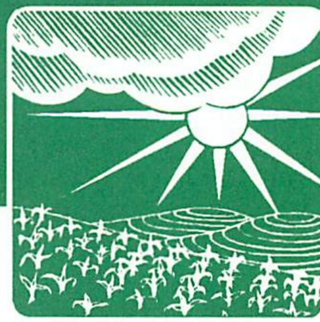

AGRONOMY

- Crops
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Small Grain Production for Iowa—Winter

Winter small grain types

Winter small grains grown in some areas of Iowa are barley, hard red wheat, hard white wheat, rye, soft red wheat, spelt, and triticale. The advantage of a winter small grain over its spring counterpart is that with good winter survival it yields 50 to 100 percent more.

Barley was planted in central Iowa for two years as part of a small-grain management study. The first year, yield was 54 corn-equivalent bushels per acre, but the second year winter kill was severe and the study was abandoned. Barley is therefore a questionable crop for Iowa , but it may have more potential in southern Iowa, especially in the southeast where winter air temperatures are not as severe.

Spelt (*Triticum spelta*) is a relative of common wheat (*Triticum aestivum*). Unlike wheat, during threshing the glumes (chaff) are not released from the kernels, giving it a lower bushel weight; there is no official bushel weight for spelt. In Ohio over a six-year period, it yielded 85 percent of soft red wheat, but 20 to 30 percent of the weight was chaff. Spelt tolerates poorly drained and low-fertility soils better than other small grains.

Rye produced in the Midwest is generally harvested for grain. It is rather unpalatable and should be a minor portion of a feed ration. There is increasing interest in rye as a winter cover crop. Also, residue of fall-planted, spring-killed rye can reduce weeds up to 95 percent compared to no rye residue. Rye is cross-pollinated. Of the small grains, it is the most susceptible to ergot.

Triticale is a cross between wheat and rye. The first crosses, in the late 1800s, were sterile. When plant breeders learned how to double chromosomes, it became possible to produce fertile polyploid varieties. Like wheat, triticale is self-pollinated.

In the early 1960s, triticale was promoted for its high protein and lysine content. Early varieties had several problems, however, such as low yield, shriveled grain, poor seed set, excessive plant growth, and poor winter hardiness. As plant breeders have dealt with these problems, protein content has decreased, but triticale still has the highest lysine content of the small grains.

Uses

All winter small grains can be used as livestock feed and some as food grains. Food grains, however, have distinct uses or current market niches (for example, organically grown), as well as strict quality standards that are often hard to meet. If you plan to sell as food grain, determine local and more distant markets when deciding which type to grow.

Hard red wheat is used for bread flour if the protein is high enough. In years with good plant-available moisture, however, kernels become plump with additional starch, reducing the protein and making the grain less valuable for milling. Under these conditions, hard red wheat is likely to be graded soft red wheat.

Mills are designed to process either hard red or soft red wheat, not both, and they market hard red or soft red wheat products, not both. A hard red mill can blend starchy hard red with good quality hard red wheat and make a satisfactory product. Alternatively, a soft red mill can blend starchy hard red with good quality soft red wheat and make a satisfactory product. This is only worthwhile, however, if starchy hard red wheat is available at a reduced price.

Hard white wheat has the same uses as hard red and has some advantages. The seed coat of hard white is thinner, and millers prefer it because they get less low-value bran. Also, if the seed coat gets into the flour, it is lighter in color and does not show as much. With its thinner seed coat, however, hard white wheat tends to sprout in the head if wet weather

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occurs at maturity. Plant breeders are reducing this tendency, but sprouting could present problems in Iowa's moist environment.

Soft red wheat is used for cracker, cookie, and cake flour. Triticale makes a more nutritious bread than wheat, but it is a heavy bread and meets only a limited taste demand in the United States. Rye is used for bread, but it is also a heavy bread with a limited market. Wheat is the main component of non-oat and non-corn breakfast cereals, but other small grains are being added to breakfast cereals and other cereal products to appeal to the increased nutrition consciousness of U.S. consumers.

