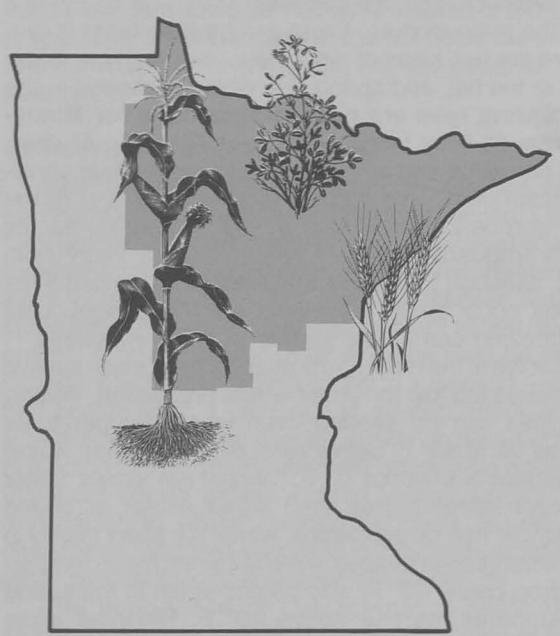
Extension Folder 662—1983

MANAGEMENT OF CROPS AND SOILS
IN NORTH CENTRAL
AND NORTHEASTERN MINNESOTA
CORRESPONDENCE COURSE

Unit 8—Growing Small Grain

Purposes

- Recognize the management factors that will help you attain best small grain yields on your farm.
- Understand which small grains will grow best on your farm.



Agricultural Extension Service • University of Minnesota

Small grains are important to the economy of north central and northeastern Minnesota; they are utilized both as cash grain crops and as livestock feed. Small grains are well adapted to most of the soils of the area, and the cool climate provides excellent growing conditions. This same climate, however, often results in difficult harvest conditions.

Oat is the most widely grown small grain in the area, followed by spring wheat, barley, winter rye, and winter wheat in decreasing order. All are produced for their grain, but oat also is produced for its straw and often is grown as a companion crop to establish forage crops.

THE SMALL GRAIN PLANT AND ITS DEVELOPMENT

Seed

Small grain seeds contain carbohydrates, protein, fat, vitamins, and minerals. Grain at harvest has 13-15 percent moisture. If kept just below 13 percent moisture, it can be stored for up to 2 years with a minimum of spoilage.

The seed has three main parts that consist of a seedcoat (pericarp), an embryo, and an endosperm. The seedcoat is the outside covering of the seed. It protects the embryo and the endosperm from injury. The embryo, or germ, is the living part of the seed that becomes the new plant when the seed is planted. The endosperm contains the starch food supply for the embryo during germination.

Seed Germination and Early Growth

When the seed of a small grain crop is planted, it germinates or sprouts if the temperature is favorable and there is enough moisture. The seed absorbs water and uses its own food reserves. When the root breaks through the seed coat it quickly grows downward and anchors the seedling in the soil, absorbing water and nutrients. These roots may eventually go 3 to 6 feet deep and 3 to 4 feet horizontally. During the early stage of development, young plants are very susceptible to injury from drought and from sunny, hot, dry weather.

Next, the young shoot (protected by a sheath called *coleoptile*) breaks through the seedcoat opposite the root and grows upward. The sharp pointed sheath breaks through the soil surface and stops growing. The growing point of small grain plants remains below the soil line until the first visible node appears above the soil line. By then, small grain plants have produced several additional shoots (called tillers) from the crown, followed by growth (elongation) of the main stem. Because the growing point remains protected below the soil line during early development, small grain plants can withstand the cold temperatures of early spring in north central and northeastern Minnesota.

Growth Stages of Small Grains

There are five basic growth stages of small grains: seedling, tillering, jointing, boot, and heading. The **seedling stage** is from germination to the stage at which tillers appear. The **tillering stage** is when the first side shoots (tillers) appear from the crown. The **jointing stage** is when

the nodes begin to separate and can be felt in the lower part of the stem. The **boot stage** is when the head can be felt inside the upper leaf sheath and the flag (last) leaf has developed. The **heading stage** is when the spikes of barley, rye, and wheat or panicles of oat emerge. During the later part of this stage the florets are fertilized and the kernels develop.

