight supported by each tower** – Short spans between towers (130 to 170 feet) have less weight than long spans (180 to 200 feet).

- **The amount of wheel contact area with the soil surface**

**Control of wheel track ruts is very simple:**

Control the water that is applied near the tower or can flow into a track. You can reduce deep wheel track problems using management or mechanical solutions. Some of the management methods you might use are:

- Schedule irrigation water applications to avoid unnecessary pivot revolutions.

- Allow the soil surface, especially the soil in the wheel track, to dry between irrigation events. Sometimes this option is not feasible after a full crop canopy develops and shades the wheel tracks.

- On sloping areas where deep wheel tracks form every year, use surface or subsurface drainage to move the water out of the wheel track.

- Keep tire pressure at the manufacturer’s recommended level. This will maintain the proper amount of tire contact area.

- If you have deep wheel tracks in a perennial crop such as alfalfa, consider cutting and harvesting within the circles. If you have deep wheel tracks in only the low areas of your field, consider filling the bottom of the wheel tracks with crushed rock (1 to 3 inches in diameter). This will provide more load support for the towers.

- During the season, observe the pivot while it operates. If excessive ponding occurs where the deep wheel tracks are formed, you have to reduce the amount of water applied to that location.

**Here are some of the mechanical changes you can make to help your pivot system reduce deep wheel tracks:**

- **Build a road for the tower wheels.** Running the system to mark the wheel track location, then using a plow, disc plow or blade to build a ridge where the track is can do this. Be sure to pull soil from both sides of the track.

- **Manufacturers of pivot systems offer a wide range of options to minimize deep wheel tracks.** These options include changing to a larger tire size, adding one or two more wheels to each tower and/or adding tracks to the wheels. Adding larger tires may require increasing the size and strength of the drive mechanism.

- **Put directional sprinklers on either side of a tower.** This directs water away from the wheel track. Some growers are using extra-long drop tubes on the two
sprinklers on either side of a tower. The drop tube drags a weighted, directional sprinkler head that sprays water behind the wheels, thus keeping the wheel track dry.

- Attach track-closing disks to each tower. A disk on each side of the track pushes soil into the track as the tower moves through the field. A problem with using this option is the pivot can be moved only in one direction.

- The sprinklers near the tower can be located on "boom backs." The boom back allows the sprinkler to apply water to the soil behind the wheel so that the track is dry when the tower passes. As in the previous suggestion, the pivot can be moved only in one direction.

The technology to address deep wheel tracks always is changing, so a visit to some irrigation dealers or checking their websites can provide other options. Remember, there is no one right solution to deep wheel tracks; you may need two or three of the options mentioned to alleviate the problem.

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