There are small markets for spelt as an organically grown speciality food and for export to Germany where the price is considerably higher than common wheat. New food products include flour, pasta, bread, and breakfast cereals, but most spelt is used as an oat substitute for livestock.

Winter survival

Winter hardiness of winter small grains is rye > hard red wheat > soft red wheat = triticale > spelt > hard white wheat > barley. It varies by variety as well as crop type. As a general rule, winter hardiness of hard red wheat varieties increases across the hard red wheat area from south to north, but there are exceptions. Also, winter hardiness among types is not constant; a hard red wheat developed in Texas may be less hardy than a barley developed in Nebraska.

Although most winter small grains are grown south of Iowa, they are also successful in states north of Iowa and in Canada where snow normally covers the ground during periods of low air temperatures. During an average five-year period, Iowa winter wheat variety trial yields were severely affected by winter injury one year, moderately affected one year, and not affected three years. Iowa's "balmy" winter days melt the snow and, when followed by cold air temperatures, jeopardize winter small grain survival, especially if winter dormancy has been broken.

A well-hardened, hardy hard red wheat will stand a minimum crown depth (about one inch below the soil surface) soil temperature of about four degrees below zero. Low-temperature damage, however, is a complex phenomenon involving tissue moisture, soil moisture, rate of temperature drop, duration of various temperatures, etc.

Research in North Dakota shows crown-depth soil temperature is zero when air temperature is 30 degrees below zero and snow cover is greater than three inches. Without snow cover, crown-depth soil temperature is zero when air temperature is 18 degrees below zero.

Canadian research shows crown-depth soil temperature without snow cover is seven to nine degrees warmer for no-till planting in 7- to 14-inch small grain stubble compared to no stubble. Although these planting effects have not been studied in Iowa, a feed grain production system of spring barley followed by winter wheat (no-till planted in the barley stubble) and followed by one to two years of no-till planted corn is appropriate for highly erosive soils.

All winter small grains (hard and soft red winter wheat, winter barley, and winter triticale) winter killed during 1992. They had not hardened enough to stand the low air temperatures which occurred in late-October and early-November. However, if we assume the spring small grains produce normal yields and give soft red winter wheat a zero yield for that year, it still produces more animal feed units than the spring small grains during the five-year period 1988-92, 56.3 bushels per acre versus 41.7 for barley and 40.0 for oat.

Comparing winter small grains

One method for evaluating small grains is to convert them to corn feed units for a livestock finishing ration. The percentage of small grain equivalent bushels compared to corn is determined as follows: (small grain bushel weight / corn bushel weight) X percentage corn feed value (pound per pound). This formula results in the following approximate percentage corn equivalents: barley and triticale (48/56) X 95% = 81%; hulled spelt (30-40/56) X 85% = 46-61%; rye (56/56) X 95% = 95%; and dehulled spelt and wheat (60/56) X 105% = 113%.

Of the winter small grains, Iowa State University conducts variety trials on hard and soft red winter wheat only. From 1981 to 1990, average yields for hard red and soft red wheat in central and southern Iowa were 46 and 51 bushels per acre, respectively—higher than average but attainable with good management. Converted to corn-equivalent bushels, yields were 52 and 58 bushels per acre for hard red and soft red wheat.

Production cost

You can estimate the cost of wheat in corn-equivalent feed units. Assume the cost per acre for all fixed and variable costs is $180, with one-third ($60) assigned to straw and two-thirds ($120) to grain. Using corn-equivalent bushels for hard red and soft red wheat (52 and 58) results in $2.31 and $2.09 per bushel. This means that if production cost for corn is more than $2.31 per bushel, hard red wheat is a cheaper feed. If the straw cannot be used or sold and all costs are assigned to the grain, the cost per bushel changes significantly. Wheat, barley, triticale, and dehulled spelt can make up to 50 percent of grain in a finishing ration without loss of efficiency; hulled spelt, 15 to 20 percent; and rye, 25 to 30 percent.