SOME CHARACTERISTICS OF DIFFERENT SMALL GRAINS

Oat

When used as a companion crop, oat often is removed during early flowering for forage. Oat grain is mostly used as livestock feed with a small amount sold for use in high protein cereals. Oat grows well on a wide range of soil types, especially if the soil is well-drained and reasonably fertile. Oat is less sensitive than wheat or barley to soil conditions, especially to acidity. Oat generally grows best on medium and fine textured soils, but it also will produce fair yields on light sandy soils if there is sufficient moisture. The oat plant requires more water for its development than does any other small grain. It also will yield better than the other small grains with less sunshine. Generally, however, oat yields are inferior to those of barley when moisture is a limiting factor.

High temperatures during flowering can increase the proportion of empty spikelets, a condition called blast. Hot dry weather during grain fill causes early ripening and reduced yield; hot humid weather during this period favors diseases.

Nitrogen management is important in attaining best oat yields. If too much nitrogen is present, lodging can be a problem and yields will suffer as a result.

Barley

Barley is used mainly for livestock feed. Studies have shown that ton for ton ground barley may be equal to corn in feeding value for dairy cows when used as 40 to 60 percent of the grain mixture. Barley consistently exceeds other spring grains in pounds of total digestible nutrients (T.D.N.) per acre. Barley often outproduces oat by more than 200 pounds of grain per acre. It also is sold to the malting industry for use in making beer and other alcoholic beverages.

Barley does particularly well when the ripening season is long and cool. Although it can withstand much dry heat, it does not do well in hot humid weather because of the prevalence of diseases under such conditions. It grows better with moderate rather than excessive rainfall. Some spring barley varieties mature earlier than oat, rye, and wheat. Barley can be grown farther north and at higher altitudes than any other cereal.

Barley is one of the most dependable crops in areas where drought, frost, and salt problems occur. It is best adapted to well-drained medium and fine textured soils with a pH of 7 to 8. It generally does not produce satisfactory yields on sandy soils. Barley often lodges when grown on soils high in nitrogen, resulting in low grain yields. Nitrogen management is therefore very important. Barley has the highest tolerance for salts of any of the small grains, but the soils in north central and northeastern Minnesota generally do not have this problem.

Hard Red Spring and Winter Wheat

Most spring and winter wheat grain is sold for making bread and other food products or for export. A small amount is used for livestock feed. Wheat, along with the other small grains, is considered a cool season crop. But it requires a longer growing period and a somewhat higher minimum heat requirement than other small grains. Warm temperatures during the late seedling and tillering stages of wheat may retard heading and cause yield loss. Daily maximum temperatures above 90° F. during the 3 to 4 weeks after flowering may ripen the grain prematurely. Above average temperatures are beneficial at seeding time, detrimental during tillering, flowering, and early grain filling, and beneficial during ripening.

Wheat is best adapted to fertile, medium to fine textured soils that are well-drained. In general, very sandy or poorly drained soils produce unsatisfactory yields. Acid or strongly leached soils are poorly suited to wheat. Under certain conditions, such as drought or high temperatures, some of the lower as well as the top spikelets of the head may fail to set seed.

Rye

Rye is used as livestock feed and is sold for breadmaking. It often is grown as a green manure crop as well. Rye is not as palatable to livestock as other small grains but does have a feeding value about 80 percent that of corn. When used in livestock feed, rye generally makes up less than a third of the grain mixture. Ergot can be a problem in rye.

There are two types of rye: fall rye, a winter type that is seeded in the fall, and spring rye, which is seeded in the spring. **Spring ryes are not recommended for Minnesota because they yield much less than winter ryes.**

Rye can withstand any kind of adverse weather conditions except heat. Rye sprouts more quickly and grows more vigorously than wheat at low temperatures. Its earliness frequently enables rye to escape injury from drought, although the heads are likely to be blasted if hot dry winds occur when the plants are in blossom. Late spring freezing can cause sterility in flowering plants.

