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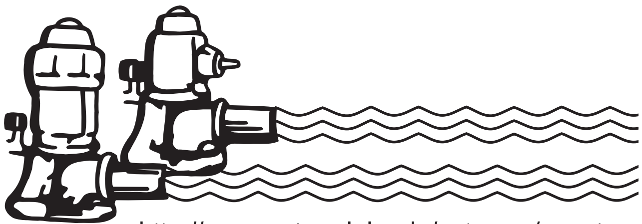

water spouts

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http://www.ext.nodak.edu/extnews/snouts

Field Days and Irrigation Tours for 2003

Streeter Central Grasslands Research Extension Center	June 25	(701) 424-3606
Minot – Canola Day North Central Research Extension Center	June 25	(701) 857-7677
Mandan – USDA/ARS Northern Great Plains Research Laboratory	June 26	(701) 663-6445
Fargo/Casselton Weed Tour	July 1	(701) 231-8157
Hettinger Research Extension Center	July 8	(701) 567-4323
Dickinson Research Extension Center	July 9	(701) 483-2348
Williston Research Extension Center	July 10	(701) 774-4315
Carrington Research Extension Center ***Irrigation Research***	July 15	(701) 652-2951
Minot North Central Research Extension Center	July 16	(701) 857-7677
Langdon Research Extension Center	July 17	(701) 256-2582
Sidney, Mont. Eastern Ag Research Center	July 23	(406) 482-2208
Oakes Irrigation Research Site	Aug. 19	(701) 742-2189

Chemigation Management

The injection of any chemical, such as nitrogen, phosphorus or a pesticide, into irrigation water and applied to the land using the irrigation system is called chemigation. The proper use of chemigation is recognized as a “best management practice” (BMP) for irrigated agriculture. However, to use chemigation to benefit your crop production, you must understand the equipment, management requirements and limitations.

Chemigation can be used with sprinkler, drip and surface (gravity) irrigation systems. The most common chemicals applied with chemigation in North Dakota are liquid forms of nitrogen, fungicides, herbicides and insecticides. Liquid nitrogen in the form of UAN 28 is the most common chemical injected into irrigation systems. To use pesticides for chemigation, the label of the pesticide container must indicate that it can be injected into the type of irrigation system you are using or else it cannot be used. For example, if you have a center pivot, the label has to specifically say the pesticide can be injected into the irrigation water and applied by the center pivot.

Chemigation in North Dakota is used almost exclusively on center pivot sprinkler systems. Chemigation is **not recommended** for use with volume guns (big guns) due to poor application uniformity and wind drift problems. Chemigation can be used with other forms of sprinkler irrigation such as wheel rolls and solid set systems.

Chemigation equipment requirements have been incorporated into the North Dakota Century Code. The law specifically requires the following equipment:

1. An anti-siphon device on the main water line
2. A backflow device in the chemical line
3. A pressure sensor on the pressurized water line
4. An inspection port (to check the operation of the check valve)
5. An injection port downstream from the anti-siphon device

6. A chemical-resistant injection pump
7. Interlock between the water pump and the injection pump (either mechanical or electric).

Chemigation with center pivots

The type of sprinkler package on a center pivot can have a large effect on the degree of benefit the crop derives from the applied chemical. Sprinkler uniformity, wind speed during chemigation, application rate and application amount in conjunction with the characteristics of the applied chemical all contribute to the effectiveness of the applied chemical.

Sprinkler uniformity is critically important because the objective of chemigation is to apply the same volume of chemical to each square foot of the field surface. Sprinkler uniformity can be checked with a "catch can test." A can test involves measuring the amount of water applied at two or more locations under each span of the pivot. This can be done with rain gauges or plastic cups, but they all must be of identical construction. After the pivot goes over the cans, the amount in each can and its location in the field should be recorded. The average application amount should be computed and the individual can amounts compared. If any deviate from the average by a large amount, then there is probably a problem with sprinklers at that location on the pivot. While running the can test, you should walk the length of the pivot and check for broken sprinklers and pipeline leaks. If any are found, they should be fixed before chemigating.

Chemigating with the endgun on is not recommended for pesticides because of wind drift and usually poor uniformity under the area irrigated by the endgun. Chemigation should not take place when the wind speed is greater than 10 miles per hour (mph), but in North Dakota it is difficult to find days with low wind. A compromise would be to start chemigating in the early evening when wind speeds generally decrease.

The type of sprinkler package and height of the sprinkler head above the ground affect the application rate of a pivot. Application rate is expressed in inches per hour and the peak application rate of a sprinkler system will determine how much runoff will occur. The application rate of a center pivot is greatest under the last span and overhang. Coincidentally, the last span and overhang cover the most irrigated area of the field.

