Know how. Know now.

EC731

Producing Irrigated Winter Wheat

C. Dean Yonts, Extension Irrigation Engineer
Drew J. Lyon, Extension Dryland Crops Specialist
John A. Smith, Extension Machinery Systems Engineer
Robert M. Harveson, Extension Plant Pathologist
Gary W. Hergert, Extension Soils Specialist
Gary L. Hein, Director, Doctor of Plant Health Program
Dipak Santra, Alternative Crops Specialist

Extension is a Division of the Institute of Agriculture and Natural Resources at the University of Nebraska–Lincoln cooperating with the Counties and the United States Department of Agriculture.

Winter wheat can extend irrigation water supplies when used in an irrigated crop rotation. Precipitation in the fall and winter help meet water needs as growth begins, while spring growth coincides with normally abundant precipitation patterns in Nebraska. Winter wheat develops an extensive and efficient root system for extracting soil water and also can use less total water than other crops such as corn. All of these factors help improve water use efficiency, reduce irrigation and energy costs, and extend aquifer life. If water for irrigation is limited, water supplies can be more easily shared with other crops requiring water after winter wheat has matured. Finally, when used in an irrigated crop rotation, durable and often abundant winter wheat residue can help reduce soil erosion and conserve soil water for the subsequent crop.

Much of the information for producing dryland winter wheat is pertinent to irrigated production. Irrigation simply relieves water stress; however, minimizing water stress may lead to increased pest pressures or make nutrients the most limiting factor. A good yield response to irrigating winter wheat is possible by addressing key crop production practices.

Tillage and Seedbed Preparation

Many irrigated winter wheat fields require some form of tillage before drilling. However, there is a steady shift in irrigated wheat production systems to use less tillage, and no tillage prior to planting. These no- or reduced-tillage systems reduce input cost, conserve surface residue to control erosion, and conserve soil water. Any tillage used depends on the previous crop, weed species and pressure, surface residue cover, and drill capabilities. Because wheat emerges so quickly, weeds must be killed using tillage or herbicides before drilling.

Tillage implements that work best to kill weeds in wheat production systems include wide blade plows and field cultivators or chisel plows with wide sweep points that overlap at least 4 inches. Tandem disks and narrow point field cultivators may allow larger weeds to escape through the implement. By themselves, primary tillage implements such as tandem disks, blade plows, and chisel plows do not provide the best seedbed ready to drill. Devices added to the rear of these implements, such as rolling baskets, ring rollers, and spiral rollers firm the soil, provide a better seedbed, and reduce soil water evaporation.

Although irrigated winter wheat is not influenced as much by soil compaction as some other crops, significant compaction can limit root development, water and nutrient uptake, crop yield, and water infiltration, and can increase water runoff. Therefore, prior to any tillage, check the field for compaction in the top 14 inches of soil using a rod-type probe. This type of probe works to detect compaction layers in the presence of good soil water conditions and may need to be used well before tillage operations. If a significant soil compaction layer is detected, use a ripping implement with parabolic shank design to shatter the soil. The shanks should be spaced less than 30 inches apart and operated several inches below the compacted layer. The soil must be dry to attain effective soil shattering. Since this is a very energy intensive operation, make sure there is a significant compaction problem, or consider doing only sections of the field where compaction is most pronounced.

Tillage in late summer or early fall is often done in dry soil conditions, creating large clods. Adding a packing device (ring roller, spiral roller) to the rear of the tillage implement will help reduce large clods, firm the soil, reduce soil water evaporation, and provide a more uniform seedbed for drilling. Providing a firm seedbed without large clods will help ensure better emergence, better root development, root health and resulting overwintering condition.

To accommodate early furrow irrigation or improve drill performance, surface residue may need to be reduced. Tandem disks and chisel plows will effectively mix surface residue into the top layer of soil. Ridges or undulating soil surface left by tillage will not allow good drill seed depth control and may create pockets for water to pond. Remember, excessive tillage can destroy desirable surface residue, increase soil water loss, reduce soil particle size, lead to soil crusting and erosion, and increase input costs.

