WHEAT

IN THE EASTERN UNITED STATES

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CONTENTS

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Wheat in the Eastern United States

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About one-fourth of the wheat grown in the United States is produced in the eastern region, which includes all the States east of the Mississippi River, also Louisiana, and parts of Missouri, Arkansas, and Texas. The western boundary is based on the type of farming and class of wheat that predominates. It is somewhat irregular and overlapping, as there is no sharp line of demarcation between the soft winter, hard winter, and hard spring wheat regions.

Most of the wheat of the Eastern United States is produced in a relatively narrow irregular belt extending across central Missouri, central and southern Illinois, Indiana, Ohio, southern Michigan, southern Pennsylvania, Maryland, and Delaware (fig. 1). Areas of lesser acreage include western New York, the Piedmont (foot of the mountain) areas and the mountain valleys of Georgia, South Carolina, North Carolina, Virginia, and eastern Tennessee. There are also producing areas in the western parts of Kentucky and Tennessee, and in north-central Texas. Although the wheat crop in these last-named areas is small compared with the national crop, it plays an important part in the local agriculture, which depends to a considerable extent on how successfully wheat is grown.

The agriculture of the entire region is generally diversified. Dairying and the raising of livestock and poultry are leading industries. The production of corn, soybeans, hay, and pasture crops is important. Cotton is grown extensively in the South.

In this region, wheat is usually grown as a supplement to and in rotation with other crops, rather than as the primary crop for grain. Wheat fits well into the different rotations. Most rotations include a grass—orchardgrass in the central part of the region, and timothy or bromegrass in the northern part—and a legume, generally alfalfa or red clover, either singly or in various combinations. These can be seeded with the wheat in the fall or in the wheat in late winter or early spring, according to the kind of grass or legume, and hence can be established without the loss of a year's time.

This bulletin describes the wheat varieties suitable for growing in different areas and discusses suitable production methods and practices, such as early preparation of the soil, fertilization, and timely seeding to evade possible damage from the Hessian fly and winterkilling. Diseases and insects and their control also are discussed.

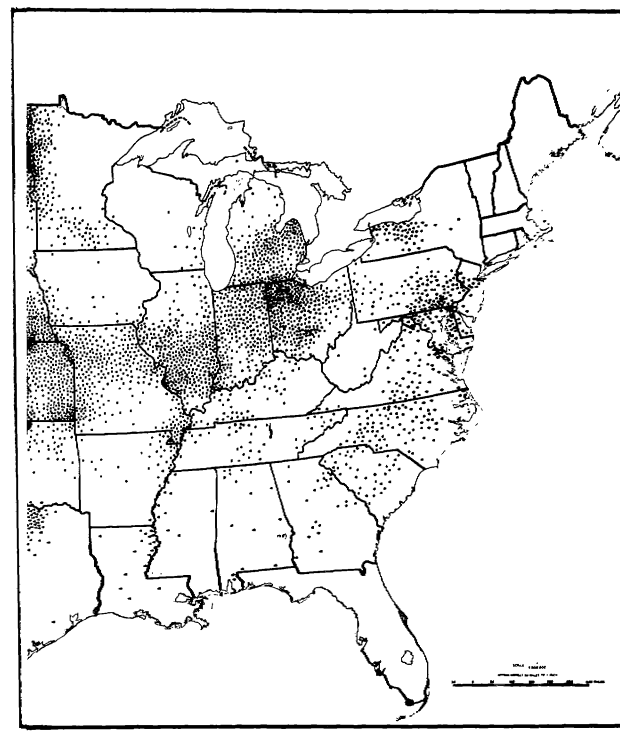

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FIGURE 1.—Distribution of the acreage of all wheat seeded in the Eastern United States in 1959. Each dot represents 5,000 acres.

USES OF WHEAT

Wheat is often grown because it is a good cash grain crop. It also serves as a cover crop to retard soil erosion and leaching during the late fall, winter, and early spring.

Most of the soft wheat grown in the eastern region is milled and sold to the bakery trade. Some, especially that grown in the lesser producing States, is fed to livestock.

The soft red winter wheat grown in this region is used for cake, cracker, biscuit, pastry, and general-purpose flours, and the white wheat is used for prepared breakfast cereals and for weaker flours used in making cookies or cake. Wheat grown in the Eastern United States is softer in texture and lower in protein content than the hard wheats used for making bread flours that are grown in the Plains States.

Wheat grain is a valuable feed for all classes of livestock. It is high in digestible nutrients, including protein. For most economical results it should be coarsely ground or rolled and under some conditions should be mixed with less concentrated feeds. Too finely ground wheat may form a heavy pasty mass in the stomach and cause an animal to lose appetite. Best results are obtained when the wheat constitutes not more than one-fourth to one-half the grain ration, with the rest made up of corn, barley, or oats. For dairy cows, the grain ration should be supplemented with a protein concentrate.

In the dairy- and beef-producing sections, wheat provides satisfactory pasture in the fall and early spring. Its use for this purpose is increasing, particularly in the Southeast. Young wheat plants are high in digestible protein, usually from 18 to 20 percent, and sometimes as high as 25 percent. The value of the wheat straw in some areas approaches that of the grain. In addition to serving as roughage for livestock, the straw is valuable for bedding and in conserving and supplementing barnyard manure.

CLIMATE AND SOIL FOR WHEAT

Wheat is adapted to a wide range of climate and soil. High rainfall, especially if accompanied by moderate or high temperature, is generally unfavorable to wheat production, because it intensifies disease and insect attacks and causes difficulties in harvesting and threshing unless the season at maturity is comparatively dry.

In the Eastern United States wheat is commonly grown in rotations with corn, soybeans, clovers, or grasses. Alfalfa is frequently used in long term rotations with wheat. Soils capable of producing satisfactory yields of these crops are well adapted for wheat. Like other small grains, wheat yields best on medium- to heavy-textured, well-drained soils with well-balanced fertility. A high nitrogen content in the soil in relation to other nutrients causes excessive vegetative growth and lodging and a predisposition to attacks by several diseases. It is not a satisfactory crop on poor, sandy soils or on poorly drained soils.

KINDS OF WHEAT

Wheat was unknown in North America before the discovery of the New World; hence, the varieties that are now grown were introduced from the Old World or are descendants of such varieties.

Since about 1915 efforts to obtain better varieties have depended mostly on hybridization, followed by selection, rather than on introduction from foreign countries. By this method the desirable traits of several varieties have been combined. Most of the acreage is now sown to improved varieties developed by State experiment stations in cooperation with the U.S. Department of Agriculture.

About 65 varieties of wheat are grown commercially in the East; the market class soft red winter wheat predominates.

Nearly all wheat grown in the Eastern United States is seeded in the fall and harvested the following spring or summer. Varieties of true winter wheat, if sown in the spring, seldom produce heads, or at best only a few heads, and for all practical purposes result in failure. True winter wheat varieties require low temperatures before normal heading occurs.

Spring wheat is relatively unsatisfactory where winter wheat will survive the winters. Conditions for seeding are less satisfactory in the spring than in the fall. Spring wheat ripens later and hence is more likely to be injured by rust, scab, mildew, and other diseases; by some insects; and by unfavorable weather. Yields usually are much lower and the quality inferior to that of the better varieties of winter wheat. Spring wheats are grown occasionally in the New England States and in the States bordering the Great Lakes, but the acreage is small.

Winter wheat falls into three classes: Hard red winter, soft red winter, and white. About 85 percent of the wheat grown in the Eastern United States is soft red winter. Soft white winter wheat is grown extensively in New York and Michigan. Hard red winter varieties as well as soft red winter varieties are grown on a considerable acreage in Illinois and Missouri, and the hard varieties to some extent in eastern Kentucky and Tennessee, and in Arkansas. The soft winter varieties are usually grown in humid climates on soils relatively low in available nitrogen. Under these conditions they produce grain low in protein, and of soft texture. This grain produces flour best suited for making cakes, crackers, cookies, and similar bakery products and for general-purpose family flours. Satisfactory bread, however, can be made from most varieties of soft wheat when the protein content is high enough, or from the flour of blends of soft and hard wheat.

In general, hard wheat is grown in areas with less than 30 inches of rainfall and on soils relatively rich in nitrogen, which favor the production of grain of high protein content. When hard wheats are grown in the Eastern United States, the grain is similar in protein content to that of soft varieties grown under the same conditions. It is harder than the grain of soft wheats, but much softer than when grown in the semiarid Great Plains. The mottled hard and soft condition of hard wheat kernels is known as yellow berry. Such grain is less desirable for low-protein flours than that produced by typical soft varieties. Nevertheless, hard winter wheat varieties are grown in some parts of the region because of their early maturity, winter hardiness, and productivity.

CHOOSING A VARIETY

Many varieties of winter wheat are grown on a commercial scale in the Eastern United States. Some have red grain, others have white; some have beards (awns), and others are beardless. They differ greatly in color of chaff and straw, in height, and especially in such important characteristics as winter hardiness, yield, quality, resistance to diseases, time of heading and ripening, resistance to lodging, and ability to tiller.

Because of the large number of varieties available and their great variation with respect to these characteristics, the choice of the best variety for a particular farm often is difficult. For example: Is it better to grow a red wheat or a white wheat? Do bearded varieties usually yield better than beardless varieties? Should disease resistance be considered? Are there important differences in quality, or is it sufficient to know that a given variety can be depended upon to give satisfactory yields? These and other questions should be considered by the grower.

Yield is the characteristic by which a variety is judged most commonly. No variety may be considered satisfactory unless its yield is good in comparison with others. However, yielding ability, or the tendency to produce a generally satisfactory yield over a period of years, is a difficult characteristic to judge. One reason for this is the variation in weather from year to year. Thus, a new variety may produce a good yield for 2 or 3 years, but may later prove to be unsatisfactory because of susceptibility to winterkilling, disease, or other damage. Farmers, therefore, may well be skeptical of new, untried varieties. To determine whether a given variety is a good yielder it must be grown for a number of years, preferably in comparison with other well-known standard varieties. This can be done most satisfactorily by agricultural experiment stations, where information should be sought if there is doubt as to the value of a variety.

Farmers of the Eastern States generally prefer beardless (or awnless) varieties. The straw from beardless varieties is more suitable for livestock use. There is considerable evidence to show that the beards aid in the filling of the grain, with the result that bearded wheats tend to have more plump grain than do beardless varieties. In some areas bearded varieties are grown because they are more winter hardy or more resistant to diseases. There is, however, no consistent relation between the presence of beards and yield in the Eastern States, and other varietal characteristics are generally more important. *It is advisable to depend upon performance records when choosing varieties.*

A satisfactory winter wheat must be sufficiently hardy to survive winters of average or more than average severity in the locality where it is to be grown. Winters fluctuate greatly in this respect.

Winterkilling in the Eastern States often is due to heaving as a result of the alternate freezing and thawing of the soil in late winter and early spring. In this process, ice lifts the plants and the roots are broken and exposed. The plants may be damaged or killed. Death due to freezing of the plant tissue is also common. Probably in many cases winterkilling is the combined result of these two types of injury and of standing water.

In general, the soft winter varieties are more resistant to heaving and less resistant to low temperatures than are hard winter varieties. Some progress has been made in producing new varieties that possess resistance to both types of cold injury.

With favorable conditions throughout the growing season, late-maturing varieties should produce the highest yields. Usually, however, conditions are not favorable throughout the season. Rust, scab, powdery mildew, Septoria, and other diseases appear in late spring; and in some areas the high temperatures of early summer are unfavorable for growth. On poor soils the supply of mineral elements may be insufficient to carry a late crop to maturity in the most satisfactory manner. For these reasons early-maturing or medium-maturing varieties usually produce better yields than those that require a long growth period.

It is often desirable to grow an early variety to get the crop off the land, so that harvest will not interfere with other farm work, or to give a grass or legume crop seeded with the wheat an opportunity to develop before hot weather, or to prepare the land for a summer crop. A delay of even a few days in harvesting can be very important.

Ability to resist lodging is a very important consideration in choosing a variety for this region, especially under conditions of heavy nitrogen fertilization, where lodging frequently occurs. The general use of the combine for harvesting has made strong straw especially important, since the harvest is delayed one or more weeks so the grain will be dry enough to store. Lodged grain is difficult and expensive to harvest. Lodging that

occurs before the grain is ripe generally interferes with the filling of the heads. This results in a low yield of grain with low test weight and poor quality. Varieties differ greatly in resistance to lodging. Most of the soft red and soft white varieties have reasonably stiff straw, and some of these are very resistant to lodging. The trend in the development of varieties for the future is toward shorter and stronger straw.

Wheat in the Eastern United States suffers from many diseases. The most significant diseases are leaf rust, Septoria leaf and glume blotch, stem rust, powdery mildew, loose smut, bunt (stinking smut), mosaic, and scab. Bunt and loose smut can be prevented by seed treatment but this requires special equipment

Diseases in general can be controlled only by the growing of resistant varieties so far as they are available. It is obviously desirable to use resistant varieties if they are satisfactory in other respects. Resistance of each variety to the various diseases is shown in tables 2, 4, and 5 (pp. 6 to 10).

Only varieties of satisfactory quality for making soft wheat products should be grown. At times the hard, high-protein, strong-gluten wheat of the Great Plains sells at a premium over soft winter wheat, and the question often arises whether high-protein hard wheat cannot and should not be grown in the Eastern United States. Hard wheats grown in this region generally are low in protein content and are not satisfactory either for bread or for cakes and cookies. Flour from such wheats is used to some extent for blending with either hard wheat flour or soft wheat flour.