Injecting nitrogen

A question often asked is how much nitrogen should be injected during each chemigation event. The most common amounts injected are from 10 to 30 pounds actual nitrogen (N) per acre (lbs/ac). How much to inject is dependent on the crop, growth stage, the amount applied previously, yield goal and soil type. By the time corn is chest high, it has a deep root system, so applying 30 lbs/ac would be reasonable. This may only be required once in the growing season, depending on how much N was previously applied. However, if you have a shallow soil, which restricts full corn root development, you may want to put on two applications of 15 lbs/ac. The root depth of potatoes is only two feet, so smaller amounts of 10 to 20 lbs/ac of N applied more frequently are desirable so the N is not lost to leaching events caused by summer storms.

Another question asked is, "How much water should be put on with the N?" Since you want to get the N to the roots, chemigating with N during a regular irrigation event is the most desirable. If circumstances are such that you need to apply the N and are not concerned about the amount of water, than the timer should be set to apply at least a quarter of an inch.

Injecting fungicides and insecticides

Fungicides are either protectants or systemic. Protectant fungicides applied by chemigation provide protection to the plant by coating the above-ground biomass of the plant. Systemic fungicides work by being absorbed by the plant and providing protection from the inside of the plant through the tissues. For both types of fungicides and insecticides, the object is to cover the plant but not wash off the pesticide by putting on too much water.

Irrigation engineers always worry about maximizing water application efficiency of sprinkler systems and interception losses by the crop canopy is always one of the major evaporation losses. Ironically, the "interception losses" of water are exactly what you are trying to optimize when chemigating with fungicides and insecticides. Therefore, low application amounts are applied. Typically, the pivot timer is set at 100 percent, which applies about a tenth of an inch of water.

Injecting herbicides

Herbicides have two modes. Either they are applied before weed emergence or they are applied after weed emergence. If you are applying pre-emergent herbicides, you want the water containing the herbicide to penetrate at least four inches into the soil. Selecting an application amount from 0.25 to 0.5 inches will accomplish this very well. If you are applying a post-emergent herbicide, the pivot timer would be set to 100 percent and the application amount would be about one tenth of an inch.

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Small Grain Irrigation Management

Interest has recently increased in growing irrigated small grain as a rotational crop with high-value crops. This article will briefly review small grain irrigation basics and recent work by North Dakota State University (NDSU).

Small grain generally can be intensively managed under irrigation similarly to dryland production. It is important to maintain high-yield potential with optimum stand establishment and crop protection strategies. Timely planting and establishment of a stand of 1.5 million wheat plants/acre is important. Necessary strategies also include providing sufficient nitrogen (N) throughout the growing season to match grain yield and quality (protein) goals, and using fungicides for seed, foliage and head protection from disease.

Other factors to consider with irrigated small grain include economics, variety selection and water management. Does wheat or barley have higher economic potential compared to corn or other rotational crops?

Small grain varieties differ in response to intensive management under irrigation. Averaged over two years (2001-02) at the NDSU Carrington Research Extension Center, wheat varieties yielded 58.5 bushels (bu)/acre with irrigation compared to dryland yield of 44.8 bu/acre. Among a database of 27 varieties, the hard red spring (HRS) wheat varieties with the greatest response to irrigation included Amidon, Ember, Hagar, McVey and Mercury.

During the same period, nine barley varieties averaged 84.7 bu/acre with irrigation compared to dryland yield of 70.2 bu/acre. The barley varieties with the greatest response to irrigation included Conlon, Foster, Lacey, Morex and Robust. Besides additional water, the irrigated trials were fertilized for a higher yield goal and foliar fungicides were used. The variety databases are available by contacting the Carrington Research/Extension Center at (701) 652-2951 or visiting this Web site: *www.ag.ndsu.nodak.edu/carringt/agronomy_program.htm* .

Water management includes providing sufficient amounts of water for the crop to minimize moisture stress. As a rule of thumb, wheat requires about six inches of water as a threshold for grain yield and each additional inch of water will provide four to five bu/acre. Water stress during the tillering stage (three- to five-leaf) will reduce the number of heads/acre and number of seeds/spike (head).

Water stress during pollination will reduce the number of seeds set/spike and during seed fill, the weight per seed. Average water use (inches/day) for wheat and barley is about 0.15 during tillering, 0.30 during boot-to-dough stage and 0.20 to 0.27 during dough stages. NDAWN provides daily, in-season estimates of crop water use *(http://ndawn.ndsu.nodak.edu/index.html)*. Estimating water use and irrigation scheduling requires knowledge of crop status (e.g. growth stage and rate, rooting depth and canopy), soil characteristics (e.g. water-holding capacity) and weather conditions.

