IRRIGATION CONSIDERATIONS FOR HIGH-YIELD WHEAT

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Wheat is the third-largest field crop produced in the United States after corn and soybeans. Although it has a reputation as a low-input crop, supplemental irrigation is often needed to meet crop water use. Winter wheat accounts for more than 60% of U.S. wheat production (Ag Marketing Resource Center, 2020).

Winter wheat takes advantage of fall and winter moisture and is harvested before summer environmental conditions cause increased evaporation. However, the total water use of winter wheat is not much less than spring wheat and irrigation is needed to produce optimum yields. Time of planting usually only affects the total seasonal water requirement of wheat crops by a few inches of water (Bauder).

Lyle Roberts, owner of Mon-Kota Fertilizer & Irrigation Inc., has been an agronomist for 40 years and a Reinke dealer for 18 years. His dealership service area in eastern Montana and western North Dakota sees about 9 to 13 inches of annual rainfall. That's not enough to produce high yields, and rain is unpredictable. Water must be available to the wheat crop at precisely the right times to create higher yields.

"Dryland wheat averages about 40 bushels per acre. With irrigation, we can more than double that. Properly fertilized and irrigated wheat will produce more than 100 bushels per acre," Roberts said.

Wheat growth stages

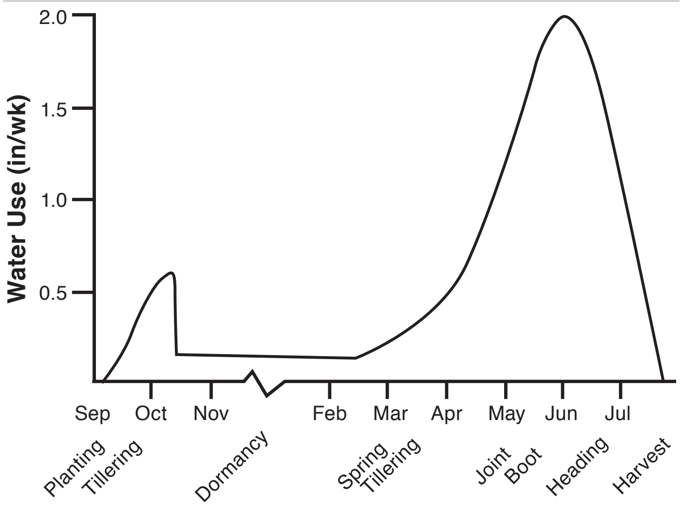
Wheat growth can be divided into five main stages: leaf and tiller development, stem elongation, heading and flowering, grain filling, and ripening (Lollato, 2018). Water use begins to increase early in the stem elongation stage. It jumps from about 0.1 inch per day at the beginning of this stage to 0.25 inch per day when the first node of the stem is visible, often referred to as "jointing."

The end of the stem elongation stage, when the wheat head develops inside the flag leaf, is called "boot." Wheat plant water use is highest at this time (Yonts et al., 2009). According to Lollato (2018), wheat water use reaches 0.3 inch per day before boot and exceeds that amount during head emergence. During grain filling, wheat water use drops off at approximately the same rate that it increased (Yonts et al., 2009).

Figure 1. Cumulative water use in the Central High Plains from emergence in the fall to various stages of plant development for irrigated winter wheat grown under unlimited soil moisture conditions. (Based on research conducted in the Panhandle of Nebraska.) (Yonts et al., 2009)

Period	Approximate Dates	Cumulative Water Use (in)
Emergence	Sept. 25-Oct. 5	
Beginning spring Growth	March 15-30	4.0
Jointing stage	April 25-May 5	8.5
Boot stage	May 15-20	11.0
Flowering stage	May 28-June 5	14.0
Milk stage of grain	June 10-15	17.0
Dough stage of grain	June 15-20	19.0
Complete maturity	July 1-5	22.0
Total		**22.0**

Figure 2. Weekly water use from planting to harvest for irrigated winter wheat (Yonts et al., 2009).



Irrigation Scheduling

The goal of irrigation scheduling is to estimate the amount of available water in the active root zone and prevent the crop from experiencing water stress. Soil texture and water-holding capacity as well as crop rooting depth affect the amount of water available to the plant.