VARIETIES FOR THE EASTERN UNITED STATES [1]

As it is impracticable to give a complete description of all the varieties of wheat grown in the Eastern United States, only the varieties of commercial importance are discussed in this bulletin. They are shown in tables 1 through 5 according to class and grain color.

Varieties With Soft Red Grain

Most of the wheat grown in the Eastern United States has soft red grain (fig. 2). Some varieties have a wide area of adaptation—Knox, for example (fig. 3)—and are produced in a number of the States. Others are suited only for growing in a restricted geographical area. A few varieties grown in the Southeastern States are particularly high in protein, although classed as soft wheat.

[1] Acreage and distribution information is based on REITZ, L. P., and BRIGGLE, L. W. DISTRIBUTION OF THE VARIETIES AND CLASSES OF WHEAT IN THE UNITED STATES IN 1959. U.S. Dept. Agr. Stat. Bul. No. 272, 83 pp., illus. 1960.

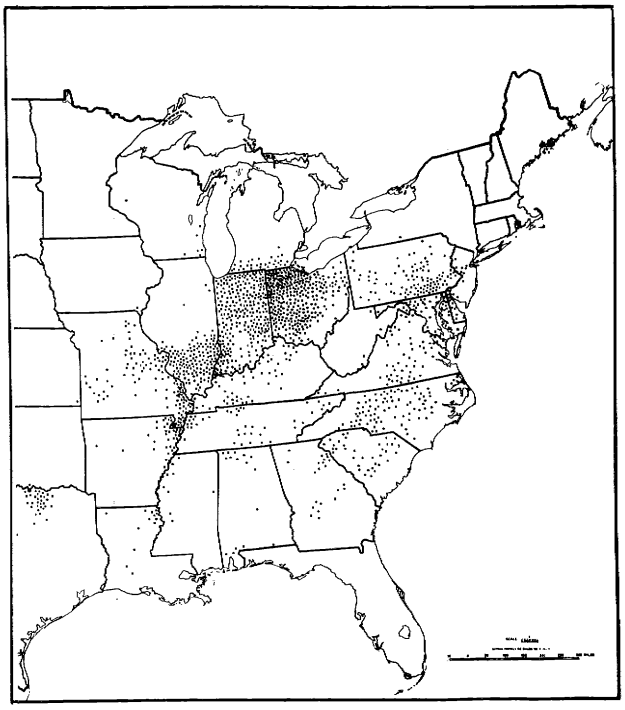

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FIGURE 2.—Distribution of the acreage seeded to soft red winter wheat in the Eastern United States in 1959. Each dot represents 5,000 acres.

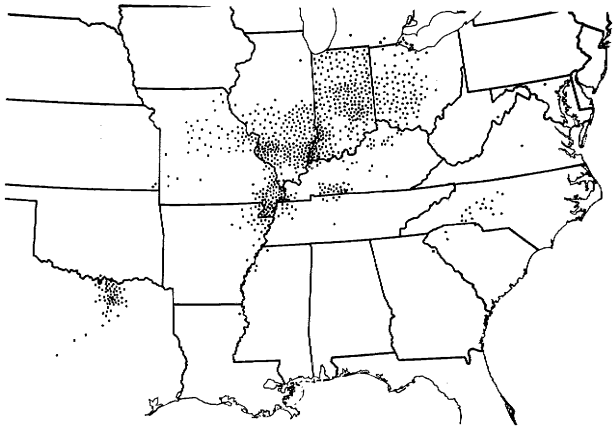

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FIGURE 3.—Distribution of the acreage of Knox, the leading variety of soft red winter wheat in 1959. Each dot represents 2,000 acres.

These soft red varieties have specialized uses, such as blending with hard wheat shipped in from the Plains States for the production of bread-baking flour. Frequently the high-protein southeastern wheats are used in the production of general-purpose or "family-type" flour. Unfortunately our present grain-marketing system does not allow

for keeping wheat of one protein level separate from another, so that variety identification is lost in the marketplace. Most buyers for the milling industry procure wheat of a specific quality type from a predetermined geographical area.

Soft red varieties presently grown in the eastern region and their quality characteristics are shown in table 1. The distribution of these varieties and their reactions to disease and insect attacks are given in table 2.

TABLE 1.—*Plant and quality characteristics of soft red winter varieties of wheat grown in the Eastern United States*

[Used for cracker-sponge or cracker-dough, biscuit, cake, cookie, doughnut, or pretzel flour, unless otherwise indicated]

Variety	Awnedness and chaff color [1]	Plant height	Strength of straw	Maturity	Relative protein level	Relative kernel texture
Ace	Awnless, white.	Short to midtall.	Midstrong to strong.	Midseason to late.	Moderate	Soft to semi-hard.
Anderson	Awnless, brown.	Tall	Midstrong	Midseason	do	Do.
Atlas 66 [2]	Awnless, white.	Short to midtall.	do	do	High	Do.
Blackhawk [3]	Awned, white.	Tall	do	Midseason to late.	Moderate	Soft. [4]
Bledsoe	Awnless, white.	do	do	Very early	do	Do.
Butler	Awned, white.	Midtall	do	Midseason	Low	Do.
Chancellor	Awnless, white.	do	do	Early	do	Do.
Clarkan	do	do	do	Midseason	Moderate	Soft to semi-hard.
Coastal	do	Midtall to tall.	Midstrong to weak.	do	do	Do.
Coker 47-27	do	Midtall	Midstrong	do	do	Do.
Dual	do	Short to midtall.	do	do	Low	Soft.
Georgia 1123	do	do	Midstrong to strong.	Very early	Moderate	Soft to semi-hard.
Knox	do	do	Midstrong	Early	Low	Soft.
LaPorte	do	Midtall to tall.	do	Early to midseason.	do	Do.
Leap	do	Midtall	Midstrong to weak.	Midseason	do	Do.
Lucas	do	do	Midstrong	do	do	Do.
Monon	do	Short	do	Early	do	Do.
Pennoll	do	Tall	do	Midseason	do	Do.
Purplestraw	do	Midtall	do	Early	do	Do.
Racine	Awned, white.	do	Weak	Midseason	do	Do.
Redcoat	Awnless, white.	do	Very strong	do	do	Do. [4]
Redhart	do	do	Strong	Early to midseason.	Moderate	Semihard.
Seneca	Awnless, brown.	do	Strong	do	do	Do.
Tayland	Awnless, white.	do	Midstrong	do	do	Do.
Taylor	do	do	do	do	Moderate	Do.
Taylor 49	do	do	do	do	do	Do.
Thorne	Awnless, brown.	do	Midstrong to strong.	do	Low	Do.
Todd	Awnless, white.	do	Midstrong	do	do	Do.
Vahart	do	do	do	do	do	Soft to semi-hard.
Vermillion	do	Short to midtall.	do	Early	do	Soft.
Vigo	do	Tall	do	Midseason	do	Do.
Wakeland	do	Short to midtall.	Midstrong	Early	Moderate	Soft to semi-hard.

[1] Awnless, i.e., beardless, class includes those varieties that are classified awnleted.

[2] Used for blending with hard wheat flour for commercial bread production, also milling of family trade flour.

[3] Used for cake and cookie flour, and breakfast foods.

[4] Under some conditions, the kernels tend to be semi-hard.

TABLE 2.—*Distribution of soft red varieties of wheat grown in the Eastern United States and their reaction to diseases and the Hessian fly* [1]

Variety and States within which grown [2]	State and year of release	Reaction of variety to—				
		Leaf rust	Powdery mildew	Soilborne mosiac	Loose smut	Hessian fly
Ace [3]	Arkansas, 1961.	Resistant	Moderately resistant.	Resistant	Moderately resistant.	Resistant.
Anderson: Alabama, Arkansas, Delaware Georgia, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, West Virginia.	South Carolina, 1951.	Moderately resistant.	do	Susceptible	do	Susceptible.
Atlas 66: Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Virginia.	North Carolina, 1948.	do	do	do	Susceptible	Do.
Blackhawk: Wisconsin	Wisconsin, 1944.	do	Susceptible	do	Moderately resistant.	Do.
Bledsoe: Alabama, Arkansas, Georgia, Louisiana, Mississippi.	Georgia, 1956	Resistant	Moderately resistant.	Resistant	Susceptible	Do.
Butler: Ohio	Ohio, 1947	Susceptible	Susceptible	do	Resistant	Do.
Chancellor: Arkansas, Georgia, Louisiana, Mississippi.	Georgia, 1947.	do	do	do	Susceptible	Do.
Clarkan: Missouri, New Jersey	Kansas, 1934.	do	do	Susceptible	do	Do.
Coastal: Alabama, Georgia, Louisiana, Mississippi, South Carolina.	South Carolina, 1949.	do	do	do	do	Do.
Coker 47–27: Alabama, Arkansas, Georgia, Mississippi, North Carolina, South Carolina, Tennessee.	South Carolina, 1950.	do	do	do	do	Do.
Dual: Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, Ohio, Pennsylvania, West Virginia.	Indiana, 1955.	Resistant	Moderately resistant.	Moderately resistant.	do	Resistant.
Georgia 1123 [3]	Georgia, 1959.	do	Susceptible	Resistant	do	Do.
Knox: Arkansas, Georgia, Illinois, Indiana, Kentucky, Louisiana, Missouri, Mississippi, North Carolina, Ohio, South Carolina, Tennessee, Texas, West Virginia.	Indiana, 1953.	do	Moderately resistant.	do	do	Susceptible.
La Porte: Indiana	Indiana, 1957.	Moderately resistant.	do	Moderately resistant.	Resistant	Do.
Leap: Maryland, Virginia	Virginia, 1907.	Susceptible	Susceptible	Resistant	Susceptible	Do.
Lucas [3]	Ohio, 1959	do	do	Moderately resistant.	do	Do.
Monon [3]	Indiana, 1959.	Resistant	Moderately susceptible.	Resistant	do	Resistant.

See footnotes at end of table.

TABLE 2.—*Distribution of soft red varieties of wheat grown in the Eastern United States and their reaction to diseases and the Hessian fly* [1]—Continued

Variety and States within which grown [2]	State and year of release	Reaction of variety to—				
		Leaf rust	Powdery mildew	Soilborne mosiac	Loose smut	Hessian fly
Pennoll: Delaware, Maryland, New Jersey, New York, Ohio, Pennsylvania, West Virginia.	Pennsylvania, 1951.	Susceptible	Susceptible	No data	Moderately resistant.	Susceptible.
Purplestraw: Georgia, Tennessee	Unknown, about 1822.	do	do	Susceptible	Susceptible	Do.
Racine: Wisconsin	Wisconsin, 1956.	Moderately resistant.	Moderately resistant.	do	Resistant	Do.
Redcoat [3]	Indiana, 1960.	Resistant	Resistant	Resistant	Moderately susceptible.	Resistant.
Redhart: Georgia, North Carolina, South Carolina, Virginia.	South Carolina, 1921.	Susceptible	Susceptible	Susceptible	Susceptible	Susceptible.
Seneca: Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, Wisconsin.	Ohio, 1950	do	do	Resistant	do	Do.
Tayland: Arkansas, Delaware, Maryland	Maryland, 1954.	do	do	Susceptible	Moderately resistant.	Do.
Taylor: Arkansas, Georgia, Maryland, North Carolina, South Carolina.	South Carolina and North Carolina, 1953.	do	do	do	do	Do.
Taylor 49: Arkansas, South Carolina	North Carolina, 1956.	do	do	Resistant	do	Do.
Thorne: Delaware, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia.	Ohio, 1937	do	do	do	Susceptible	Do.
Todd: Kentucky	Kentucky, 1956.	do	Moderately resistant.	do	Resistant	Resistant.
Vahart: Virginia	Virginia, 1945.	do	Susceptible	do	Moderately resistant.	Susceptible.
Vermillion: Arkansas, Illinois, Indiana, Kentucky, Missouri, Ohio.	Indiana, 1955.	Resistant	do	do	Susceptible	Do.
Vigo: Indiana, Kentucky, Missouri, Ohio, Tennessee, West Virginia.	Indiana, 1946.	Susceptible	do	Moderately resistant.	Moderately resistant.	Do.
Wakeland [3]	North Carolina, 1959.	Moderately resistant.	Moderately resistant.	Susceptible	do	Do.

[1] Disease and insect reactions are based on current field observations only.

[2] Acreage of variety listed as grown within the State is 1 percent or more of total State wheat acreage in 1959.

[3] Recently released varieties that did not appear in Distribution of the Varieties and Classes of Wheat in the United States in 1959. U.S. Dept. Agr. Stat. Bul. No. 272, 1960.

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Varieties With Soft White Grain

Varieties with soft white grain are of importance only in New York and Michigan (fig. 4), where they occupied 96 and 83 percent, respectively, of the acreages sown to wheat in 1959. Only four varieties of this class are important commercially in the Eastern States. Their quality characteristics are shown in table 3 and their reaction to diseases and to the Hessian fly, in table 4.

These varieties produce grain that is very soft and that mills into flour of weaker gluten strength than most of the soft red varieties. Much of the grain is used for prepared whole-grain breakfast cereals, and flour milled from soft white wheat is used for cookies or other products that require flour with low gluten strength.

