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water spouts

No. 259 September 2011

Why is Well Development Important?

During the last few growing seasons, rainfall has been timely and of the right amounts, and the water levels in most aquifers are high. Consequently, the number of hours many irrigation systems have run has been reduced greatly.

However, that doesn't mean the well and screen have not been affected. They may be plugging slowly, but this won't be recognized until lower aquifer water levels happen in response to more pumping during dry periods. To keep your well in good working condition, it should be chlorinated properly every year, and if it is an older well, it may need redevelopment.

I often hear irrigators say they don't want to pay for the cost of development because it doesn't help with well performance. If the well isn't developed properly, that might be a true statement. However, if the well is developed properly at the time of construction, it will have less drawdown, save on pumping costs and have less trouble supplying water during high water-use periods. As energy costs increase, anything that reduces the drawdown in a well will pay big dividends in the future.

A well provides access to the aquifer, where the water is located. During pumping, if a well is functioning properly, the water from the aquifer will enter the well screen with the lowest amount of restriction possible. Anything that restricts the flow of water into the well can affect energy costs and flow rate by increasing the drawdown.

The drawdown is the difference between the static water level and the pumping water level, Figure 1. From a hydraulic point of view, drawdown is the head (pressure) required for water to flow into the well. The greatest amount of drawdown occurs within a few feet of the well, where the velocity is the greatest.

Most irrigation wells are constructed with a rotary drilling rig that uses a high-viscosity fluid (often called a "drilling mud") to keep the borehole open during the drilling process. Although necessary, the drilling mud seals the borehole and often penetrates into the surrounding aquifer formation.

In addition to the drilling mud, the rotary drilling process also smears the borehole surface, which compacts the natural material around the borehole. The most common drilling mud uses bentonite, a naturally occurring clay mined in Montana and Wyoming. If left in place after construction, the drilling mud will seal part of the aquifer and increase the drawdown.

After the casing and screen are set in the borehole, removing the drilling mud left in the aquifer formation is very important, Figure 2. This process is called well development. It is even more important with gravel-packed wells because the gravel pack is a barrier to removing the drilling mud.

Several methods for developing a well are available. They are in order of effectiveness as well as cost: air lift pumping and agitation, surging and jetting. Development is also very important after a well has been rehabilitated.

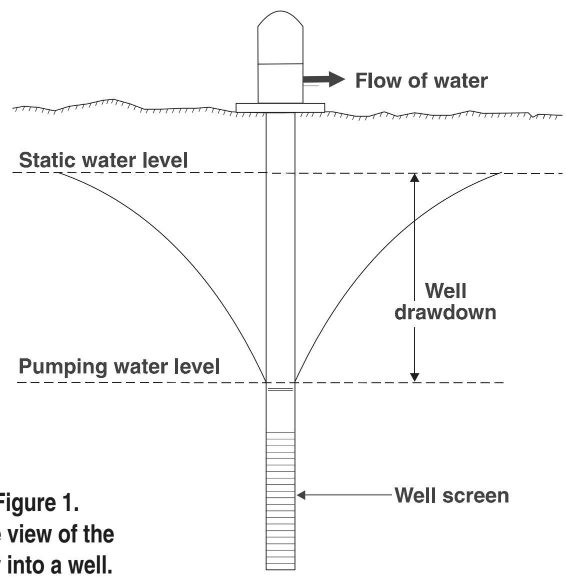

**Figure 1.
Side view of the
flow into a well.**

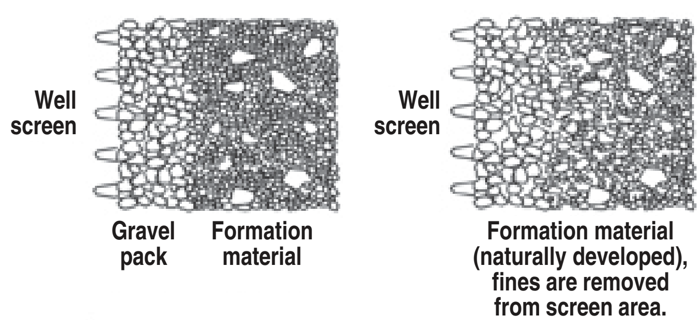

Figure 2. Side view of the materials just outside the well screen for a naturally developed and gravel pack well.