In small-grain management studies conducted for three years in central Iowa, triticale yielded 73 percent and 63 percent corn-equivalent feed units of hard red and soft red wheat, respectively. In a two-year study in southeast Iowa, triticale yielded 78 percent and 64 percent corn-equivalent feed units of hard red and soft red wheat. The higher protein and lysine content of triticale makes it a good feed grain, especially for young animals. In Iowa, winter triticale has not been infected with ergot as has spring triticale.

Variety selection

Base your choice of winter small grains on variety yield test reports and disease resistance. Scab, powdery mildew, tan spot, septoria, helminthosporium, barley yellow dwarf, and rust can be significant disease problems.

Several species of *Fusarium* cause scab in cereals and are present in nearly all crop residues and soils. Whether scab will be a problem in a given year depends on weather conditions during small grain flowering when florets are infected. Susceptibility to scab is wheat > triticale > barley. In Iowa from 1985 to 1991, scab was a severe problem on wheat one year and on triticale one of the three years it was grown.

Powdery mildew fungus is generally specific to each small grain type. It is most common during a cool-wet spring. During the seven-year period, powdery mildew was a severe problem one year on wheat and one of three years on triticale.

Tan spot is also more likely to occur during cool-wet weather, whereas septoria and helminthosporium are problems at warmer air temperatures and when plants are wet from rain or dew for extended periods. Septoria was a major problem one year and tan spot and helminthosporium were minor problems on wheat during the six-year period.

Barley yellow dwarf virus, called "red leaf" on oat, is spread by aphids. Aphids do not survive the winter in Iowa but are blown in from the South in the spring. They may have the virus when they arrive or pick it up feeding on perennial grass hosts. Barley is most susceptible to barley yellow dwarf. Rust resistance varies among varieties; select resistant ones.

Grain infested with ergot and/or scab can cause problems when fed to livestock, especially swine. Scabby grain may produce two toxins: vomitoxin causes swine to vomit, and zearalenone causes pregnant females to abort. Test scabby grain at a Veterinary Diagnostic Laboratory to determine if it is producing either toxin.

Grain with 0.3 percent ergot infestation is unfit for food or feed. Continual feeding of grain with 0.1 percent ergot infestation may result in reduced feed intake, lameness, gangrene, and lack of milk production in swine after farrowing.

Conditioning grain with seed condition equipment, especially a gravity table, removes some of the ergot sclerotia and some scab-infected kernels. The safest way to dispose of infested grain is to dilute the grain and feed it to non-breeding ruminants. Consult your veterinarian.

Fungicide

Apply non-systemic fungicide to small grains after emergence of the flag leaf to protect it from plant diseases; apply systemic fungicide prior to flag leaf emergence. Fungicides will not control scab, ergot, or barley yellow dwarf, but they do increase grain yields in Iowa when some plant diseases are present. Plant diseases are not a problem every year, however, so you may not be able to justify an annual fungicide expense of $9 to $12 per acre plus application cost. You can monitor your small grains and apply fungicide(s) when disease(s) begin to appear, but this takes considerable dedication.

Growth regulator

When lodging is a problem, growth regulator can reduce plant height and lodging and in some cases increase yield, but it does not eliminate lodging in Iowa. When lodging is not a problem, growth regulator reduces yields, sometimes significantly. Growth regulator costs $2 to $3 per acre plus application cost. It tends to increase the incidence of plant diseases, so use it in conjunction with fungicide. Growth regulator is not cleared for all small grains. Because its effect on yield is not always positive, select varieties resistant to lodging.

Pre-plant tillage

Keep tillage at a minimum to reduce cost and soil erosion. You can get good yields when small grain seed is broadcast, but yields usually increase when seed is planted with a drill. The drill provides good seed distribution, uniform planting depth, and, when equipped with press wheels, good seed-soil contact. Dual press wheels beside the row allow planting in wetter soil. They are less likely than press wheels directly on the row to cause crusting over the seed if planting is followed by a hard rain.

Properly operated, no-till drills are excellent for planting small grains. Purdue University researchers report, however, that soft red winter wheat suffered from delayed seedling emergence, stunted growth, reduced tillering, and reduced yields by as much as 29 percent when planted no-till into heavy soybean stubble, compared to reduced and conventional tillage. They suggest chopping residue finely and distributing it evenly on the soil surface for no-till.