TABLE 3.—*Plant and quality characteristics of soft white and hard red varieties of wheat grown in the Eastern United States*

Type and variety	Awnedness and chaff color [1]	Plant height	Strength of straw	Maturity	Relative protein level	Relative kernel texture [2]	Appropriate use
SOFT WHITE WINTER							
Avon	Awnless, brown.	Midtall	Midstrong	Midseason	Low	Soft	(3)
Cornell 595	do	do	do	do	do	do	(3)
Genesee	do	do	do	do	do	do	(3)
Yorkwin	Awnless, white.	Tall	do	do	do	do	(3)
HARD RED WINTER							
Concho	Awned, brown.	Short to midtall.	do	Early to mid-season.	Moderate	Hard	(4)
Pawnee	Awned, white.	Short	Strong	Early	do	do	(4)
Ponca	do	do	Midstrong	do	do	do	(4)
Triumph	do	do	do	Very early	do	do	(4)
Westar	do	Midtall	do	Early to mid-season.	do	do	(4)
Wichita	Awned, white with black.	Short	do	Very early	do	do	(4)
HARD RED SPRING							
Henry	Awned, white.	Midtall	do	Midseason	do	Semihard	(4)
Russell	do	do	Weak	do	do	do	(4)
Selkirk	Awnless, white.	Short to midtall.	Strong	Early to mid-season.	do	Hard	(4)

[1] Awnless, i.e., beardless, class includes those varieties which are classified as awnleted.

[2] Varieties herein described as hard in texture have low pearling and particle size indices, characteristic of hard wheats, but are generally nonvitreous, i.e., starchy (when grown in the soft wheat area), and are often referred to as "semihard."

[3] Cake and cookie flour, and breakfast foods.

[4] Blending with hard wheat flour for commercial bread production, also milling of family trade flour.

TABLE 4.—*Distribution of soft white varieties of wheat grown in the Eastern United States and their reactions to diseases and the Hessian fly* [1]

Variety and States within which grown [2]	State and year of release	Reaction of variety to—					
		Leaf rust	Powdery mildew	Soilborne mosaic	Loose smut	Dwarf bunt [3]	Hessian fly
Avon [4]	New York, 1958.	Susceptible	Susceptible	Moderately resistant.	Moderately resistant.	Resistant	Susceptible.
Cornell 595: Michigan, New Jersey, New York, Tennessee.	New York, 1942.	do	do	Resistant	do	Susceptible	Do.
Genesee: Michigan, New York.	New York, 1951.	do	do	Moderately resistant.	do	do	Do.
Yorkwin: Michigan, New York.	New York, 1935.	do	do	Resistant	Susceptible	do	Do.

[1] Disease and insect reactions are based on current field observations only.

[2] Acreage of variety listed as grown within the State is 1 percent or more of total State wheat acreage in 1959.

[3] Based on field tests conducted in New York.

[4] Recently released variety that did not appear in Distribution of the Varieties and Classes of Wheat in the United States in 1959. U.S. Dept. Agr. Stat. Bul. No. 272. 1960.

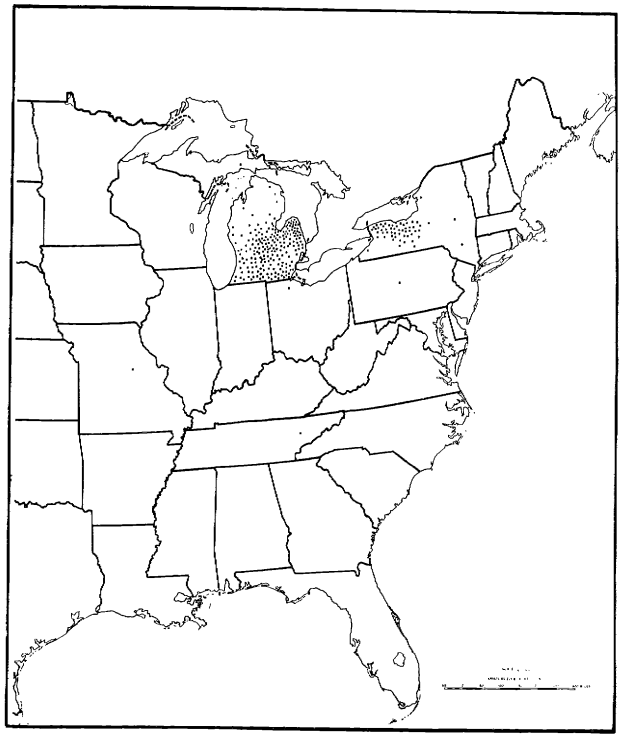

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FIGURE 4.—Distribution of the acreage of white wheat in the eastern region of the United States in 1959. Each dot represents 5,000 acres.

Hard Red Wheat

The acreage of varieties with hard red grain has increased greatly in recent years in Missouri and occupied three-fourths of the wheat acreage in that State in 1959. Hard red winter varieties (tables 3 and 5) continued to be grown on a large acreage in Illinois and occupied about two-thirds of the wheat acreage of the State in the 1959 survey. Most of this acreage consists of Pawnee, Triumph, and Ponca winter wheats well adapted to the transition area between the soft red winter and the hard red winter regions. Those hard red winter wheats have become popular with farmers because of their early maturity, short stature, and ability to yield. Such wheats fit well into the management systems of eastern farmers. The wheat can be harvested and the land prepared for a second crop—generally soybeans or some other legumes—or it can be kept clean of weeds prior to fall planting.

Reactions of hard red winter wheat to diseases and the Hessian fly are listed in table 5.

Recently developed soft red wheats, such as Knox, Vermillion, and Monon, fit equally well into the same management systems, through early maturity, short and strong straw, and outstanding yields. They are expected to compete favorably with the hard red wheats for acreage in the transition zone.

When hard wheat varieties are grown in the soft wheat region, the protein content of the two

TABLE 5.—*Distribution of hard red varieties of wheat grown in the Eastern United States and their reactions to diseases and the Hessian fly* [1]

Variety and States within which grown [2]	State and year of release	Reaction of variety to—				
		Leaf rust	Powdery mildew	Soilborne mosaic	Loose smut	Hessian fly
WINTER WHEATS						
Concho: Arkansas	Oklahoma, 1954.	Moderately resistant.	Susceptible	Resistant	Moderately resistant.	Susceptible.
Pawnee: Illinois, Indiana, Kentucky, Missouri, Tennessee, Virginia, West Virginia, Wisconsin.	Nebraska, 1942.	do	do	Susceptible	Resistant	Do.[3]
Ponca: Arkansas, Illinois, Missouri	Kansas and Oklahoma, 1951.	Resistant	do	do	do	Resistant.
Triumph: Arkansas, Illinois, Kentucky, Missouri, Tennessee.	Oklahoma, 1940.	Susceptible	do	do	do	Susceptible.
Westar: Illinois	Texas, 1944	Moderately resistant.	do	Moderately resistant.	Susceptible	Do.
SPRING WHEATS						
Henry: Wisconsin	Wisconsin, 1944.	do	do	(4)	do	Do.
Russell: Wisconsin	Wisconsin, 1956.	Susceptible	Moderately resistant.	(4)	Resistant	Resistant.
Selkirk: Wisconsin	Manitoba, Canada, 1953.	Moderately resistant.	do	(4)	do	Susceptible.

[1] Disease and insect reactions are based on current field observations only.

[2] Acreage of variety listed as grown within the State is 1 percent or more of total State wheat acreage in 1959.

[3] Pawnee is resistant to the strains of Hessian fly predominant in the hard red winter region (particularly Central Plains States), but is susceptible to the strains predominant in the eastern soft wheat region.

[4] Reactions not available on spring wheats.

is approximately the same. When grown in Missouri and Illinois the protein content is lower than is desired for most hard wheat flours, and the texture of the grain and other properties make these varieties undesirable for soft wheat flours. They are used for blending with high-protein grain, and for general-purpose flours.

Hard red spring wheat is not grown extensively in the Eastern States, except for a limited amount in Wisconsin and occasionally in northern Illinois.

GROWING WINTER WHEAT

Many factors are involved in growing a crop of wheat successfully. Only the more important factors are considered here.

ROTATIONS

It is not advisable or profitable to grow wheat continuously on the same land in the Eastern United States, but wheat fits into many of the crop rotations used in this region. The crops to be used in a rotation, their sequence, management, and use are determined by the climate, length of growing season, soil type and fertility, and type of farming. State agricultural experiment stations conduct rotation and fertilizer experiments on the different types of soil and are prepared to make specific local recommendations.

Winter wheat serves as a good winter cover crop to reduce leaching and erosion during the winter. At the same time it may be of considerable value for pasture, especially in the South where it provides grazing during midwinter when other pasturage may not be available.

Wheat fits well into a rotation which contains at least one legume and one or more cultivated or row crops. Adequate attention must be given to lime and fertilizer requirements to make rotations fully successful. Seeding with wheat serves

as a convenient and inexpensive means of obtaining a stand of clover, as the preparation of the ground for wheat suffices also for clover, even when the latter is sown in the late winter or early spring. As a companion crop, wheat shades the ground less and is harvested earlier than oats and usually is more profitable than rye. Inasmuch as cattle are raised on most farms, the growing of wheat is an advantage, as wheat furnishes valuable pasture and straw, and occasionally the grain is used for feed.

The fact that wheat is well suited as a companion crop for clover or grasses, whether alone or in combination, means that it should occupy a place in the rotation preceding them. Where corn can be grown successfully, it makes better use than most crops of the improved productivity of the land brought about by growing clover and grass. Corn, therefore, is usually grown following these crops.

Spring oats can be sown conveniently after corn, particularly in Corn Belt States, and the crop is harvested early enough to provide plenty of time to prepare the land for wheat. Thus a natural and efficient rotation for much of the Eastern United States is wheat 1 year, clover or grass and clover 1 or 2 years, and corn 1 or more years, and oats 1 year. Ordinarily, the clover and grass, or as much of the clover as is left after the first winter, is grown 2 years. On very rich soil corn may be grown 2 or more years successively, thus increasing the length of the rotation and the acreage of the corn crop. Corn is likely to produce the greatest amount of feed or acre return in the rotation.

Soybeans or cowpeas may be substituted very profitably for oats or for corn in many localities when an increased acreage of these crops is desired. In tobacco-growing localities, tobacco may be grown in place of the oats. Barley may occasionally be substituted for oats, but spring barley is not a satisfactory crop on poor soil in rotation with corn in localities where scab or chinch bugs are likely to be prevalent, as in Illinois and Missouri.

In recent years wheat often has been more profitable after soybeans than after corn, because soybeans are harvested earlier and the seedbed for wheat can be prepared earlier and with less effort. Hence, when these crops are grown, the rotation may well be corn, soybeans, wheat, and clover, each 1 year. Such a rotation is especially satisfactory if the soybeans are to be cut for hay. Usually all that is necessary to prepare soybean land for wheat is a thorough disking, and even this may sometimes be dispensed with if the ground is loose and mellow.

With the advent of early-maturing wheat and soybean varieties the practice of double-cropping (2 crops in succession during 1 year) has gained favor. Where wheat can be harvested early enough, a soybean crop can follow immediately that same season.

Where wheat follows corn, the corn may be cut and put into the silo, or shocked, thus permitting earlier preparation of the land and seeding. When the crop is harvested with a mechanical picker, the stalks should be plowed under in preparing the seedbed. Wheat occasionally is seeded between the standing rows of corn.

Some good rotations or cropping systems for the central and northern parts of the Eastern United States are as follows:

Rotation No. 1: Corn; wheat; red clover.

Rotation No. 2: Corn; wheat (red clover and grass seed with wheat); red clover and grass 2 years. Orchardgrass generally is used in the central part, and timothy or bromegrass in the northern area.

Rotation No. 3: Corn (rye planted in standing corn for winter cover); soybeans; wheat; red clover.

Rotation No. 4: Corn; oats (red clover seeded with oats as catch crop for winter soil protection); soybeans; wheat; red clover.

Sweetclover can be used in the above rotations in place of red clover provided effective insecticides are used to control the sweetclover weevil (*Sitona cylindricollis* F.). In recent years, damage from the weevil has become the restricting factor in the use of sweetclover as a legume in common rotations.

In long term rotations, alfalfa can well be used in place of red clover, sweetclover, or the clover-grass mixture. In some instances a mixture of alfalfa with the clover (grass can be included also) is grown and left down for 2 or more years.

In the South, somewhat different rotations are needed because of the longer growing season, different type of soil, mild, rainy winters that favor erosion, and the fact that cotton is an economically important crop. Because of the late maturity of cotton, wheat does not follow it satisfactorily in many areas. Usually, if cotton is included in the rotation, it is followed by corn or soybeans. The following rotations including wheat have been found satisfactory:

Rotation No. 1: Wheat, followed by cowpeas or soybeans (rye or crimson clover for winter cover); cotton, well-fertilized, with a legume (crimson clover, vetch, persian clover or rough peas), legume and ryegrass mixture, or ryegrass alone between the rows for green manure; corn.

Rotation No. 2: Wheat, followed by cowpeas or soybeans and then winter cover crop; corn followed again by a winter cover crop; soybeans.

Rotation No. 3: Wheat (clover and grass seeded with wheat); clover and grass 2 years for hay or pasture; corn, crimson clover at last cultivation; soybeans or cowpeas.

Wheat and oats, whether grown for grain, cover crop, or green manure are commonly grazed. Rye

is grazed also, but is seldom grown for a grain crop in the South.

FERTILIZATION

Commercial fertilizers and manure may be used to good advantage in growing the wheat crop in most areas in the Eastern States. The best fertilizer or fertilizer combination to use on wheat or in a rotation containing it depends largely on the soil type and state of productivity of the soil. Productivity is related to the nature of the soil, its previous treatment, and climatic conditions.

Soils of the Eastern United States, except the dark-colored soils of the prairies and of low-lying, imperfectly drained areas, commonly are low in nitrogen. The nitrogen deficiency can be corrected by plowing under crops of legumes, adding manure, or by applying commercial fertilizer. When the wheat plants have light-green foliage, it is usually an indication of shortage of available nitrogen.