Variety Selection

Varieties selected must have adequate straw strength to hold the increased yield compared to rainfed wheat and reduce risk of lodging. Short straw can help with this but is not the entire answer. Look for varieties that have a strong to very strong straw strength rating. Several of the more modern semi-dwarf varieties, such as Wesley, 2137, Overland, and NuDakota, have straw strength that is essential for irrigated production.

Choose varieties that are resistant to the foliar diseases — most importantly, the rusts. Leaf rust and stem rust can be serious problems in irrigated winter wheat. Resistance is frequently broken by the emergence of new races of a rust pathogen, so disease ratings should be consulted to ensure older varieties offer resistance. Other foliar diseases in which resistance can be beneficial include Cephalosporium stripe, Cercospora leaf spot, and glume blotch. These diseases can be minimized in rotations that include intensely tilled row crops and late planting dates that occur when winter wheat follows dry bean or potato.

Yield potential is certainly a factor that should be evaluated when selecting a variety. Other factors to consider include grain protein content, test weight, maturity, tolerance to wheat streak mosaic, coleoptile length, and winter hardiness. If growing 100 acres or more, plant varieties with at least two distinct backgrounds; i.e., two varieties should be from two different wheat variety families. Because it is impossible to predict what problems will occur in a given year, it is important to select a group of varieties with different genetic backgrounds to minimize the risk of a potential pest. The process of selecting different genetic backgrounds is referred to as *variety complementation.*

For more information on wheat varieties and wheat production, visit the CropWatch Web site at *http://cropwatch.unl.edu/web/wheat.* Also look for a link to the *Fall Seed Guide* (EC103), which provides a list of wheat variety families and varieties in each family.

Drill Selection and Operation

High yields of irrigated winter wheat depend on good crop stands, making seedbed and drill selection and operation important. Drill designs are available for a wide range of planting conditions, from no surface residue to relatively heavy surface residue, and for a range of surface soil conditions. Know your drill capabilities and prepare the field accordingly.

Maximum wheat yield and maximum crop competition for weeds are usually obtained with row spacing of 5 to 7 ½ inches. This requires a drill with single or double disk openers. Certain cropping conditions may require wider row spacing or other drill opener types. For example, if wind erosion is expected before crop establishment, consider a hoe-type opener at a 10- to 12-inch row spacing to create surface clods and ridges.

When irrigation is used, most winter wheat varieties selected will have a short coleoptile length. These varieties require a consistent and relatively shallow, 1 to 1 ½ inches, seeding depth. Select a drill that has accurate depth control and use previous tillage operations that match the capabilities of your drill. The drill press wheel design should provide good firming of the seed into the bottom of the furrow and firming of the soil around the seed. The press wheels should not flatten the complete soil surface or destroy surface clods that can help minimize soil crusting and erosion.

Loose or wet soil can aggravate deep tractor tire tracks during tillage or drilling. These tire tracks often impair correct seeding depth and cause soil compaction or water channeling. Minimize tire track effects by creating a firm seedbed, avoid operation when soil is too wet, and use tractor tire or track configurations that allow low soil contact pressure and high flotation.

Irrigated winter wheat seeded during the optimum time period should be drilled at about 90 lb/ac (1.35 millionseeds/ac). If planting is delayed, increase seeding rate to a maximum of 180 lb/ac (2.7 million seeds/ac) to offset reduction in tillering that occurs with cooler temperatures.

Fertility Management

Management practices which provide an adequate, but not excessive, supply of plant nutrients are essential for top yields of high-quality irrigated winter wheat. Good yield increases from nitrogen (N) and phosphorus (P) fertilization are common throughout Nebraska. Most Nebraska soils have enough potassium for maximum wheat production; however, some sandy soils may require sulfur (S) for higher yielding irrigated wheat. Soil testing is the foundation of nutrient management for irrigated winter wheat. The goal of soil testing is to characterize the amount of nutrients in the soil prior to planting. Fertilizers can then be applied to ensure optimal nutrition for the crop.