An intensively managed, irrigated HRS wheat trial has been conducted at the Carrington Center since 2001 and continues in 2003. The trial factors include HRS varieties, nitrogen fertility and three irrigation strategies. Varieties tested include Alsen, Briggs, Keene, Russ, Reeder, Dandy and Norpro. N fertilizer is applied according to recommendations for 60-, 80- or 100-bu/acre yield goal. During the first two years of the trial, wheat response to the intensive management has been limited.

References available for review on this subject include the following:

- NDSU Extension Service publication SF-101 "Irrigation of Small Grains."
- NDSU Extension Service publication AE-792 "Irrigation Scheduling by the Checkbook Method."
- Irrigation of Cereal Crops, Saskatchewan Water Corporation.
- A Report of Agricultural Research and Extension in Central North Dakota, 2002, NDSU Carrington Research Extension Center. Volume 43.

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Center Pivot Sprinkler Packages

The sprinklers on a center pivot are the most important part of the irrigation system, but are sometimes the least understood.

The set of sprinklers on a pivot are called the "sprinkler package." The area covered by each sprinkler increases as it gets farther from the pivot point, which results in larger-diameter nozzles at the end of the pivot. A computer program is used to select the nozzle diameter used in each sprinkler from the pivot point to the end. To do this, the program needs specific operational information about the center pivot. Accurate estimates needed to design the sprinkler package include: the flow rate, pivot point pressure, type of sprinkler head, pivot length, use of drop tubes, maximum elevation change along the pivot and whether an endgun will be used.

A properly designed sprinkler package will apply water uniformly over the entire length of the pivot. Uniform application of water is very important, especially for high-value crops (potatoes) and chemigation.

The application rate of the sprinkler package is the amount of water applied in a period of time (Table 1). It must be matched to the intake rate of the dominant soil in the field (Table 2). Generally, low-pressure sprinklers have a higher application rate than high-pressure sprinklers. Low-pressure sprinklers have a smaller diameter of throw and consequently apply a given amount of water in a shorter period of time.

Table 1. Sprinkler application rates at the outer tower of a center pivot. Values were calculated for a pumping rate of 800 gallons per minute applying 1 inch of water and a pivot revolution time of 84 hours.

	Application Rate	
Diameter of Throw	Average	Peak
(feet)	(inches/hour)	(inches/hour)
10	9.8	12.2
20	4.9	6.1
30	3.3	4.1
40	2.5	3.1
50	2.0	2.5
60	1.6	2.0
80	1.2	1.5
100	0.98	1.23
150	0.65	0.82

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Table 2. Typical infiltration rates for various soil types.

Soil Texture	Average Infiltration Rate	Infiltration Rate
	(inches/hour)	(inches/hour)
Sandy	2	1.0 to 10.0
Sandy loam	1	0.5 to 3.0
Loam	0.5	0.3 to 0.8
Clay loam	0.3	0.1 to 0.6
Silty clay	0.1	0.01 to 0.2
Clay	0.2	0.05 to 0.4

The highest application rates occur near the last tower of the pivot because it is the point of fastest travel.

The diameter of throw of a sprinkler is dependent on the pressure, the sprinkler head design, the nozzle diameter and the height above the ground. A spray nozzle mounted on drop tubes may have a diameter of throw of 10 to 15 feet, however, if it is mounted on the span pipe of the pivot, its diameter of throw could be from 20 to 30 feet. Low-pressure impact sprinklers will generally have a greater diameter of throw than a sprinkler mounted on a drop tube.

The intake rate of a soil is its capacity to absorb irrigation water from the surface and move that water into the soil profile. The intake rate is affected by soil moisture content, soil pore size, cracks, vegetation and crusting. However, the main controlling factor of intake rate is the soil texture. Coarser-textured soils have high intake rates and finer-textured soils have low intake rates (Table 2).

The potential for runoff exists if the application rate of a sprinkler system exceeds the soil intake rate. Runoff is water that leaves the field or ends up in low spots in the field rather than where it was applied. Runoff is affected by slope and surface storage. Roughness and residue on the soil surface increase surface storage, thereby reducing runoff.

If you are putting up a new pivot or planning to change the sprinkler package on an existing pivot, select a sprinkler package that fits the soils in the field. Check the county soil survey book. It will provide information about the soils in the field where the pivot is located and the range of intake rates for those soils. Check the amount of slope in the field. Consult with your irrigation dealer or sprinkler supplier about the application rate of the sprinkler package you are considering. Then select a sprinkler package that has an application rate that matches the soil intake rate and field slope.

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