Inoculated legumes fix uncombined nitrogen from the air. The amount of nitrogen (up to 50 to 100 pounds per acre) added to the soil depends on the kind of legume grown and the type of management program followed. Generally, when more top growth is turned under, more nitrogen is added. Nonleguminous crops such as wheat depend on nitrogen derived from decomposition of soil organic matter and manure, or from applied chemical fertilizers.

Manure is a valuable fertilizer and soil conditioner for wheat, but it is used most economically when applied to the corn, tobacco, or cotton crop in the rotation. On both light sandy soils and heavy clay soils, application of well-rotted manure supplies humus which improves the physical condition of the soil and also adds valuable nutrients, particularly nitrogen and potash.

Commercial fertilizer is generally applied to wheat land at seeding time by means of an attachment to the grain drill. A complete chemical fertilizer is most often used. Additional amounts of nitrogen may be added in the spring as a top dressing. The fertilizer formula and the rate of application will vary with locality, soil type, and cropping history. Recommendations from the local county agricultural agent or soil testing laboratory of the State agricultural experiment station should be followed.

Average amounts of nutrients per fertilized acre and percentage of total wheat acreage fertilized in some of the Eastern States are shown in table 6. About 70 percent of the wheat acreage in the humid region in the Eastern States received fertilizer.

There has been a trend toward increasing rates of nitrogen application in all parts of the region. The Southeastern States generally use higher N (nitrogen) rates than other humid region States.

TABLE 6.—*Wheat: Percentage of acres fertilized, and rate of application of nutrients per acre, Eastern States, 1954*[1]

State	Harvested acres fertilized	Nutrients per fertilized acre		
		Nitrogen	Available phosphoric oxide	Potash
	Percent	*Pounds*	*Pounds*	*Pounds*
Delaware	90	35	50	50
Georgia	72	37	34	32
Illinois	71	12	55	56
Indiana	92	25	34	37
Maryland	92	21	34	19
Michigan	83	12	40	40
Missouri [2]	84	15	26	18
New Jersey	83	26	52	52
New York	88	21	36	29
North Carolina	85	28	36	29
Ohio	91	17	35	35
Pennsylvania	88	11	35	27
South Carolina	90	32	13	14
Tennessee	66	24	29	11
West Virginia	84	14	43	22

[1] Source: ADAMS, J. R., NELSON, L. B., and IBACH, D. B. FERTILIZATION OF WHEAT ON INCREASE, BUT BIG POTENTIAL REMAINS, USDA SURVEY SHOWS. Croplife 5 (37): 5. 1958. (Also reprinted as a separate of Croplife, Sept. 15, 1958, under title of "Crop-Use Patterns of Fertilizer in the United States.")

[2] Does not incude data for 30 counties in southeastern Missouri.

Coastal Plain soils in the Carolinas and Georgia receive somewhat higher rates than soils in the adjacent Piedmont area. The sandstone and shale soils of the Allegheny-Cumberland Plateau of eastern Ohio receive about double the rate of N used in the remainder of that State.

High rates of potash (K_2O) and phosphate when applied to wheat give favorable responses on many soils in the region.

Nitrogen is generally applied in the form of ammonium nitrate. Nitrogen solutions and anhydrous ammonia are becoming increasingly important. Sodium nitrate is also commonly used in the Southern States east of the Mississippi River and ammonium sulphate in Ohio, Indiana, Illinois, Michigan, and Wisconsin.

Phosphate is applied generally as superphosphate or ammoniated phosphate.

Most potash is used in the form of potassium chloride.

When the soil is more than moderately acid, an application of 1 to 2 tons per acre of ground limestone can be beneficial, but most of the benefit may be indirectly gained by improving the legume crop in the rotation. Wheat itself is not injured by a slightly acid soil, but most legumes grown in the rotation, especially alfalfa and sweet-

clover, will be decidedly benefited by the proper use of lime.

Time and rate of fertilizer application have an effect on the protein content of the wheat crop harvested. With the advent of shorter and stronger strawed varieties, farmers are currently using heavier rates of application. Frequently available nitrates in the soil are still plentiful when the wheat plants reach the heading stage. Under these conditions more nitrogen than usual is stored in the kernel in the form of protein, and a high protein grain crop is produced. If the wheat crop is topdressed with nitrogen in early spring, generally the protein content of the ensuing grain crop is not affected. However, if the rate of application is unusually heavy, or if the nitrogen is not applied until near heading time, this practice also can increase the protein content of the grain. High protein content is desirable in hard wheats, but not in the soft wheats processed through conventional milling procedures.

Preparing the Land

The time and method of preparing the land for wheat depends principally on the crop that precedes it. Unless rainfall is high and the land subject to erosion, it is desirable to have the land prepared considerably in advance of seeding to permit settling and the accumulation of moisture and available plant food, especially nitrates. When the land is to be plowed, as after a small-grain crop, at least a month should intervene between plowing and seeding. The soil can generally be plowed easily with best results when it is in a proper friable condition. This often occurs soon after harvest. After the ground dries, it is likely to turn up cloddy and lumpy and will be difficult to work into a good seedbed. If plowing must be delayed for any reason, disking the ground immediately after harvest is beneficial.

The depth of plowing should be governed to a considerable extent by the quantity of stubble, weeds, and cover crop to be turned under, and should be deep enough to do this thoroughly. Also, the land should be plowed somewhat deeper if it is done early rather than late. A common practice is to plow 6 to 7 inches deep in July and early August, gradually decreasing the depth to 4 to 5 inches in late August and September. Ordinarily there is no advantage in plowing deeper than is here indicated.

After plowing, the ground should be disked and harrowed to control weeds and volunteer grain and to put the soil in condition for seeding.

Much of the acreage of wheat in the Eastern United States follows corn or soybeans in rotation. Usually, the time of harvesting and the condition of the land after the crop is removed determine the preparation of the ground for wheat.

Where corn is harvested with mechanical pickers, the land preferably should be plowed to turn under the cornstalks, which helps to control the corn borer and the scab fungus that are in or on the stalks. When winter wheat is to follow corn that has been harvested with a picker, there usually is not sufficient time to permit plowing before seeding wheat, except in the South. The cornstalks should be thoroughly disked to permit seeding with a grain drill. The use of earlier maturing corn hybrids allows more time for seedbed preparation. Soybeans often leave the ground free from weeds, friable, and in good condition for seeding, with little or no preparation needed other than disking and harrowing.

Seed and Seeding

Wheat, unlike rye or corn, is normally self-pollinated; therefore, pure seed of an adapted variety will not change, because of the locality in which it is grown, provided there is no outcrossing or mixture with other varieties. It is best to thresh that part of the crop to be used for seed after threshing the main crop of the same variety, to lessen the chance of mixing. It is also advisable to go back to a source of certified seed whenever mixtures, weeds, or seedborne diseases contaminate the variety.

Weed seeds, smut balls, and broken and small kernels often may be removed with the fanning mill. If wheat has a heavy infestation of bunt (stinking smut) or nematodes, is moldy, or shows signs of having sprouted, it should not be used for seed.

Sound wheat that has been stored in a dry bin ordinarily germinates satisfactorily. However, if it has been wet or there is any other reason to suspect that its vitality has been injured, it should not be sown, unless it germinates at least 90 percent. The germination can be determined by a simple test. Viable seed placed on moist blotting paper, enclosed in a glass container with a loose-fitting cover, will germinate in 3 to 5 days if maintained at room temperature and exposed to normal light (not in direct sunlight). Wheat 1, 2, or even 3 years old may be used for seed if it germinates satisfactorily. Seed older than this is likely to be unsatisfactory.

In the early history of this country wheat was sown broadcast for want of satisfactory machinery, but at present wheat is sown with a drill. Drilling saves seed, insures better germination and more uniform stands, reduces winter injury, and almost always produces better yields. Drills are of three general types—hoe, shoe, and single- and double-disk drills. Single-disk drills are used most commonly. Hoe drills are satisfactory only on clean land and have some advantages on stony land. Drills with rows 6, 7, or 8 inches apart

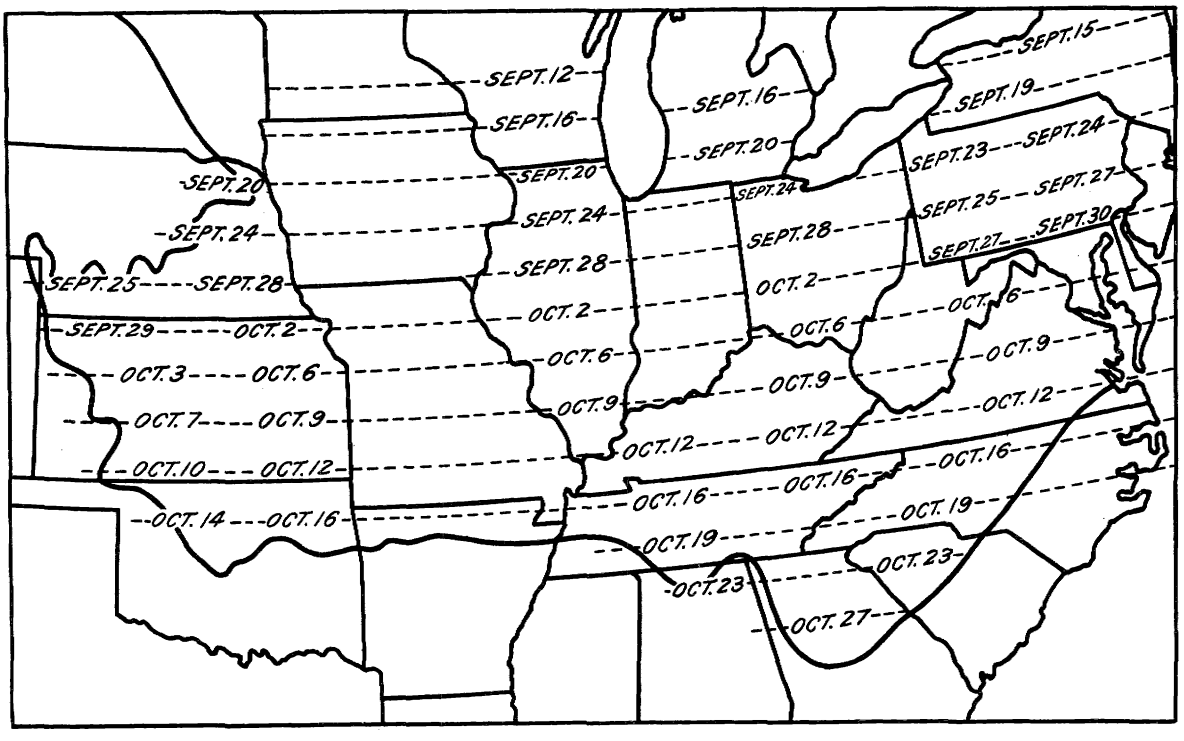

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FIGURE 5.—Approximate safe dates for sowing winter wheat to avoid fall infestation from Hessian fly.

are generally the most satisfactory. If the land is subject to washing, the drilling should be on the contour to reduce erosion.

Winter wheat in the Eastern United States is usually sown at the rate of from 5 to 8 pecks per acre. Generally seeding at the rate of 6 pecks per acre will produce larger yields than will a lesser rate. Heavier seeding ordinarily is advisable if seeding is delayed beyond the normal date, as there is less opportunity for the plants to tiller. Wheat grown primarily for grazing is generally sown at the rate of 8 pecks or slightly more per acre.

Varieties differ in their tillering capacity, but all recommended varieties, if seeded at the proper rate and time and under favorable conditions, will produce enough stems to insure optimum occupation of the land.

There is no advantage in seeding wheat deeper than is necessary to insure sufficient moisture for good germination. In light soils the seed may be safely sown deeper than in heavy soils. Covering the seed from 1 to 1½ inches is usually sufficient.

Wheat should be sown early enough to become well established before winter, but not so early that it makes a rank growth or starts to shoot before winter, nor early enough to become infested with the Hessian fly if this insect is prevalent. Usually this means early enough to permit tillering so that the wheat will cover the ground reasonably well. Average dates are mid-September in the Northern States to early November in the South. Wheat grown for grazing should be seeded up to 3 weeks earlier than the so-called normal date, providing the variety used is resistant to the Hessian fly. Recently developed resistant varieties are available. (See tables 2, 4, and 5.) Occasionally heavy epidemics of leaf rust or mildew will occur during the fall on early sown wheat. State experiment stations can provide information on resistance in the seedling stage to these diseases.

To avoid fall infestation of susceptible varieties of wheat by the Hessian fly it is advisable to delay fall seeding until the safe date (fig. 5), which is the earliest date in the fall at which wheat can be seeded and still, under average conditions, escape fall damage from this insect. These dates have been established experimentally and, of course, vary for different parts of the country and from year to year. Wheat growers are advised to consult their State agricultural experiment stations or county agents regarding the best seeding date for specific counties or areas for any given year. Use of fly-resistant varieties is desirable, whether sown early or on the approximate fly-free date.

PASTURING

Wheat is a highly nutritive pasture crop, because the young plants contain nearly as much protein as does alfalfa hay. Little or no injury to the grain crop results when pasturing is done judiciously. The plants should be well established before pasturing begins; otherwise, they may be uprooted by grazing animals. The date for turning in livestock depends upon the growing season. Livestock should be kept off the field when the ground is wet and soft. Injury is likely to be especially severe to grass or clover underseeded in the wheat, if it is pastured when the land is muddy.