For more information on proper soil sampling and wheat fertilization, see EC143, *Fertilizing Winter Wheat, http://www.ianrpubs.unl.edu/sendIt/ec143.pdf*. It should be noted in reference to this information that research has not shown a greater phosphorus requirement for irrigated wheat compared to dryland wheat.

Nitrogen for irrigated wheat must be managed properly to obtain high yields and quality. Some nitrogen should be applied in the fall to ensure good nutrition for seedlings. Recent research comparing all preplant during fall versus one-third of the nitrogen in fall plus-two thirds at boot stage compared to one-quarter in the fall, one-half at jointing and one-quarter at the boot stage has shown both split applications were preferable to all preplant nitrogen. There was not a significant difference in yield or protein between the three-way split versus the two-way split. In several experiments the two-way split (one-third fall, two-thirds jointing) produced the highest yields. Later nitrogen applications generally have little effect on grain yield, although grain protein content may increase. This timing effect on fertilization for optimal yield and quality should be taken into account when a major portion of nitrogen is to be applied with the irrigation water. Much of the irrigation water will be applied after jointing. To increase grain protein and obtain premium grain prices, 20 - 40 lb N/ac can be applied with the irrigation water around heading. Late-season nitrogen applications can be beneficial to protein content in years of abundant wheat growth. However, when available nitrogen is too high, yield losses due to lodging often result, especially with high soil water during May to early June. This emphasizes the importance of soil tests to determine soil nitrogen availability for high yield management.

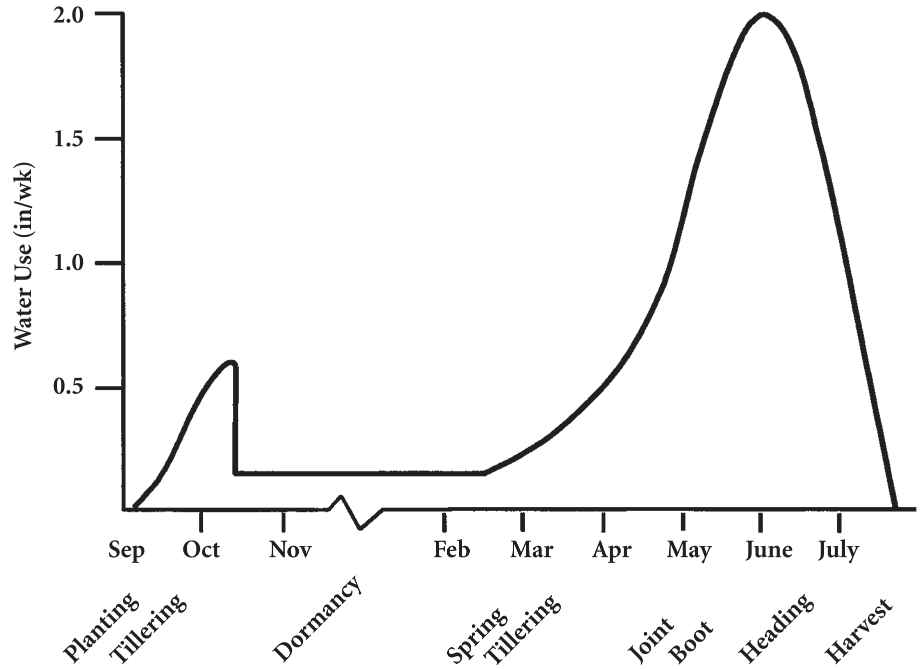

Figure 1. Weekly water use from planting to harvest for irrigated winter wheat.