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Air Lift Pumping and Agitation

Air lift pumping forces compressed air through an air line to the bottom of the well. As air bubbles rise, they create a surging effect that carries water and fines out of the well. Air lift pumping is alternated with short periods of no pumping, which forces water out into the formation to help break up sand bridging around the screen. Well development is effective only if the water is deep enough in the well to get the surging action. Air lifting does not work if lift to the surface is too great.

Mechanical Surging

Surging alternately forces water into and out of the formation through the well screen openings. A pistonlike tool moves up and down in the well to create the surging action. The surging of the water through the well screen loosens the mud and fines in the borehole and draws them into the well to be removed by pumping or bailing. Surging is especially suited to cable tool drilling. While common for bridge or louvered-well screens, surging is not very effective with very deep wells (more than 200 feet) or those with multiple screens.

Jetting

The best well development method is high-pressure water jetting with simultaneous air lift pumping. High-velocity water jets through the screen and gravel pack into the formation to loosen and break down the fine materials. The jetting tool rotates slowly as it moves up and down inside the well screen. Air lift pumping removes the loosened sand and mud as they enter the well screen. The jet stream can be directed at any part of the formation around the well for selective development. Cage wound screen is best for jetting because its design allows the jet to impinge directly on the gravel pack or borehole. Well screens that use louvered or bridge openings do not respond to this type of development because the opening design interferes with the jet of water. Jetting is often the most costly development method.

Redevelopment of Older Wells

As water flows into a well, it carries minerals with it. With use, these minerals can build up on the formation materials near the well screen because that is where the water velocity is the greatest. This may sound counter-intuitive, but some minerals will precipitate at the high velocities. Through time, the deposition of minerals can encrust the screen and formation, which increases the resistance to the flow of water into the well.

By adding a weak acid to the well and combining that with agitation, these mineral deposits can be dissolved and removed. By combining water jetting with acid, the well can be redeveloped and often brought back to almost new production.

Caution: This method should be used only on stainless steel and plastic screen. Some older iron screens are susceptible to acid and may collapse.

Tom Scherer, (701) 231-7239
NDSU Extension Agricultural Engineer
thomas.scherer@ndsu.edu

NDAWN: Economic Benefit for N.D. Agriculture

The North Dakota Agricultural Weather Network (NDAWN) was established in 1989 by John Enz, former North Dakota state climatologist and professor emeritus of climatology in the Soil Science Department at North Dakota State University.

Originally, the network consisted of six automated weather stations. Today, 72 stations are operating in North Dakota and its neighboring states, primary in agricultural locations.

The principal benefits of the network are to provide weather information to the area growers and the crop-specific agricultural applications.

The NDAWN Center *(http://ndawn.ndsu.nodak.edu/)* has assisted many North Dakota growers in making weather-critical decisions concerning their crops, livestock and livelihood. The network provides weather data, which is instrumental in developing various agricultural models, including the late blight model; degree day and growth stage models for barley, corn, canola, potatoes, sugar beets, sunflowers, wheat and other small grains; irrigation scheduling; crop water use; sugar beet root maggot; and insect development.

For example, sugar beet growers in the Red River Valley utilize the NDAWN data for several applications that are designed to better inform the growers of the existing environmental conditions and help target optimum timing for applications of herbicide, insecticides and fungicides.

American Crystal Sugar Co. designed a new pest text alert system that utilizes NDAWN data, applies parameters and sends a text message to growers, company staff and allied industry members. The pest alerts are designed to be an early warning system for the onset of pending disease and insect problems (Figure 1). The pest alert system advises growers to apply fungicide treatment when the soil temperature is between 65 and 70 F to be the most effective.

NDAWN's sugar beet root maggot application also can prevent insect damage through proper timing of pesticide application. Nearly $8 million in net benefit can be attributed to the use of NDAWN data by increasing control of root maggot flies, cercospora and rhizoctonia.