Spring pasturing may be practiced under favorable conditions, but a loss in grain yield should be expected. The loss is likely to be especially heavy if pasturing is permitted after the plants begin to shoot, which usually takes place a few weeks after spring growth starts. As soon as the growing point is raised high enough to become endangered by grazing, livestock should be kept off the field. If this is not done grain yield will be reduced and maturity will be delayed. The stage of growth can be observed by pulling up some of the more advanced plants and stripping back the outer leaves. The first nodes (joints) can be felt and the growing point located by cutting the stem lengthwise. Excessive pasturing at any time of the year is likely to reduce yields.

In the South, wheat, rye, or winter oats provide pasture during the winter months, December to February, when most other pasture crops are dormant. They are profitable crops when sown primarily for pasture during this period.

CULTIVATING

Ordinarily no tillage is necessary after seeding. When the soil is badly cracked or the wheat plants have been heaved by alternate freezing and thawing, rolling the soil with a corrugated roller may be beneficial. This operation must be done as soon as growth starts in the spring but not while the topsoil is wet.

HARVESTING

Essentially all wheat in the Eastern United States is harvested with the combine. Harvesting and threshing can be done rapidly when the weather is favorable, with a saving in time and labor over the old method of cutting with a binder, then shocking, and later threshing. Grain cannot be stored safely until the moisture content is down to 14 percent or less. Artificial drying of wet wheat can hasten the harvest date when appropriate equipment is available. There is also danger of damaging the kernels if moisture content is too high. Spoilage in the bin almost inevitably results when damp or slightly immature grain is put into a tight bin in large quantities. The main objection to combine harvesting is that the grain must stand until it is ripe and dry.

As wheat approaches maturity the kernel loses moisture rapidly, and after it has ripened (stopped growing) it dries out even more rapidly. Eight to ten days before ripening the kernels may contain up to 50 percent of moisture. At binder harvesttime the wheat may contain 30 percent of moisture. Wheat cannot be combined for several days after it appears mature enough to be cut with a binder. To test for degree of dryness of a wheat head, one can rotate or rub the head between the palms of the hands. If the kernels shell out and a majority of central stems of the heads break, then the moisture content is about right for combining. If the kernels do not shell out readily, the wheat will be too green or damp for threshing. When the separated grain feels damp or is easily dented with the thumbnail, it is too wet to combine. When a moisture meter is available at a nearby country elevator, relatively accurate moisture determinations can be made.

A combine is subjected to strain when operating in a crop heavily infested with green weeds, for high-moisture content makes them comparatively heavy. Chopped-up green weeds are difficult to separate from the threshed grain and the excess moisture in them is absorbed by the grain within 24 hours. Operation of the cutter bar above the level of the weeds helps some, but grain can be lost in this procedure. Generally, a weedy field is best harvested with a windrower and later combined, after the grain and weeds have dried. For best results in windrowing, the windrow should be supported and held above the ground by the stubble to prevent wet weather from damaging the crop. After sufficient drying the combine with a pickup attachment should be driven along the windrow in the same direction as that in which the crop was cut. When this is done the straw is more likely to be fed headfirst to the cylinder. Another alternative is to kill the weeds a few days before harvest with a chemical herbicide.

Characteristics desirable in wheat for combine harvesting are strong straw, uniform ripening, nonshattering seed habit, and erect heads of uniform height.

In some areas of the East, wheat straw is a valuable part of the crop. The combine scatters the straw over the field, but it can be gathered after harvest with a pickup baler.

STORING THE GRAIN [2]

The most important factors in storage of wheat are the moisture content of the grain and tempera-

[2] For further information on storage of wheat see SHEDD, C. K., and COTTON, R. T. STORAGE OF SMALL GRAINS AND SHELLED CORN ON THE FARM. U.S. Dept. Agr. Farmers' Bul. No. 2009, 27 pp., illus. 1949.

ture. The drier the grain and the lower the temperature, the better the wheat will keep. Atmospheric humidity is of minor importance. Dry grain will take up moisture if exposed to damp air, but only the grain at the surface of a bin is exposed. Insects, rodents, and birds should be excluded.

The removal of weed seeds, broken kernels, chaff, and other foreign materials improves the keeping quality of wheat. If the grain contains many green weed seeds or broken bits of green stems, these should be removed immediately to prevent absorption of moisture by the wheat.

If artificial drying is used to get the moisture content of the threshed wheat down to 14 percent or less, temperatures must be watched carefully. The upper limit is about 110° F. if the grain is to be used for seed. A maximum of 140° F. can be used if the wheat is to be milled.

A number of insects attack wheat in storage. Insects can be controlled by having the grain clean and low in moisture content before storing; by cleaning and spraying empty bins with insecticide; by general sanitation in and near the bin; and by fumigation. Stored grain insects are more prevalent in the Southern States than farther north where temperatures of stored grain are less favorable for insect development.

Along the eastern seaboard the Angoumois grain moth is a common pest in stored wheat. It often infests the grain in the field before harvest. Wheat in this area should not be left standing in the field longer than necessary.

GROWING SPRING WHEAT[3]

Usually spring wheat occupies the same place in the rotation as oats—that is, after corn. Both corn and wheat harbor the fungus that causes scab. As the fungus spores live through the winter on old cornstalks and are disseminated by the wind in the spring, there is serious danger of scab infection in spring wheat if the cornstalks are not removed or plowed under. As early seeding is desirable, it is a good plan to plow in the fall if the land is not subject to washing. However, a thorough disking and harrowing in the spring will prove reasonably satisfactory if fall plowing is not done. It is especially important that spring wheat be seeded as early as the ground can be prepared.

The rate of seeding is usually higher for spring than for winter wheat. Approximately 2 bushels per acre is suggested.

[3] For additional information consult AUSEMUS, E. R., and REITZ, L. P. HARD RED SPRING AND DURUM WHEATS. U.S. Dept. Agr. Inform. Bul. No. 249. 24 pp., illus. 1962.

DISEASES AND THEIR CONTROL

Rusts, smuts, scab, powdery mildew, mosaic, and Septoria are the most common and most destructive diseases of wheat in the Eastern United States. Others, such as take-all, and Helminthosporium leafspot, may cause important local losses in some years. Several other diseases such as the nematode disease, ergot, black chaff, and basal glume rot are of lesser importance. A checklist of common diseases follows:

Common Name of Disease	*Scientific Name of Causal Organism*
Barley yellow dwarf	(a virus)
Basal glume rot	*Pseudomonas atrofaciens* (McCull.) F. L. Stevens
Black chaff	*Xanthomonas translucens* Dows.
Bunt and dwarf bunt	*Tilletia* spp.
Ergot	*Claviceps purpurea* (Fr.) Tul.
Flag smut	*Urocystis tritici* Koern.
Glume blotch	*Septoria nodorum* Berk.
Head nematode	*Anguina tritici* (Steinbuch) Filip.
Leaf rust	*Puccinia recondita* Rob. ex Desm.
Leafspot	*Helminthosporium* spp.
Loose smut	*Ustilago tritici* (Pers.) Rostr.
Mosaic (soilborne)	(a virus)
Powdery mildew	*Erysiphe graminis* DC.
Scab	*Gibberella zeae* (Schw.) Petch
Speckled leaf blotch	*Septoria tritici* Rob. ex Desm.
Stem rust	*Puccinia graminis* Pers. f. sp. *tritici* Eriks. & E. Henn.
Streak mosaic	(a virus)
Take-all	*Ophiobolus graminis* Sacc.

RUSTS

Two important diseases of wheat in the Eastern United States are stem rust and leaf rust; the first is so-called because it attacks the stems of the plants principally, and the second because it attacks the leaves. Both are caused by small parasitic fungi, the spores of which are carried by the wind to the wheat plants, where they develop at the expense of the wheat. Spores must be present and also weather must be favorable for the development of the fungus on susceptible varieties.

Stem Rust

Of the two kinds of rust, stem rust (fig. 6) is more conspicuous and destructive. This disease causes badly shriveled kernels and within a very few days may reduce the yield to a fraction of what would otherwise be obtained. Fortunately, it does not often occur in damaging amounts in the Eastern United States, although it may cause severe losses in localized areas in some years.

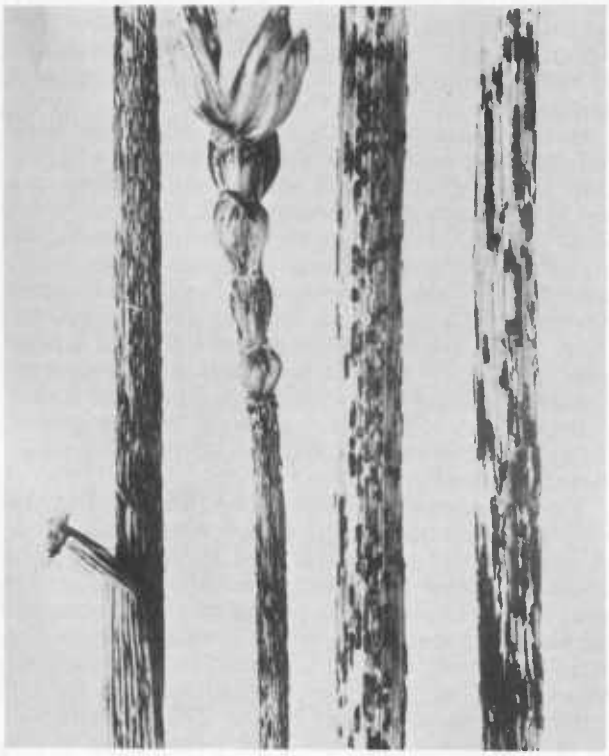

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FIGURE 6.—Black stem rust of wheat.

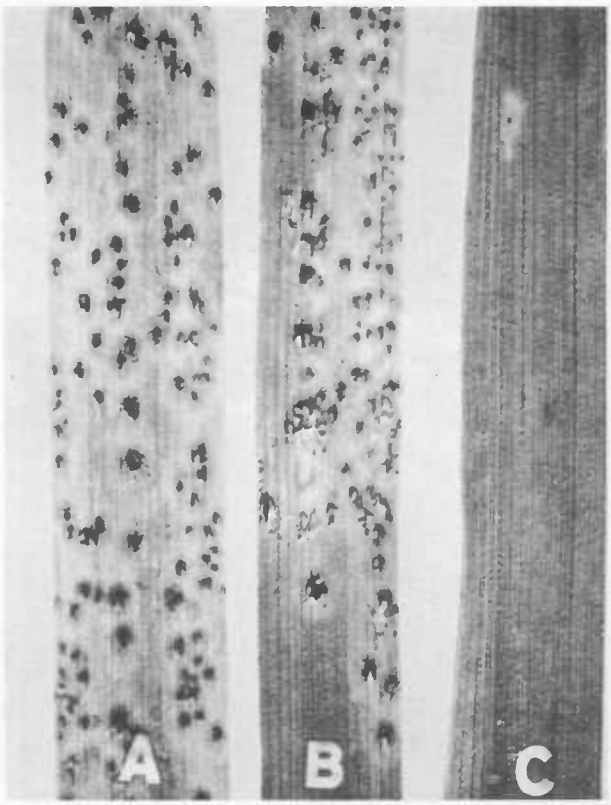

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FIGURE 7.—Leaf rust of wheat. A and B susceptible varieties, and C resistant.

Leaf Rust

Leaf rust (fig. 7) is present nearly every year over most of the soft wheat region. It can reduce the number and size of kernels and the yield and protein content of the grain. The effect is not conspicuous, however, and losses from it are often underestimated. In the aggregate the losses are heavy in the Eastern States.

Neither leaf rust nor stem rust can be prevented by seed treatment, nor indeed by any kind of treatment that is practicable after the plants once become infected. Destruction of certain kinds of barberry plants on which the stem rust fungus passes one phase of its life cycle reduces losses in the vicinity of the bushes. However, widespread epidemics of stem rust usually result from spores carried by the winds from southern Texas or northern Mexico where the disease overwinters on wheat.

Losses from either leaf or stem rust can be reduced by growing resistant varieties or those that are able to escape damage because of their early maturity.

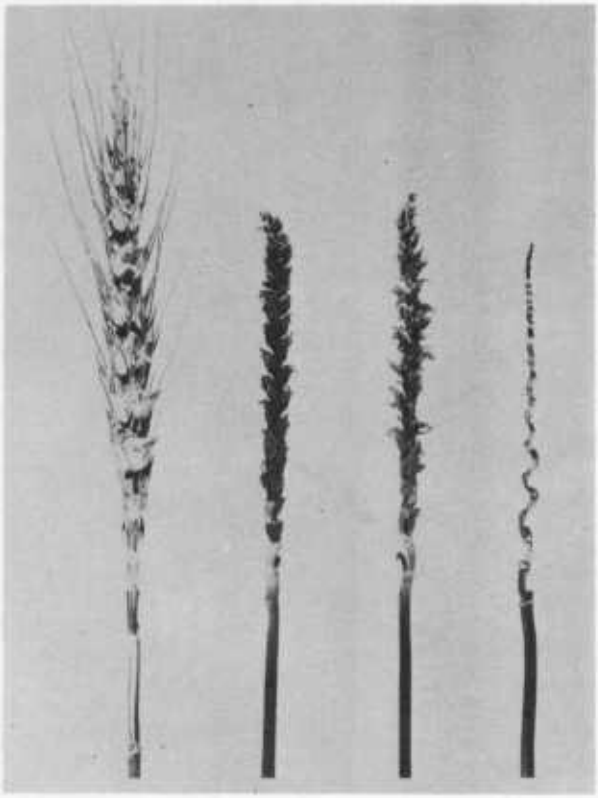
There are varieties of wheat well adapted to some sections of the Eastern and Southern United States that are highly resistant to leaf rust. (See tables 2, 4, and 5.)