Other Nutrients

When soil zinc levels are less than 0.4 ppm (DTPA test) wheat may respond to zinc. Most fine textured soils in Nebraska have adequate amounts of organic matter and/or residual sulfate sulfur deeper in the soil for maximum yield. The exception may be irrigated sandy soils. Irrigated wheat on sandy soils with low organic matter and low sulfate levels in the irrigation water may require 15 - 20 lb S/acre. Experiments conducted in western Nebraska on dryland winter wheat showed little response to chloride even though many soils contained low chloride based on guidelines developed from South Dakota research. At this time we are not recommending chloride for winter wheat.

Water Management

To manage irrigation water, you must know the soil water holding capacity and crop rooting depth. As an example, a medium textured soil with a water holding capacity of 2.0 in/ft and a 4.0-foot profile can hold up to 8.0 inches of water. To avoid stress, only 60 percent (4.8 inches) of this value should be used by the plant. In contrast, a light textured soil with a water holding capacity of 1.5 in/ft and a 3.0 foot profile will only hold 4.5 inches of water. In this case, only 2.7 inches of water is available for the plant to use.

Figure 1 illustrates the relationship between a specific time during the growing season and the approximate weekly water use of winter wheat. Keep in mind this curve is average water use. Within a given year, water use on a day-to-day basis can vary by as much as 50 percent or more.

Crop water use or evapotranspiration (ET) is made up of evaporation from the soil surface and transpiration from the plant leaves. Winter wheat has two peak water use periods: fall and late spring. The spring peak water use is greater than in the fall due to having a full canopy cover and greater atmospheric demand. In the fall, although much of the ET is a result of evaporation, water use continues as long as weather conditions are favorable. Upon freezing, transpiration by the wheat is near zero, but evaporation from the soil continues.

Once spring green-up occurs, water use gradually increases until late May or early June. As winter wheat reaches the boot stage of growth, water use is near its peak. At this stage, the plant begins to turn the energy it receives into grain production. Even though grain is being produced, water use begins to drop off at nearly the same rate as it increased. Approximately four weeks after peak water use, the winter wheat nears maturity.

Seasonal water use values are given in *Table I*. Up to 4.0 inches of water can be used from planting through plant dormancy. Total evapotranspiration during dormancy is dependent on duration of snow cover that prevents evaporation from the soil. Winter snow and early spring precipitation can supply or replace much of the water used during this period. The amount of seasonal water use varies with variety and growing season. Note,

Table I. 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.)

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

approximately half of the water used by the crop occurs before the boot stage.

Fall Irrigation

Because of the need for water during fall and winter, if fall precipitation is not adequate, irrigation is recommended. Soil water must be present in the top 2.0 feet of the soil profile to be of use in this early stage of growth. It could take 2 inches of water on sandy soil and 4 inches on clay soil to fill the top two feet of soil. The goal is to provide adequate water for germination and early growth, yet leave room for precipitation. This allows one to take full advantage of off-season precipitation, yet meet winter wheat water requirements.

Be sure soil water in the fall provides adequate water below the seed. Water that is in the soil moves from wet areas to dry areas. As evaporation dries the surface, soil water moves from the deeper depths to replace water evaporated near the surface. As water migrates, it replenishes soil water around the seed during germination and emergence.

If soil conditions are extremely dry, irrigation before planting should be considered to partially fill the soil profile. Planting into moist soil allows more consistent and uniform seeding depth. Applying 1.0 - 2.0 inches of water after the seed has been planted will cause soil particles to dislodge and move from the tops of soil ridges into the seed furrow. This results in the seed being covered with more soil. More importantly, the soil moved by the water over the seed is composed of fine soil particles that are tightly packed, increasing crusting and making emergence more difficult.

In-Season Irrigation

Use caution if irrigating during the early spring to reduce the risk of bringing the plant out of dormancy prematurely or applying water when the soil profile is full. Remember, irrigation and precipitation during the fall and winter should have been adequate to stimulate good growth and a deep rooting pattern. Because winter wheat is exposed to water evaporation from the soil surface throughout the winter, surface soils can become very dry. Irrigation in the spring should only be used to avoid plant water stress and plant desiccation.