Row width

Row-width studies have been conducted in Iowa with 3-inch, 6-inch, and 12-inch rows. Yields and lodging were equal for 3- and 6-inch rows, and both were superior to 12-inch widths. A row arrangement study was also done. Seed planted north-south in 6-inch rows was compared to a crisscross method where half the seed was planted north-south in 12-inch rows and half was planted east-west in 12-inch rows. The 12-inch crisscross was equal to the 6-inch and superior to the 12-inch rows, even though there was visible evidence of tractor compaction across the plots. Be careful not to compact the soil with oversized equipment.

Planting date

Hessian fly can be a significant insect pest in wheat, rye, or triticale. Its free date for Iowa varies from 14 September at the northern border to 28 September at the southern border. In a three-year, date-of-planting study with hard and soft red wheat in southeast Iowa, wheat was planted 10 days prior to fly free date, fly free date, 10 days later, and 20 days later. Yield at the early planting date was no better than the fly free date. Early plantings increase the possibility of Hessian fly damage; therefore, plant on or shortly after the fly free date. If planting is delayed, increase the planting rate.

Plant barley seven to 14 days before Hessian fly free date; triticale the same date as wheat. Due to its superior winter hardiness, rye can be planted later than wheat.

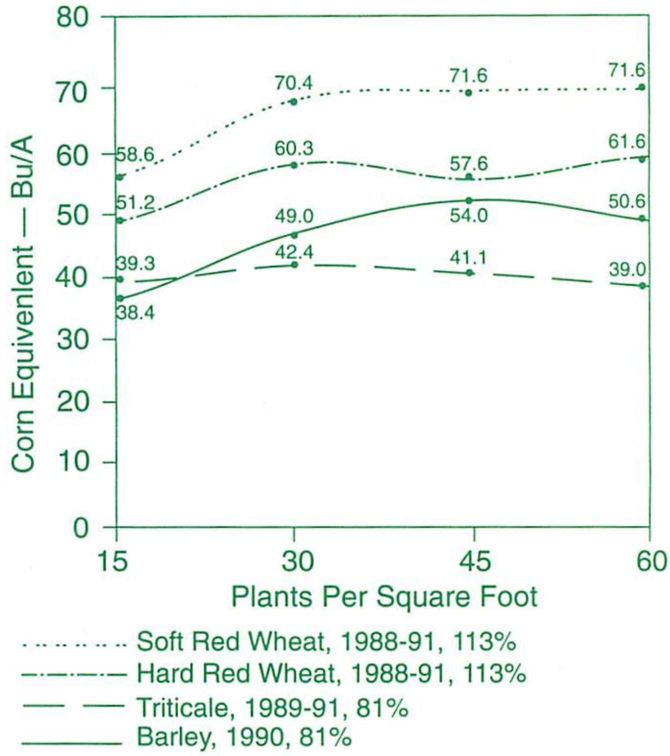
Planting rate

A rate-of-planting study has been conducted for four years in central Iowa. Seeding rates were to produce 15, 30, 45, and 60 plants per square foot. The data, shown in Figure 1, are in corn-equivalent bushels per acre. To convert to bushels per acre for a small grain, divide the data in the table by the grain's percentage corn equivalent (for example, soft red wheat at 70.4 bu/A / 113% = 61.9 bu/A). Seed used in this study had high germination percentages and was treated.

The problem in determining planting rate lies in knowing how many seeds are in a pound. During the four-year study, seeds per pound varied as follows: barley, 13,500 to 16,000; hard red, 12,000 to 20,700; soft red, 11,700 to 16,000; and triticale, 11,000 to 17,200. Using averages, you need 130 pounds of barley, 80 pounds of hard red, 90 pounds of soft red, and 100 pounds of triticale per acre to get about 30 seeds per square foot. Plant spelt at about 75 pounds per acre. Seed tested for germination at the Iowa State University Seed Lab is also tested for seeds per pound. Planting seed that has not been tested for germination, weed seed, etc., is foolish, at best.