SMUTS

There are three kinds of smut of wheat in the Eastern United States: Loose smut, bunt or stinking smut, and flag smut. Loose smut is the most important in the Eastern United States and can be distinguished by the fact that black spores replace both the grain and the chaff and are blown away by the wind before harvest, leaving the bare central stem (rachis) of the head. Bunt, or stinking smut, on the other hand, replaces only the grain with galls or balls full of spores, leaving the chaff intact. As the name implies, stinking smut is easily distinguishable by its characteristic fetid or fishy odor. Flag smut, which rarely occurs, attacks the leaves and culms instead of the heads.

Loose Smut

Loose smut is common in the wheatfields of the Eastern United States and causes an average loss in yield of about 1.5 percent. Losses from this disease in individual fields may amount to 30 percent or more.



CER-1012

FIGURE 8.—Loose smut in wheat. The glumes (chaff) and grain are replaced by the black masses of spores of the smut fungus. Healthy head (left); others diseased.

Loose smut is very noticeable as soon as the wheat heads appear (fig. 8). The glumes and other floral parts of the newly emerged heads are almost completely replaced by black masses of smut. The spores are held loosely in the smutted heads and are carried away at the time the healthy wheat heads are in flower by winds, rain, insects, or other agents. After the smut is gone, only the inconspicuous central stalk of the head remains.

Some of the spores, in the course of their dissemination, are carried to the flowers within the glumes, or chaff, of the healthy wheat heads. Here the spores germinate and produce an internal infection of the developing kernels. When mature, the infected kernels cannot be distinguished from noninfected kernels. However, if the infected kernels are used for seed without being treated, the internally borne fungus starts growing as the kernel germinates and spreads upward into the plant as it develops. Finally, when the heads appear, they are composed of the smut masses described above.

Because the loose smut organism invades the internal parts of the kernel, the disease cannot be controlled by treating the seed with the easily applied surface disinfectants, as described for bunt. It may, however, be effectively controlled by anaerobic treatment or by a modified hot-water treatment.

In the anaerobic method, loose smut has been controlled by soaking the seed in water for 8 hours, then draining off excess water, and holding the wet seed in airtight containers for 36 to 48 hours at 32° C. (90° F.) or for 48 to 60 hours at 28° C. (82° F.). After treatment the grain must be removed from the airtight containers and dried. Essentially no reduction in seed germination results. It is convenient to put the seed in burlap bags (30 to 40 pounds per bag) for treatment. A 55-gallon steel drum with a clamp-on lid makes a convenient container. A foam rubber gasket between the drum rim and the lid makes a satisfactory air seal.

The hot-water treatment is as follows: Put the seed in burlap bags, until each is about half filled, then tie at the top. The seed is then soaked in unheated water for about 6 hours. During this time the sacks should be placed on their sides and should be turned or rolled occasionally. The presoaked seed is then dipped for 2 minutes in water held at 120° F.—then immersed for 10 minutes in water held at 129°. The sacks should be moved about to insure even penetration of the heat. Immediately after treatment the seed should be spread out in a thin layer to cool and dry.

Neither method is recommended for treating seed for an entire crop. The hot-water method particularly is difficult even with the best of equipment, since temperature and time limits are critical. A sufficient quantity of seed can be treated to sow a plot some distance from the main crop, so that seed from the treated plot will serve as a source of clean seed for the following year. Isolation is important, because infection may take place if loose smut is present in nearby fields.

A few varieties of wheat are resistant to most prevalent races of loose smut (tables 2, 4, and 5). Growing resistant varieties is the best means of control.

Bunt, or Stinking Smut

Bunt, or stinking smut, is carried over from one crop to the next as black spores on the seed or as smut balls mixed with the seed (fig. 9). When bunt-infested seed is sown in moist, cool soil, the smut spores germinate and the fungi penetrate into and infect the young seedlings. As the infected plants grow, the parasitic smut organisms grow within them and produce what are commonly called smut balls instead of kernels in the heads. When the wheat is ripe, the presence of these smut balls is made evident by the odor and the appearance of the smutted heads.

CER-737

FIGURE 9.—Stinking smut of wheat. Normal seeds (left); smut balls and broken smut balls (right).

The smut balls are grayish brown or almost black and somewhat smaller than wheat kernels. When crushed in the fingers, the smut balls are found to be filled with foul-smelling smut dust—the spores of the causal fungus. Badly smutted wheat must be washed or "scoured" before milling to remove both the smut spores and the odor. Because of this, smutty wheat is discounted on the market.

Not all varieties of wheat commonly grown in the Eastern United States are resistant to all strains of bunt, although some varieties are more resistant than others. Therefore, seed treatment, to a considerable extent, must be relied upon for control.

Badly smutted wheat should not be used for seed. Moderately smutted seed can be used safely if thoroughly cleaned in a good fanning mill and then well treated with a suitable seed disinfectant.

Dwarf bunt, another kind of stinking smut, causes extreme dwarfing of infected plants. It has occurred in New York State. The spores live over in the soil for several years in addition to being carried on the seed; hence seed treatment is not effective. Control has been obtained on an experimental scale by applying hexachlorobenzene (HCB) in the form of a spray directly on the soil in which wheat has been sown.

The most effective seed treatments for bunt or stinking smut, in winter wheat grown in the Eastern United States are the mercurials and hexachlorobenzene (HCB). They are all poisonous and extreme care should be used in handling them as well as the seed treated with them. Seed treated with these fungicides ordinarily can be kept from one season to the next, provided the seed was sound and free from surface injury when treated. A germination test, however, is advisable before planting. None of the mercurials should be used in excess amounts. *Follow the instructions on the label of the container.* The mercurials are satisfactory in the Eastern United States where soil infestation does not occur, provided the wheat seed has been thoroughly cleaned before treatment to remove all smut balls. Wheat that is black with smut spores is unsuitable for seed even when treated.

Seed-treatment compounds may be purchased at drug stores, seed houses, or other places where seed and similar products are sold. For more information about treating seed-grains and instructions for the use of each of the compounds, consult your county agent.[4] Treated seed is poisonous and should not be eaten, fed to livestock, or sold except for seeding purposes.

CAUTION: All mercurial and hexachlorobenzene seed treatments are poisonous!

Extreme care should be used in handling them and the seed treated with them. Do not get these mercurials in eyes, on skin, or on clothing. May produce delayed chemical burns! If mercurials get on skin, wash immediately with soap and warm water. If in eyes, flush with water for at least 15 minutes, and get medical attention.

May be fatal if swallowed! If swallowed, give milk or white of egg beaten with water, then a teaspoon of salt in a glass of warm water, and repeat until vomit fluid is clear. Repeat milk or white of egg beaten with water. Call A Physician Immediately!

Avoid breathing the dust, fumes, or spray mist. Wash thoroughly after handling. Treat seed in a well-ventilated place.

Do not use treated seed for food, or feed purposes. Do not store treated seed near food or feed. Follow carefully the directions on the container.

Flag Smut

Flag smut formerly occurred in limited areas in Illinois, Missouri, and Kansas. On susceptible varieties it may cause losses of more than 30 percent, but the resistant varieties now being grown in the areas formerly infested have practically eliminated the disease.

Flag smut produces dark stripes in the leaves, sheaths, and stems. It stunts the plants and usually prevents the formation of normal heads. It is carried over from one crop to the next, both on the seed and in the soil of infested fields. It may be controlled most advantageously by the use of adapted, highly resistant varieties. The disease also may be controlled if the seed is carefully treated with a fungicide, as described for stinking smut.

[4] For additional information about treating seed grain, see LEUKEL, R. W., and TAPKE, V. F. CEREAL SMUTS AND THEIR CONTROL. U.S. Dept. Agr. Farmers' Bul. No. 2069. 28 pp., illus. 1954.

SCAB [5]

Scab occurs most commonly when wheat follows corn in the rotation and occasionally it takes a very heavy toll. Some years it is severe in the Corn Belt and in the East Central States.

The scab fungus attacks the seedlings and also the heads of the plants. The infected seedlings are killed or greatly weakened, and the infected parts of heads are killed (fig. 10). The most conspicuous symptom on the heads is a premature ripening of one or more spikelets, giving the infected part of the head a bleached or whitened appearance. Individual spikelets or various parts of heads may be killed. Usually pink- or salmon-colored masses of spores of the scab fungus are evident at the edges or bases of the affected glumes. The kernels in killed portions of the head are much shrunken, almost white, and scabby in appearance; hence, the name "scab."

CER-3671

FIGURE 10.—Scab on wheat heads: Healthy head (left); upper half of head killed (center); entire head killed (right).

[5] For additional information see LEUKEL, R. W. SCAB OF CEREALS AND HOW TO CONTROL IT. U.S. Dept. Agr. Leaflet No. 426, [5] pp., illus. 1957.

The scab fungus is carried over from one crop to the next, both in the seed and on crop refuse, such as cornstalks in the fields. The fungus carried with the seed can infect wheat seedlings, depending on conditions at seeding time, and can cause seedling blight. The fungus from cornstalks or wheat or barley straw allowed to remain over winter on the surface of the soil may infect the heads and cause head blight. The disease is most severe where wheat follows corn.

Scab is difficult to control. In areas where it is frequently severe, the most effective control is obtained by not sowing wheat after corn. Where it is necessary to do so, the cornstalks either should be plowed under thoroughly or cut as low as possible and removed from the field before the land is disked. In any case, the seed should be cleaned thoroughly and treated with a mercurial before sowing.

Some wheat varieties are less susceptible to scab than others, but none is even moderately resistant.

TAKE-ALL

Take-all, or foot rot, has been reported from most of the Eastern States, but has been of minor importance in recent years.

Take-all may kill the plants in the rosette stage, it may so dwarf them that only a few low culms with small heads are formed, or it may kill plants that have attained about the normal size as the heads are beginning to fill. Nearly all the plants in certain spots, frequently circular in shape, or scattered plants in a field may be killed. Stems of infected plants usually are black to a height of 1 or 2 inches above the soil, and the plants pull easily because of the rotted, infected roots.

The take-all fungus is not carried on the seed but persists in the soil for several years. The only feasible control measure known is to keep wheat, barley, and rye off infested land for about 4 years. In the meantime, it is advantageous to plow under a green-manure crop, such as sweetclover. No resistant varieties are known.

POWDERY MILDEW

Powdery mildew has caused considerable damage especially in the States along the Atlantic coast from New York to Georgia. When mildew develops in the fall and weather conditions are favorable, it may remain active on wheat throughout the winter and spring, causing almost complete loss in individual fields.

The fungus causing mildew grows on the leaves and leaf sheaths and produces gray powdery spores in lesions on the surface (fig. 11). These spores are carried by the wind to other plants and other fields, and from one locality to another. The infected areas on leaves are killed, and in severe cases the entire leaf may be destroyed. Severely

infected plants may be stunted or fail to head. After death of an infected wheat plant, small, black, fruiting bodies appear on the mycelium and serve as a means of overwintering of the fungus. Spores that are produced in these fruiting structures in the spring are liberated and infect healthy wheat plants. Wheat severely infected with mildew is very likely to lodge, as the disease weakens the stems.

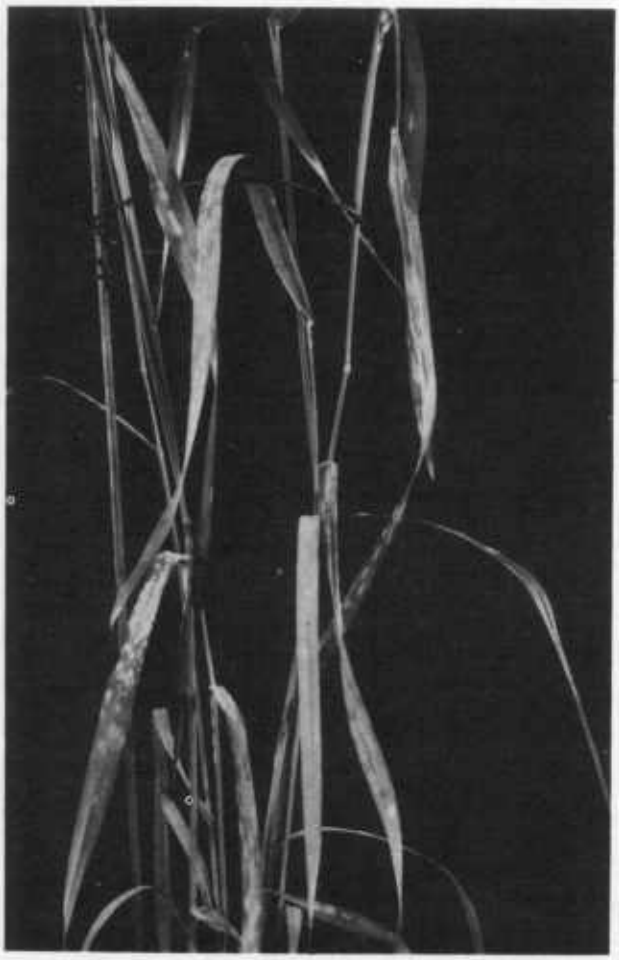


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FIGURE 11.—Powdery mildew on wheat leaves.

The development of mildew is favored by rank, succulent growth and by cool, humid, cloudy weather. Heavy use of nitrogen fertilizers may increase losses from mildew.

The growing of resistant varieties is the most successful method of controlling mildew. There are many races that attack different varieties of wheat. Some wheat varieties, however, are resistant to many of these races. (See tables 2, 4, and 5.)

SEPTORIA

Septoria leaf blotch occurs rather widely over the northern half of the eastern soft winter wheat region and in some localities losses are often serious. It appears during the fall, spring, or early summer as light-green to yellow spots between the veins of leaves. The lesions form light-brown irregular blotches that have a speckled appearance as the small, black, fruiting bodies appear. Under severe conditions the leaves soon die (fig. 12).