Have adequate water available as the plant reaches the boot stage of growth and the wheat starts to head. Many irrigation systems are not designed to meet peak water needs of a crop. Consider a 600 gpm system on 120 acres. Assuming a 90 percent efficiency, the irrigation system supplies approximately 0.23 inches of water per day. Water use for winter wheat exceeds this amount for approximately a three-week period during peak consumption. Irrigation should begin early enough to start storing water in the soil profile prior to boot stage. When peak water use occurs, the plant can draw on both stored soil water as well as water supplied by irrigation to avoid water stress.

In general, winter wheat requires 3.0 to 4.0 inches of water during the last month of growth. Knowing the amount of water available in the soil can help determine when to irrigate. Remember, coarse textured soils require earlier and more frequent irrigations to prevent stress. Monitoring soil water, knowing water use rates, and knowing how much water you apply can improve overall management. These measurements allow the irrigator to schedule irrigations based on crop needs, the capacity of the soil to hold water, and the ability to effectively use precipitation during the season.

Weed Management

Irrigated winter wheat is often seeded late behind a summer crop such as dry beans and as a result is not competitive with winter annual weeds, such as tansy mustard and field pennycress. However, crop rotations that include late spring seeded crops effectively break the life cycle of winter annual weeds. Wheat fields should be scouted in late fall or winter for winter annual weeds. If present, these weeds should be treated by mid-April, before weeds bolt. Treat for blue mustard in February or March because it flowers earlier than other winter annual weeds.

Irrigated winter wheat can be more competitive with weeds by planting into a firm, moist seedbed, maintaining adequate fertility (including use of a starter fertilizer), using high-quality seed, carefully selecting a variety, and seeding at the proper rate and depth.

When properly established, irrigated winter wheat is very competitive with summer annual weeds. If broadleaf weeds emerge, there are several herbicides that provide excellent control with minimal wheat injury. In irrigated wheat, growers should select herbicides with minimal soil residual activity in order to maintain maximum crop rotation flexibility. Many sulfonylurea herbicides labeled for wheat have recrop intervals exceeding four to six weeks. A few exceptions to this include Affinity® BroadSpec and Harmony® Extra. In addition to sulfonylurea herbicides, Curtail® and WideMatch® also have recrop restrictions exceeding a couple of months. Many broadleaf weeds commonly found in Nebraska winter wheat fields can be controlled at a modest price and with little concern for restricting recrop options by using amine or low volatile ester formulations of 2,4-D. Growth regulator herbicides, such as 2,4-D and Banvel®/ Clarity should not be applied to wheat before it is fully tillered or injury will likely occur. This injury may not be evident until the wheat begins to head. Growth regulator herbicides also may cause crop injury when applied after jointing. Bronate® Advanced™ may be applied to winter wheat up to the boot stage, but good coverage is necessary and weeds should be small. Avoid late irrigations, which stimulate weed growth and cause harvest problems.

Disease Management

Dense foliage in irrigated winter wheat may favor development of different foliar and leaf spotting diseases. Anthracnose, Alternaria leaf spot and Aschochyta leaf spot all are more severe under conditions of high humidity and high temperatures (>80°F). In general, genetic resistance is the most economical option for control, as they seldom warrant fungicidal applications. Alternaria leaf spot may be the exception, if fungicides are used in conjunction with methods of forecasting environmentally conducive disease conditions.

Diseases such as powdery mildew, Septoria leaf and glume blotches, and leaf rust are more severe at lower temperatures (<75°F). Growth of powdery mildew in particular is markedly retarded above 78°F. Other diseases such as stripe rust and tan spot, are favored by temperatures below 70°F. All foliar diseases require extended periods of leaf wetness in combination with favorable temperatures for disease development. Treatment with fungicides is not economically necessary until the flag leaf becomes infected, at which point a number of fungicides, including Tilt®, Headline®, Quilt®, Quadris®, or Stratego®, may be effective for all foliar diseases in susceptible varieties. In general, leaf diseases are more severe in situations of high relative humidity and nitrogen levels. These conditions result in thicker, denser canopies, which limit air movement to help dry leaves.