Minnesota and North Dakota sugar beet factory districts issue a daily spray advisory via recorded telephone messages for producers in the district. These advisories are based on the total daily infection value (DIV) that has accumulated in the past

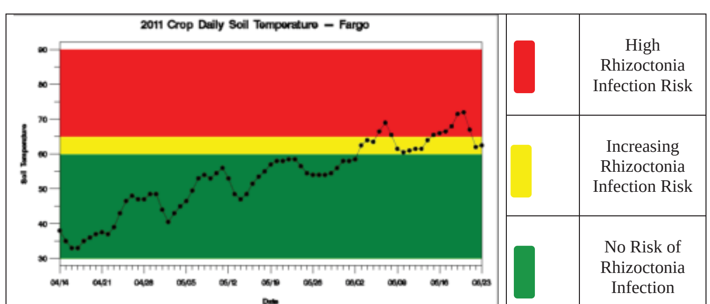

Figure 1. Pest Alert: Rhizoctonia Fungicide Application

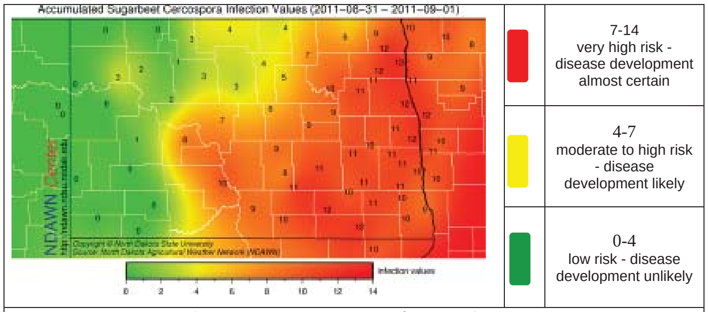

Figure 2. NDAWN Two-day Sugar Beet Cercospora Infection Values

two days. If the past two-day DIV total is less than 6, infection conditions are considered unfavorable. A two-day DIV total equal to 6 is marginal and greater than 6 means conditions are favorable for infection. (Figure 2)

NDAWN's cercospora application can reduce the amount of fungicide the sugar beet growers use. Growers make two to four applications of fungicide per growing season, depending on the weather. Each application costs Red River Valley sugar beet growers $9 million. If growers can eliminate one fungicide application from their cercospora program, they have the potential to save $9 million annually ($20 per acre for the cost of the chemical times 450,000 acres of sugar beet land).

With a similar agricultural application that allows the area potato growers to utilize potato late blight severity values, they can save $1 million to $2 million per year by avoiding one to two applications of fungicide using NDAWN data N. Gudmestad, Plant Pathology professor, NDSU).

NDAWN is a valuable regional resource, and so far only a fraction of its potential has been realized. These data have become part of the North Dakota climatological archive and will become more valuable as the period of record grows and/or new applications are discovered by scientists in all fields. The timing of these applications is a direct economic environmental gain.

Adnan Akyuz, (701) 231-6577
NDSU Assistant Professor, Soil Science Department, and State Climatologist
Adnan.Akyuz@ndsu.edu

Corn Drying Tips for 2011

An early frost creates another challenging year for corn in the region. The first step is to determine the corn maturity and expected harvest condition.

The National Agricultural Statistics Service indicated on Sept. 18 that 83 percent of the corn in North Dakota was dented and 20 percent was mature. South Dakota and Minnesota were at about 90 and 92 percent dented and 28 and 30 percent mature.

Corn Maturity

Based on the crop progress report, a large variation will occur in corn test weight and moisture content. Corn that was only in the dough stage would have extremely low test weight and yield losses would be severe. Even corn that had just reached dent stage may have low test weight and yield. Yield loss would be minimal and test weight would be reasonable if the corn were at 50 percent milk stage.

Effect of Frost on Corn

Corn Kernel Stage	Frost Damage: Leaves and Stalks Grain Yield Loss	Frost Damage: Only Leaves Grain Yield Loss	Test Weight	Grain Moisture
	(%)	(%)	(lb./bu)	(%)
Dough	66	41	—	70
Dent	55	23	47	60
75% Milk	35	18	50	52
50% Milk	10	5	53	40
25% Milk	3	2	54-55	37
Mature	0	0	56	32

Yield and Harvest Considerations for Frost Damaged Corn, Sept. 15, 2011
http://blog.lib.umn.edu/efans/cropnews/2011/09/yield-and-harvest-consideratio.html

Field Drying

The amount of drying in the field depends on parameters such as corn maturity, hybrid, moisture content, air temperature, relative humidity, solar radiation and wind speed. The moisture content to which corn will dry is determined by the corn's equilibrium moisture content, or EMC, which is based on air temperature and relative humidity.