Septoria glume blotch occurs principally from Tennessee and Virginia southward and may cause loss of leaves and shriveling of the kernels. It occurs commonly on the glumes of the spike, leaves, and nodal tissues of the stems (fig. 12). The lesions are somewhat oblong, light to dark brown, and the fruiting bodies are less conspicuous because the lesions are darker than in the leaf blotch. Heavily infected heads are badly dwarfed and have shriveled kernels.

Crop rotation and plowing under volunteer wheat plants in the fall help to reduce losses in areas where these diseases occur. Varieties seem to differ in degree of resistance. A few are moderately resistant to Septoria leaf blotch. No effective resistance of plants to glume blotch is known.

VIRUS DISEASES

Mosaic (soilborne), a virus disease, is common through the north central part of the eastern soft wheat region, and in some of the Southern States, particularly in the Piedmont area of North Carolina. Characteristic symptoms of the disease are whitish- or light-yellowish-green mottling and striping of the leaves (fig. 13). Affected plants are stunted and may fail to head. The rosette symptom, in which the plant never develops beyond the rosette stage, is common in a few susceptible varieties when grown in areas of Illinois. Not all plants of even the most susceptible varieties rosette, however. The infective agent may persist in the soil for several years. Serious loss in yield can occur.

A number of commercially grown varieties resistant to soilborne mosaic are shown in tables 2, 4, and 5.

Several other virus diseases affect wheat, and the same virus may affect varieties somewhat differently. Streak mosaic, the virus disease that occurs farther west in the hard winter Wheat Belt, is transmitted by a tiny mite and is not carried over in the soil. A third virus found in wheat is barley yellow dwarf. It is transmitted by the greenbug and other species of aphids.

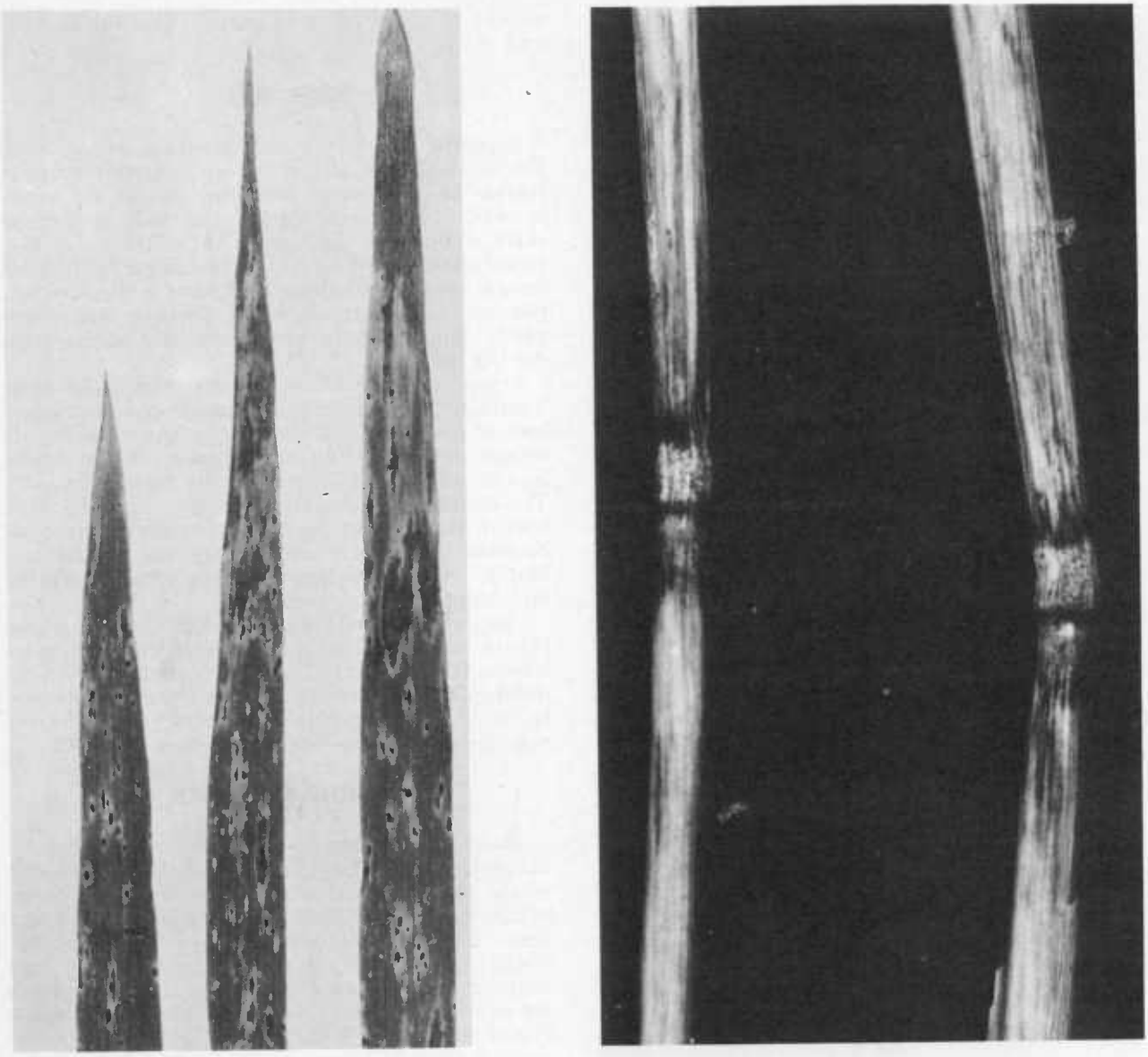

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FIGURE 12.—Glume blotch on leaves of wheat (left), and on the stems (right).

NEMATODE DISEASE [6]

The head nematode disease occurs to some extent in Maryland, Virginia, West Virginia, North Carolina, South Carolina, and Georgia. Losses on individual farms may range from very slight to as much as 70 percent. The disease occurs on both wheat and rye and is caused by a species of very small eelworm or nematode that forms galls instead of kernels in the wheat heads. The nematodes also damage other tissues of growing plants.

The nematode is carried over from one crop to the next in galls mixed with the seed or in infested soil. The disease may be controlled by sowing noninfested seed on noninfested soil. It is extremely difficult to remove all nematode galls from seed wheat. Therefore, it is usually advisable to obtain seed that is known to be free from nematodes and to sow it on land that has grown neither nematode-infested wheat or rye nor had infested manure or infested crop refuse spread on it for 1 year.

[6] For further information consult LEUKEL, R. W. NEMATODE DISEASE OF WHEAT AND RYE. U.S. Dept. Agr. Farmers' Bul. No. 1607, 16 pp., illus. 1957.

CER-W-1104

FIGURE 13.—Mosaic (soilborne) in wheat. Healthy plant (left), mottled and stunted (center), and rosetted (right).

WEEDS AND THEIR CONTROL [7]

Weeds are a serious problem to all wheat farmers in the Eastern United States for they compete with growing wheat for water, light, and mineral nutrients. They increase the cost of labor and equipment, reduce the quantity and quality of the grain, and harbor insects and certain diseases. A large plant of common mustard may use twice as much nitrogen, twice as much phosphorus, four times as much potash, and four times as much water as a well-developed wheat plant.

The most serious weeds in wheat in the Eastern States are perennials, such as field bindweed, Canada thistle, wild onion (southward), wild garlic, milkweed, and curly dock. Perennial weeds have underground stems or bulbs in which reserve foods are stored, making them extremely difficult to control. They occur not only in wheat but in other crops as well.

A second important class of weeds is the annuals, such as cheat, corncockle, mayweed, chickweed, skeletonweed, yellow rocket, ragweed, wild buckwheat, wild vetch, wild mustard, pigweed, smartweed, and others. These weeds cause serious losses in wheat yields and quality. They are somewhat easier to control than perennial weeds. The more common weeds are listed:

Common Name	*Scientific Name*
Perennials:	
Buckhorn plantain	*Plantago lanceolata* L.
Buttercup	*Ranunculus acris* L.
Canada thistle	*Cirsium arvense* (L.) Scop.
Climbing milkweed	*Ampelanus albidus* (Nutt.) Britt.
Curly dock	*Rumex crispus* L.
Field bindweed	*Convolvulus arvensis* L.
Milkweed	*Asclepias* spp.
Wild garlic	*Allium vineale* L.
Wild onion	*Allium canadense* L.
Annuals:	
Cheat	*Bromus secalinus* L.
Chickweed	*Stellaria media* (L.) Cyrill.
Cocklebur	*Xanthium pensylvanicum* Wallr.
Corncockle	*Agrostemma githago* L.
Lambsquarters	*Chenopodium album* L.
Mayweed	*Anthemis cotula* L.
Pennycress	*Thlaspi arvense* L.
Pigweed	*Amaranthus retroflexus* L.
Ragweed	*Ambrosia artemisiifolia* L.
Skeletonweed	*Lygodesmia juncea* (Pursh) D. Don
Smartweed	*Polygonum pensylvanicum* L.
Sunflower	*Helianthus annuus* L.
White cockle	*Lychnis alba* Mill.
Wild buckwheat	*Polygonum convolvulus* L.
Wild carrot	*Daucus carota* L.
Wild mustard (charlock).	*Brassica kaber* (DC.) L. C. Wheeler
Wild oats	*Avena fatua* L.
Wild radish	*Raphanus raphanistrum* L.
Wild vetch	*Vicia angustifolia* L.
Yellow rocket	*Barbarea vulgaris* R. Br.

Wild garlic and wild onion are probably the most objectionable weeds in wheat. The plants grow from underground bulbs and also from aerial bulblets that ripen with the wheat. The green bulblets are very difficult to separate from wheat, but they shrink during storage and if thoroughly dry may be removed by means of the fanning mill or other cleaning equipment. If not removed, they form gummy masses on the rolls in flour mills, and the flour may be tainted with garlic odor.

In the official grain standards of the United States, wheat containing two or more garlic bulblets or their equivalent in approximately 2 pounds of wheat is specially designated as "light garlicky" or "garlicky." Such wheat is discounted in price. Wild garlic is a very difficult weed to control and every effort should be made to keep it off the farm.

Cheat, or chess, is also a serious problem in wheatfields. It is a weedy species of bromegrass and not a degenerate form of wheat. The seeds of cheat are difficult to remove from wheat and are often sown with it, thus perpetuating the cheat from year to year. However, it is possible to remove cheat seed from wheat by careful adjustment of the fanning mill. When this is done and a good farming system including rotation of crops is used, there is less chance of having serious trouble from this pest. Fortunately, the seeds of cheat do not live long in the soil.

Corncockle, or purple cockle, often is found in fields of winter wheat. The rough, dark-colored seeds are difficult to separate from wheat. If present in appreciable quantities, they produce a dark, bad-flavored flour of poor quality. The seeds do not live long in the soil, and the use of clean wheat seed, together with careful cultivation, chemical methods of control, and suitable rotations, will help to reduce the growth of this weed.

Mayweed, chickweed, skeletonweed, yellow rocket, and similar weeds compete with winter wheat and may reduce the yield and quality seriously if they occur in large numbers.

CULTURAL METHODS

Weeds are troublesome; however, they can usually be controlled by good farming methods. The use of appropriate varieties, good seedbed preparation, proper time and rate of seeding, effective fertilization, and herbicides will control most of the weeds in wheat in the Eastern States.

A wide variety of perennial and annual broadleaved weeds can be effectively, economically, and safely controlled in wheat without reducing yields or quality of the crop.

CHEMICAL METHODS

The phenoxy herbicides such as 2,4-dichlorophenoxyacetic acid (2,4–D) and 2-methyl-4-chlorophenoxyacetic acid (MCPA) are highly selective weedkillers that may be used in combi-

[7] Prepared by Warren C. Shaw, Crops Research Division, Agricultural Research Service.

nation with good cultural practices to control weeds in wheat. These herbicides are not toxic to humans or animals and do not leave residues or affect the quality of grains when used according to instructions on the distributor's label. *Farmers should follow the recommendations on the label carefully.*

Chemical and cultural methods of control are greatly influenced by underseeding with legumes.

Wheat Underseeded With Legumes

For the emergency control of serious infestations of mustard, yellow rocket, and other broadleaved weeds in wheat that is *underseeded* with a mixture of legumes such as alfalfa, birdsfoot trefoil, lespedeza, red clover, sweetclover, white clover, or other legumes an amine salt of 2,4–D or MCPA should be used at the rate of ⅛ to ¼ pound in 5 to 20 gallons of water per acre, or amine salt of DNBP (4,6-dinitro ortho secondary butylphenol) at the rate of ¾ to 1 pound in 30 to 50 gallons of water per acre. DNBP is less likely to injure legumes than 2,4-D. If DNBP is used, it should be applied only when the weeds are in the seedling stage.

The 2,4-D or MCPA herbicides should be applied after wheat is well tillered (usually 4 to 8 inches tall), but before reaching the boot stage. The legumes are less likely to be injured if a small grain canopy is allowed to develop before applying the 2,4–D or MCPA. In order to reduce penetration of the canopy with the spray it is well to apply the lowest gallonage possible at low pressure. The use of 2,4-D and MCPA should be avoided, except where the weed infestation threatens to reduce or destroy legume stands and severely reduce small grain yields.