In general, fine-textured soils, such as silt and clay, hold more water than coarse-textured, or sandy soils. Soils with low water-holding capacities require more frequent, light irrigation applications.

Wheat roots can extend deep into the soil. One study found winter wheat roots can reach depths of more than 7 feet, while spring wheat roots extend about half that depth

(Thorup-Kristensen et al., 2009). Despite differences in rooting depth, 95% of soil water extraction for both spring and winter wheat occurs in the top 28 inches of the soil (Entz et al., 1992).

Placing soil moisture sensors at various depths within the crop root zone can provide precise readings of current soil moisture. To keep the soil moisture within an acceptable range, growers must replace the amount of water that is evaporated from the soil and transpired by the plant. Evapotranspiration (ET) data can be obtained from a subscription service or local media. ET changes depending on plant development stages and weather variables, such as solar radiation, wind, air temperature and humidity.

Irrigation scheduling can be compared to a checkbook where rainfall and irrigation are deposits and ET is a daily withdrawal (Melvin & Yonts, 2009). Like other weather data, ET is forecasted ahead to help growers predict and schedule irrigation.

Total seasonal water requirement for both spring and winter wheat are about 18 to 24 inches, depending on location and seasonal weather variations, with spring wheat typically using a few more inches of water than winter wheat (Bauder). Kent McVay, cropping systems specialist at Montana State University Extension, maintains an online tool at www.sarc.montana.edu/php/wx_trends to help Montana growers determine the amount of water their crop has used during the season.

Winter wheat has two peak water use periods, fall and late spring, although the peak in late spring is much higher. Before planting winter wheat in the fall, there should be adequate moisture below the seed. If soil conditions are extremely dry in the fall, a light irrigation is necessary. The soil profile should not be filled completely when irrigating before planting. Rather, there should be room for precipitation, but adequate water for germination and early growth. Irrigation immediately after planting is not recommended for winter wheat (Yonts et al., 2009).

Evaporation from the soil surface continues through the winter unless there is snow cover. An irrigation application or precipitation in the fall, combined with winter precipitation, usually is adequate for early spring growth (Yonts et al., 2009). Since wheat's water use rate increases during the stem elongation stage, irrigation should begin during this time unless precipitation is abundant.

If an irrigation system applies less in one round than the crop's daily maximum ET at peak water use, begin irrigation early enough to store water in the soil profile before the wheat crop reaches boot stage. The surplus will be used by the plant during peak water use. Irrigation requirements will vary by year and region. Bauder estimated that total seasonal irrigation for wheat can vary from 16 inches down to 0 inches, when ideal weather conditions occur.

Recommended Irrigation Systems

The majority of wheat growers near Montana's Yellowstone River use flood irrigation. They pay for access to water, not for the amount they use. Flood irrigation can cause a number of environmental problems. Excess water often causes sediment erosion, as well as pesticide and fertilizer runoff. With flood irrigation, crop sediment left over from harvest must be cleared before the field is ready for irrigation. Wind blows soil from the bare fields, causing a second form of erosion. With flood irrigation, growers must thoroughly soak their fields so the water reaches the end of furrows. It is not efficient or uniform.

"We've promoted using sprinkler irrigation systems for water use efficiency and to prevent sediment erosion," McVay said. "Growers here are stuck using flood irrigation because that's what they've always done. When they go to a sprinkler system, they can manage the water better, which keeps nutrients and pesticides out of our waterways. It also builds soil quality by reducing sediment erosion."

The City of Billings relies on treated drinking water from Yellowstone River. McVay said city officials have considered subsidizing pivot installations for farms near the river to prevent phosphorus runoff.

Environmental benefits aside, pivot irrigation systems are a good choice since they generally have one of the lowest per-acre installation costs, are easy to operate and are energy-efficient because they operate at low pressure. Reinke dealers can recommend specific irrigations systems to fit individual fields. ReinCloud®, Reinke's remote monitoring system, allows growers to see real-time sensor data and control pivots from a smartphone, tablet or computer.

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