Winter rye is the most hardy of all cereals. It can survive temperatures too low for winter wheat production. Winter-hardy types can be seeded even where temperatures frequently fall to 40° F. below zero, or where mean winter temperatures are about 0° F. Winter rye grows faster under cool temperatures than either winter or spring wheat. Under normal conditions, winter rye tillers mainly in the fall. Most growth ceases in the fall when mean temperatures drop below 40° F. and begins again in the spring when temperatures rise above 40° F. Ripening takes place at temperatures of 50° to 68° F. Temperatures above 77° F. may injure the crop.

Highest rye yields usually are obtained on fertile, well-drained, medium and fine textured soils. Rye is adaptive, however, and is more productive than the other grains on

infertile, sandy, acid soils. Rye is an especially good crop for drained marshlands or newly cleared timberland. Under conditions favorable for winter wheat, rye usually yields less grain because of its shorter growth period and heavier straw yield. Rye often is seeded on less productive land and grows quite well with poorer seedbed preparation than is customary for wheat. Winter rye can utilize spring moisture more effectively than the spring seeded small grains. As a result, winter rye generally will yield more in soils that become droughty in early summer.

Rye volunteers freely because the grain shatters so readily. Since rye matures earlier than other grains, some of the seed is again shattered from volunteer plants before the regular planted crop is harvested. Consequently, it is difficult to eradicate rye in a system of continuous small grain.

CULTURAL PRACTICES FOR SMALL GRAINS

Tillage: Seedbed Preparation

The purpose of primary and secondary tillage is to prepare a firm seedbed with adequate moisture for good germination and seedling development. Good seed-soil contact is essential when the grain is seeded. Dry, loose soil makes for an unsatisfactory seedbed. Secondary tillage to remove any weeds that are growing also is important. Too much tillage can pulverize the soil, which can lead to soil erosion due to wind and water or crusting after rainfall. Working plant residues into the soil near the surface helps to control erosion and protect the seed.

Disking and harrowing the land before seeding is a common method of preparing a seedbed for oat in Minnesota. Field cultivators can be used instead of a disk. Initial preparation of the seedbed in the fall helps the soil to dry and warm up faster in the spring and makes earlier seeding possible.

Selecting a Variety

Selecting high quality seed of an adapted variety is important for profitable small grain production. Other cultural practices cannot make up for lack of seed quality and freedom from weeds. Factors that are important in selecting a variety include: yield, maturity, disease resistance, straw strength, shatter resistance, plant height, and grain quality. In most cases, relative yields may be the most important factor, but susceptibility to a disease—even one that occurs only 1 year out of 5—can affect any yield advantage. Premiums paid for quality or benefits obtained in feeding higher quality often will offset yield advantages. Important quality factors include protein content, milling, and baking of wheat; malting approval, protein, kernel plumpness, and test weight in barley; and groat protein, groat percentage, and test weight in oat.

The importance of characteristics such as straw strength and plant height may vary from field to field and from year to year. Straw strength may not be as important on fields with low soil moisture reserves, but it is very important in preventing lodging on fields with good moisture and high fertility. Straw strength is particularly important when oat is used as a companion crop. Lodging may damage forage seedlings.

Disease resistance also is important in selecting a variety, especially if a particular disease has been a problem in your fields. The important diseases are leaf (crown) rust and smut in oat; stem and leaf rust, tan spot, and scab in spring wheat; take-all in winter wheat; stem rust, loose smut, and spot blotch in barley; and ergot in rye (information relating to variety selection can be found in Minnesota Report 24, *Varietal Trials of Farm Crops*).

Winterhardiness is an important consideration in selecting a variety of winter wheat or rye. Always use the best winterhardy variety of these crops, providing the variety is a good yielder.

Planting

Small grains should be seeded as early as possible after the frost is out of the ground. Although germination of these cereal crops begins at 24° to 36° F., soil temperatures should be 40° F. before planting. Early seedings generally produce higher yields than later seedings because small grain plants develop best during cool, moist growing conditions. If temperatures go above 90° F. during pollination, yields can be drastically reduced due to poor pollination and seed set. By seeding early, small grain crops normally complete their development before the hot weather in July. Oat, barley, and spring wheat should be seeded from late April to early May. Winter rye and wheat should be planted early enough in the fall so the plants can become well-established before the first killing frost. Winter rye should be planted in early to mid-September; winter wheat should be planted in late August and early September.