The relative yields at lower seeding rates shown in Figure 1 should be helpful in estimating yield potential when a crop is damaged by winter kill. For example, soft red wheat yield at 15 seeds per square foot is 83% of that at 30 seeds per square foot.

Figure 1. Winter small grains rate of planting — Ames.



If winter kill occurs with hard red winter wheat, do not overplant with hard red spring wheat. Because hard red spring matures at least seven days later, the grain would probably be graded "mixed wheat," making it difficult to market as a food grain. Although millers often mix hard red spring and hard red winter wheat, they do so based on the protein content of each wheat to get the desired protein content in the flour. Overplanting hard red spring into soft red winter wheat is even less advisable; the difference in maturity is likely to be 14 days. If overplanted wheat is to be used for feed, harvest when the winter wheat is past maturity and the spring wheat is not mature, and artificially dry it. The longer you delay harvest, however, the more likely the winter wheat will lodge.

Fertilization

Pounds of nitrogen, phosphate, and potash in a bushel of wheat, barley, and rye are 1.3-0.63-0.38, 1.1-0.41-0.36, and 1.17-0.5-0.36, respectively. Pounds of nitrogen, phosphate, and potash per ton of wheat, barley, and rye straw are 13-3-23, 15-5-30, and 10-5-17. Removal of nitrogen, phosphate, and potash by triticale is similar to wheat. It is doubtful it would pay to apply phosphate or potash when the soil test is medium or higher.

A nitrogen-response study was conducted with hard and soft red winter wheat in southeast Iowa for three years. Rates were 0, 50, 100, and 150 pounds nitrogen per acre. Yields at zero nitrogen for hard red and soft red ranged from 32 to 83 and 47 to 88 bushels per acre, respectively. Assuming straw production was two tons per acre, nitrogen utilized by the grain and straw at the zero rate would have been 68 to 140 pounds. The year the soft red yielded 88 bushels per acre at zero nitrogen, it yielded 93 bushels per acre at 50 pounds of nitrogen. One year, wheat followed corn; two years, it followed soybean.

Lodging was not a problem two of the three years regardless of nitrogen rate. The other year, lodging was a problem and was more severe at the higher nitrogen rates. Plant diseases were also a problem that year, however, and heavy rainfall accompanied by high winds occurred at harvest maturity. Lodging is therefore a complex issue involving plant-available moisture, nutrient availability, and rainfall accompanied by high winds, especially at or near maturity, not simply "too much nitrogen."

Some states use nitrate-nitrogen tests for the upper one to two feet of soil to determine nitrogen rates for small grains. Other researchers have found a leaf nitrogen test shortly after spring green-up correlates better with nitrogen needs. Detailed studies like these have not been conducted in Iowa but are desirable because nitrogen recommendations based on grain and straw removal do not appear to be adequate.

Frost-seeding legumes into winter wheat has been successful in states south and north of Iowa. Limited work in Iowa to establish annual alfalfa, annual sweet clover, mammoth red clover, and Korean lespedeza into winter wheat by frost-seeding has been unsuccessful. However, with the exception of Korean lespedeza, no-till planting into winter wheat has been successful.

Harvest

For safe storage, small grains should be 13 percent moisture or less. Whether to harvest grain standing or from the windrow depends on the situation. If green weeds are present, windrowing allows them to dry prior to combing. Some food processors, however, do not like grain harvested from the windrow. If rainfall and cloudy weather occur following windrowing, grain may dry slowly, initiating germination and reducing the quality of the grain.

Additional information

Variety information on hard red and soft red winter wheat is published in *Wheat and Barley Variety Tests,* AG-6, available from Publications Distribution, Ames, IA 50011, or from county extension offices. Variety information on these and other small grains is also available from the University of Nebraska, Lincoln, Neb. 68583; South Dakota State University, Brookings, S. Dak. 57007; University of Minnesota, St. Paul, Minn. 55108; and the University of Wisconsin, Madison, Wis. 53706.

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