A predictor of the drying rate might be potential evapotranspiration, or PET, which is based on parameters similar to those that affect drying. Values for PET calculated by the North Dakota Agricultural Weather Network for 2008 are shown in the following table. The data indicate a good correlation between PET and field drying experience.
The table shows these EMC, GDD and PET values and the estimated percentage points of field drying for each month.

Estimated Corn Field Drying

Month	EMC	GDD	PET	Estimated Drying: Month	Estimated Drying: Week
	(%)		(in.)	(%-pt.)	(%-pt.)
Sept.	15	250-350	4.0-5.0	18	4.5
Oct.	16	100-125	2.8-3.5	11-12	2.5
Nov.	19	20-30	0.8-1.2	4-5	1
Dec.	20	0	0.5-0.8	2	0.5
Jan.	21	0	0.5-0.8	2	0.5
Feb.	21	0	0.5-0.9	3	0.8
March	19	0	1.3-1.6	5	1
April	16	50-90	3.2-4.5	6	4
May	14	200-300	6.5	30	7

PET = potential evapotranspiration
(NDAWN, weather, Total PET, estimate: 1 inch ≈ 4 % drying)

EMC = equilibrium moisture content; GDD = growing degree-days;
%-pt. = percentage points of moisture reduction
(for example, from 20 to 15%, reduction is 5%-pts.)

continued

North Dakota State University
Agriculture Communication
NDSU Dept. 7070
P.O. Box 6050
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The following table provides field-drying rates for corn in Minnesota.

Date	Grain moisture loss (% per day)
Sept.15-25	0.75-1.00
Sept. 26-Oct. 5	0.50-0.75
Oct. 6-15	0.25-0.50
Oct. 16-31	0.00-0.33
After Oct. 31	Very little

Source: Hicks (2004)

www.extension.umn.edu/cropenews/2008/08MNCN26.html

Standing corn in the field may dry about 0.5 to 0.7 percentage point per day during September, about 0.3 to 0.5 percentage point per day during October and 0.15 to 0.2 per day or less during November, assuming normal weather conditions. Field drying normally is more economical until mid to late October and mechanical high temperature drying normally is more economical after that.

Corn at 40 percent moisture content on Sept. 15 might be expected to dry to about 31 percent by Oct. 1 and 20 percent by Nov. 1. However, corn at 60 percent moisture content on Sept. 15 might be expected to dry to only about 50 percent by Oct. 1, 40 percent by Nov. 1 and about 35 percent by Dec. 1. Therefore, the moisture content at harvest likely will range from low to mid-20 percent for corn near maturity to extremely wet if it had just reached the dent stage.

Immature corn may dry more slowly in the field than mature corn, and frosted high-moisture corn can mold on the stalk.

Field drying is extremely slow during winter months, and corn will dry to only about 20 percent moisture content based on the equilibrium moisture content for average monthly air temperature and relative humidity conditions. Corn left in the field during winter in 2008-09 dried from 25 to 30 percent moisture in November to 17 to 20 percent when harvested in February and early March. Corn that is not harvested until late spring is expected to dry to 14 to 16 percent moisture content.

Leaving corn in the field during winter has been done to reduce the drying cost, particularly with light test weight corn with moisture contents in late fall exceeding 30 percent.

Corn losses generally have been small if the corn stalk was strong in November. Frosted corn typically will have weaker stalks, so field losses might be much greater this year than in previous years.

Examine the stalks and push on them to determine stalk condition before deciding to leave corn stand through the winter. Corn losses can range from very little to very large. Wildlife feeding in the corn can cause large losses. Accumulated snow and cover on the snow and ground from the corn can result in wet fields in the spring.

For more information, do an Internet search for NDSU corn drying.

Kenneth Hellevang, (701) 231-7243
NDSU Extension Agricultural Engineer
kenneth.hellevang@ndsu.edu