Small grains usually are planted about 1 to 2 inches deep, depending on soil moisture and soil texture. Wheat, barley, and rye cannot be planted as deep as oat. Semidwarf wheat varieties cannot be planted as deep as tall varieties.

A grain drill with press wheels is the best machine for seeding small grains because it distributes the seed evenly at a uniform depth and gives good soil-seed contact. Broadcasting wastes seed and often results in uneven stands. If forage crops are seeded with oat, the grass and legume seed should be covered by ½ inch of soil. Oat should be seeded at 80 pounds per acre, barley at 85, spring wheat at 80, winter wheat at 75, and winter rye at 60. When oat is used as a companion crop the seeding rate should be reduced to 64 pounds per acre. Higher rates will be harmful to the new seeding of grass and legume.

Soil Fertility Needs of Small Grains

Although small grains require lesser amounts of the major nutrients than do forages or corn, adequate amounts of nitrogen, phosphorus, and potassium must be present for good yields. Generally these three elements are added according to soil tests, past cropping history, and expected yield goals. Most soils in north central and northeastern Minnesota supply adequate amounts of all nutrients, with the exception of sulfur on sandy soils and copper on

organic soils. A soil test will show whether sulfur or copper is needed.

The major portion of nutrients is taken up by the small grain plant between the tillering and heading stages. Much of the nitrogen and phosphorus in the whole plant is removed with the grain. To avoid nitrogen and phosphorus deficiencies, small grain producers usually apply phosphorus and nitrogen at seeding time with the grain drill. This is especially important in cool moist soils in which little soil nitrogen and phosphorus is readily available to plants when the soil temperature is below 50° F. Using a fertilizer attachment on the drill also is important because of the higher efficiency of uptake of the plant nutrients, especially nitrogen and phosphorus.

When winter rye and winter wheat are planted, phosphate and potassium fertilizers should be applied in the fall. Nitrogen should be topdressed the following spring on these crops.

Most nitrogen fertilizer sources can be used for small grain production. The nitrogen should be applied just prior to seeding time. The amount of nitrogen needed depends primarily on the previous crop and on your yield potential or yield goal. Nitrogen, for example, may not be needed if the previous crop was a good legume. If your previous crop was corn or small grains, however, substantial application of nitrogen probably will be necessary for best small grain yields. Although a nitrogen test is not run for soils in north central and northeastern Minnesota, a nitrogen recommendation will be given when you have your soil tested.

Soil testing offers the only effective means of determining phosphorus and potassium levels in your soil. This information can be used to determine the additional quantity needed to attain good yields. This test should be run every 2 to 3 years.

Weeds

Many weeds, both broadleaf and grassy types, can be troublesome in small grain fields. These weeds must be controlled either by tillage before the small grain is planted or by using selective herbicides.

A good stand of vigorous small grain plants will compete with weeds fairly well. Early seeding of high quality seed in a good seedbed with adequate fertility will get the crop off to a good start before "warm season" weeds have a chance to get established. Warm season weeds include annual grasses such as foxtail, wild oats, and quackgrass, and annual broadleafs such as mustard, pigweed, lambsquarters, and wild buckwheat.

If the seeding date of the small grain is delayed, these weeds must be controlled with selective herbicides. Annual broadleaf weeds, such as wild mustard, lambsquarters, pigweed, wild buckwheat, and smartweed, will overgrow small grain even if the crop is planted early. In such cases, a broadleaf herbicide must be used. Wild buckwheat, Canada thistle, and sowthistle are particularly troublesome in the northeast because historically chemicals have not been used to control weeds in small grains in that area.

DISEASES

Fungi, along with bacteria and certain viruses, are responsible for several diseases that affect small grain production. Many of these diseases are spread by spores that are carried by wind or water. Fungal diseases can survive and overwinter on dead plant material, in stored seed, and in the soil and can infect the crop the following growing season.

Fungus diseases may attack the leaves or the developing heads of small grain plants. Among the leaf diseases, leaf rust, septoria leaf blotch, and Helminthosporium leaf spot are the most common. Smuts and ergot damage the heads of small grain plants and can be carried over into next year's crop by the infected seed.