Several root diseases are also often observed in irrigated wheat and include take-all and Pythium root rot. Both are more severe in wet, poorly drained soils. Ensuring proper fertility, especially nitrogen and phosphorus, can reduce take-all severity. Crop rotation also can be beneficial as continuous wheat increases take-all severity. Avoiding seeding into wet soils, heavy with residue, and planting fungicide-treated seeds into well-drained soils can manage Pythium root rot.

Scab inoculum survives on infected corn residue, but if dry beans are grown between corn and winter wheat most inoculum is destroyed. Certain corn cultivars are susceptible to wheat streak mosaic and can serve as a source of the virus when growing adjacent to an emerging winter wheat crop. Resistant corn cultivars are available for use where winter wheat and corn are grown in adjacent fields.

Insect Management

Insect problems in irrigated winter wheat will not likely be much different from dryland wheat. The major difference for irrigated wheat is that because of increased yield potential, insect economic thresholds will be lower. This is because the overall value of the crop per acre is greater, and lower insect numbers are needed to economically justify insecticide treatments. An example of this would be the Russian wheat aphid. For a typical 40 bu/ac dryland yield, a likely threshold would be 15 percent

Table II. Most probable insect problems in winter wheat and times when scouting needs to be done to detect problems.

Fall: (before planting)	• Adjacent volunteer wheat that can host wheat curl mite and Hessian fly • Adjacent corn that may host wheat curl mite • Grasshoppers
Fall: (emergence to dormancy)	• Grasshoppers • Russian wheat aphid • Greenbugs and other cereal aphids • Hessian fly
Early Spring: (breaking dormancy)	• Army cutworms • Russian wheat aphid
Mid-spring: (tillering to jointing)	• Pale western cutworm • Russian wheat aphid • Hessian fly
Late spring: (heading)	• Cereal aphid • Say's stink bug • Grasshoppers

infested tillers, but if the yield potential is 100 bu/ac the threshold would be 6 percent infested tillers.

Insect problems in wheat are nearly always sporadic in occurrence but can happen in any year. No consistent insect pests occur that growers need to deal with on a yearly basis, and as a result growers seldom scout their wheat fields regularly. The increased value of irrigated wheat should justify increased scouting. At a minimum, fields need to be checked once in the fall and twice in the spring. In the fall, evaluate stand and determine the presence of potential insect problems. In the spring, check wheat early as the plants are re-growing from dormancy and at least once later in spring, one to two weeks before flag leaf emergence. This scouting should identify most fields that will develop serious problems; however, more regular scouting is needed to identify all potential problems. See *Table II*.

Information on management and control of these insects can be found on the University of Nebraska, Department of Entomology Web site (*http://entomology.unl.edu/fldcrops/*) or the High Plains Integrated Pest Management Guide Web site (http://*www.highplainsipm.org/*).

Harvest

With an increase in winter wheat yield comes an increase in the amount of straw and chaff that must pass through the combine. The combine should be equipped with a straw spreading unit that will chop and distribute the long straw uniformly across the full width of the combine header. With 35 foot and wider combine heads, it is equally important that the chaff and fines also be spread across the width of the header. A separate chaff spreader may be required. Without adequate spreading of both straw and chaff by the combine, tillage and planting for the next crop in rotation will be made more difficult because of the dense material left behind. Windrows of chaff concentrate volunteer wheat and weeds making weed control more difficult. Excessive straw or chaff over the planted row may reduce vigor of, or even kill, the emerging plants of the following crop.

This publication has been peer reviewed.

UNL Extension publications are available online at *http://extension.unl.edu/publications*.