Many of these problems can be controlled or reduced by treating seed, by using certified seed, by planting resistant varieties, and by applying fungicides.

Many disease resistant varieties of small grains have been developed. To make sure you choose a resistant variety, consult Minnesota Report 24, *Varietal Trials of Farm Crops.*

Glossary of Terms

Blast: The drying out (desiccation) of flowers due to high temperatures. This desiccation kills the developing grain.

Boot stage: The growth stage in grasses at which the inflorescence (group of flowers) expands (swells) the top of the stem.

Coleoptile: The sheath covering the first leaf of a grass seedling as it emerges from the soil.

Crown: The base of the stem where roots arise.

Embryo: The young, dormant plant within a seed; the germ.

Endosperm: The starchy interior of a grain.

Ergot: A fungus disease of small grains that replaces the kernel with a purple-black growth.

Germ: The young, dormant plant within a seed; the embryo.

Germination: When the young, dormant plant within a seed begins to grow after the seed absorbs water and temperatures are suitable.

Groat: An oat kernel with the hull removed.

Jointing: The growth stage in grasses when the stems develop distinct nodes and internodes (section of stems between nodes).

Lodging: When plants fall over due to poor root anchorage or stem breakage.

Node: The place (joint) on a stem where a leaf is attached.

Panicle: The inflorescence (group of flowers) at the top of a stem that has a central axis and subdivided branches, as in oat.

Pericarp: The modified and mature ovary wall; the outer, protective covering of a kernel.

Rust: A fungus disease found on both leaves and stems. It is the most serious disease of small grains. The disease is characterized by round, raised, orange-red spots.

Scab: A fungus disease of wheat caused by the same organism that causes stalk rot of corn. The heads become infected with a pinkish mold. The disease is worse when wheat follows corn.

Shatter: When seed falls from the plant before a crop can be harvested.

Sheath: The lower part of the foliage leaf, which is wrapped around the stem.

Smut: A fungus disease of small grains that can infect the head in wheat and barley and the panicle in oat. Masses of black spores appear on the flowers.

Spike: The inflorescence (group of flowers) at the top of a stem that has a central axis and flowers attached directly to it, not on branches, as in wheat and barley.

Spot blotch: A fungus disease of small grains, particularly barley. The fungus causes speckled discoloration or blotches on leaf blades and sheaths. The disease starts in cool weather and affects the lower leaves.

Sterility: The failure of kernels to develop into flowers due to poor pollination, environmental conditions, and genetic reasons.

Tan spot: A fungus disease on wheat leaves that appears as lens-shaped tan spots. It is more severe when wet conditions prevail.

Tillering: The growth stage in grasses when stems develop at the base of the main stem.

Volunteer: A plant developed from seed that was not planted intentionally.

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Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Norman A. Brown, Director of Agricultural Extension Service, University of Minnesota, St. Paul, Minnesota 55108.

Growing Small Grain

Please fill out and return

Name _____

Address _____ County _____

1. Which small grains do you raise and why do you raise the ones you do?

2. From what you have read in this unit about various small grains, do you plan to continue growing the same small grains or do you plan to grow different ones? Explain your answer.

3. After reading this unit, are there any changes you would make to increase productivity of your small grain crop? What are these changes?

(over)

4. What general problems do you have in growing small grains? Could you solve some of them by selecting the proper variety?

5. Please list any questions you have concerning small grain production.

The following material also is available on request. Please check those you would like to receive.

- ☐ *Aphid Pests of Small Grains,* Entomology Fact Sheet 43
- ☐ *Barley Smuts,* Plant Pathology Fact Sheet 6
- ☐ *Chemical Control of Cereal Leaf Diseases,* Plant Pathology Fact Sheet 24
- ☐ *Ergot of Cereals and Grasses,* Plant Pathology Fact Sheet 21
- ☐ *Seeding Dates for Small Grains and Flax,* Agronomy Fact Sheet 26
- ☐ *Varietal Trials of Farm Crops,* Minnesota Report 24
- ☐ *Weed Control in Small Grains,* Extension Folder 493
- ☐ *Wild Oat Identification and Control,* Agricultural Chemicals Fact Sheet 9