Wheat Not Underseeded With Legumes

Mustard, wild radish, yellow rocket, ragweed, wild vetch, lambsquarters, pigweed, cocklebur, smartweed, sunflowers, plantain, docks, field bindweed, and others may be controlled by applying an ester or amine salt of 2,4-D or MCPA at the rate of ¼ to ½ pound in 5 to 20 gallons of water per acre after wheat is well tillered (usually 4 to 8 inches tall), but before the early boot stage. Growth of wild garlic, Canada thistle, curly dock, buttercup, field bindweed, and several other weeds may be effectively inhibited but not necessarily killed. Grasses and several weeds, such as white cockle and milkweed, will not be controlled by the treatment.

Precautions in the Use of Herbicides

Phenoxy herbicides in excess of 1 pound per acre should be used only when necessary to kill weeds causing serious damage to wheat.

Both 2,4-D and MCPA at moderate rates of treatment can be used to control weeds in wheat without injuring crops if treatments are restricted to the most tolerant stages of growth. Greatest benefits to the grain crop result from early removal of the weeds. *Fall treatments usually are severely injurious to winter wheat.*

Applications of 2,4-D or MCPA can injure wheat in the susceptible stages. These are the early seedling stage before tillering, late jointing and boot stages, and early heading stage. Damage consists of reductions in yield, malformation of heads and leaves, and associated deleterious effects on the plants.

If wheat is underseeded to legumes, the minimum rate of amine salts of 2,4-D, MCPA, or DNBP necessary to control weeds should be used. Most legumes are susceptible to 2,4-D and MCPA, and serious injury may result if these herbicides are applied at rates greater than ¼ pound per acre. If wheat is underseeded with legumes, application of MCPA or 2,4-D should be delayed until the maximum small-grain canopy has developed, but not later than the early joint stage.

INSECTS AND THEIR CONTROL[8]

HESSIAN FLY

In the principal areas where wheat is grown in the Eastern States, the Hessian fly is without doubt its most formidable insect enemy. A portion of a wheat plant infested with Hessian fly maggots is shown in figure 14. The most important and practical means of controlling this pest is to use resistant varieties where available (tables 2, 4, and 5) or to plant winter wheat at a date that will delay the appearance of the young wheat above ground until after the main brood of flies has emerged and died (fig. 5).

Sound cultural practices that contribute to the vigor of the growing crop are an important help in combating the Hessian fly. Chief among these practices are plowing under the stubble of the preceding wheat crop before the flies emerge from it in the early fall, prompt destruction of volunteer wheat, sowing of good seed, and promotion of rapid, vigorous growth by proper fertilization and planting in a well-prepared, firm seedbed. Improved wheat varieties resistant to the Hessian fly and adapted to specific areas have been released to farmers during the past few years. Other resistant varieties better adapted to wheat-growing conditions of the Eastern United States are in the process of being developed.

[8] Contributed by the Entomology Research Division, Agricultural Research Service.

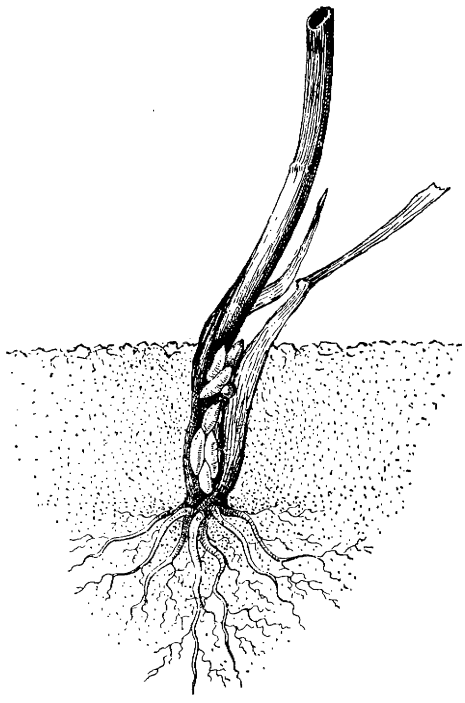

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FIGURE 14.—Hessian fly maggots beneath leaf sheath in the soil. Natural size.

CHINCH BUG

The chinch bug (fig. 15) feeds on and deposits eggs upon the growing wheat plants, but under conditions of vigorous growth and early maturity the bugs usually migrate to corn before the wheat has been seriously injured. In the spring the bugs congregate in the thinner, poorer parts of the fields, and in years of extreme infestation may kill or greatly reduce the growth of the wheat in such areas. A heavy stand of winter wheat is seldom seriously injured by chinch bugs. Promoting a heavy, thrifty stand of wheat, preferably intermixed with clover, is a good protective measure. Thorough tillage, ample fertilization, and timely seeding help to reduce injury from the bugs.

In years when chinch bugs are abundant, spring wheat grown within the infested areas is almost certain to be seriously damaged. Its younger stage of growth at the time of infestation and longer period of succulence thereafter render it most attractive to the bugs.

The burning in the winter of grasses and leaves in which the chinch bug hibernates is not generally a practical or effective method of control. However, burning may be of value within limited areas where large numbers of the bugs have congregated in the grasses, if done before the first flight of the bugs in spring.

Toxaphene applied at 2 pounds or dieldrin at ¼ pound per acre can be used as a spray or dust on a field scale to control chinch bugs but such treatments are seldom used.

A good barrier to prevent migration to adjoining fields of corn and sorghum can be made by spraying dieldrin at the rate of ½ pound per acre in strips along the edge of a field of infested small grain. If the bugs have matured to the winged stage, barriers are of little value.[9]

WHEAT JOINTWORM

The wheat jointworm is one of the most consistently injurious insect enemies of soft wheat in

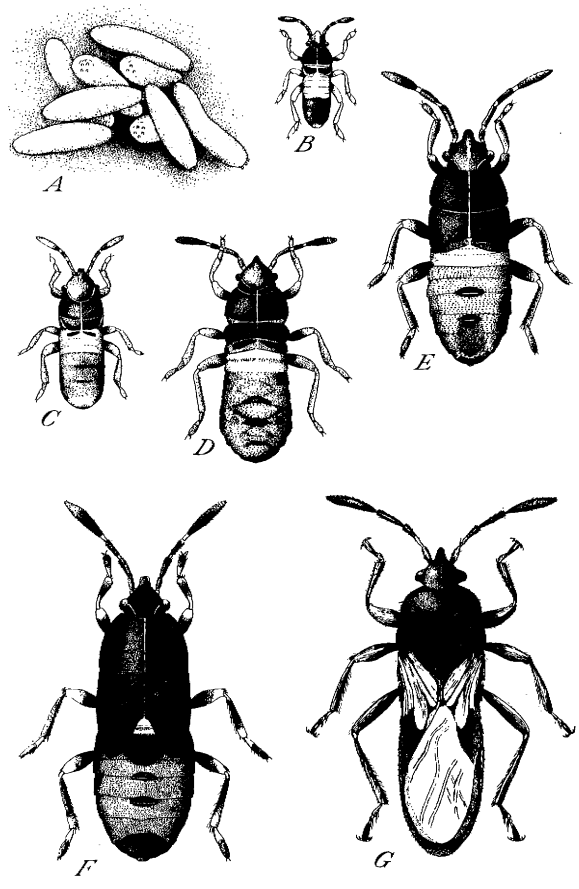

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FIGURE 15.—Chinch bugs: *A*, eggs; *B–E*, red nymph; *F*, black nymph; *G*, winged adult. (All greatly enlarged.)

[9] For details on the control and life history of chinch bugs see the following publication: CHINCH BUGS. HOW TO CONTROL THEM. U.S. Dept. Agr. Leaflet No. 364 (rev. ed.) 8 pp., illus. 1958.

the East Central and Atlantic States. Its work usually remains undetected (fig. 16), and losses caused by it are often attributed to unfavorable weather or cultural conditions. It robs the heads of nourishment by causing hard knots or galls in the stems. Where very abundant, it may cause lodging of the ripening grain and thus call attention to its presence.

The jointworm may be controlled by cutting the wheat as high as practicable and plowing under the stubble immediately after harvest in order to bury it so that the adults cannot emerge. This procedure is not generally practicable where grass, clover, or other legumes are seeded with the wheat, except in extremely heavy infestations.

SAWFLIES

The black grain stem sawfly and the European wheat stem sawfly occur in the North Atlantic States. The first species has now spread through eastern Ohio, Virginia, and some northern counties in North Carolina. The European wheat stem sawfly is now found not only in New York, where it first became established, but in Pennsylvania, New Jersey, Delaware, and Maryland, where it is largely replacing the other species. Except for a few localized attacks in southern New Jersey, neither species has caused much damage in recent years.

Where the sawflies have become abundant, serious losses are likely as a result of the breaking-over of straw, shattering of grain, and difficulty of harvesting.

The sawfly larva is a yellowish-white worm with a brown head. It develops from an egg laid by a small wasplike insect inside the wheat stem about the time of heading. The worm feeds inside the stem and gradually works its way downward until by harvesttime it has become full grown and about three-eighths of an inch long. It then cuts a ring almost through the stem wall close to the ground, leaving just enough outside fiber intact to hold the stem erect until it can securely plug the end of the stub, in which it forms a resting cell. As the stem dries and becomes brittle, the weight of the head, together with wind or rain, causes the stem to break off close to the ground where the worm has weakened it. The larva remains in the stub until the following spring, when it changes to the adult, wasp stage and emerges to lay eggs in the currently maturing crop.

Cultural practices and fertilizers that encourage a strong, heavy stand help materially in reducing losses due to sawflies and are recommended throughout the infested areas.

To avoid much loss from falling straw in heavily infested areas, the wheat should be cut as early as possible. The crop thus can be harvested before much lodging caused by sawfly injury occurs. Obviously, the combine harvester, which operates successfully only in mature, dry grain, is not suitable for use in heavily infested fields.

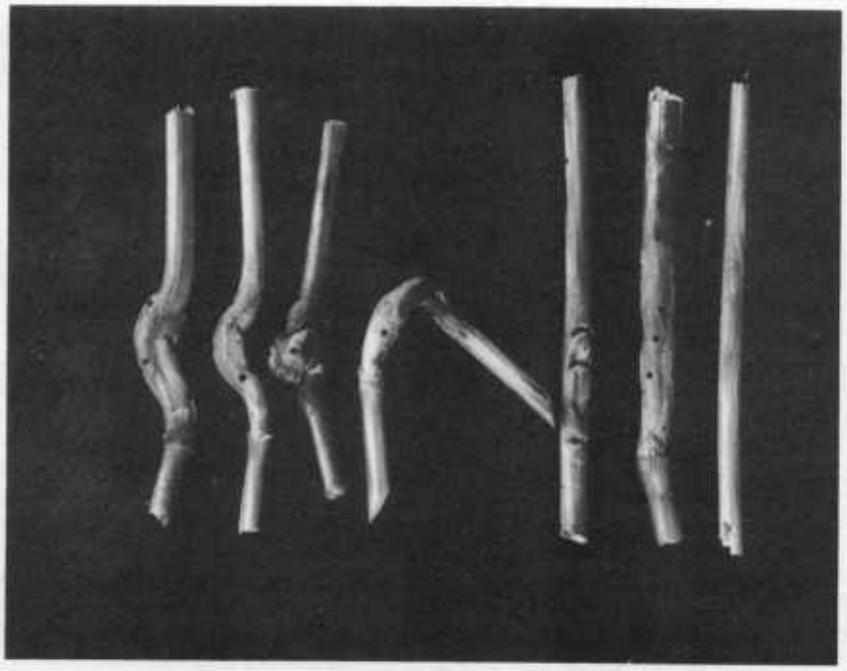

FIGURE 16.—Work of the wheat jointworm. Natural size.

C&F 870

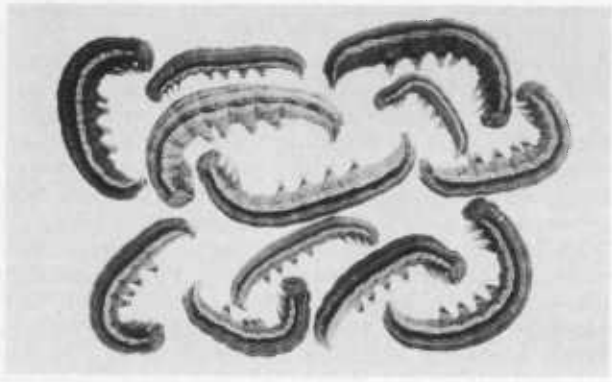

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FIGURE 17.—Armyworm larvae. Natural size.

However, the fallen straw can be harvested after the regular harvest with a pickup attachment supplied for most combines by the manufacturers. This procedure considerably increases the cost of operation.

ARMYWORM

In years favorable to its development, the armyworm (fig. 17) sometimes inflicts serious and widespread damage on the winter wheat crop. This is most likely to occur in the southern halves of the East Central and Middle Atlantic States and to follow a mild, open winter that has emerged into a cold, wet spring. Such a sequence of weather conditions is favorable for the buildup of armyworm populations but not that of its natural enemies which usually are effective in the termination of an outbreak. In its early stages, the armyworm usually works concealed among the lower leaves of the grain. Frequently its presence remains undetected until it is almost full grown and is doing great damage to the heads of the grain. Its early detection is necessary to prevent serious loss.

Several of the new insecticides will kill armyworms, especially if applied when the larvae are young. Excellent control has been obtained with a toxaphene spray applied by aircraft at the rate of 1½ to 2 pounds of toxaphene in 2 gallons of spray per acre. For the 1½ pound dosage mix 1 quart of 60-percent or 1½ quarts of 45-percent toxaphene emulsifiable concentrate thoroughly with enough water to make 2 gallons. A spray containing 1½ pounds of DDT in 5 gallons of water per acre applied by aircraft or with ground equipment has also given satisfactory control. Dusts containing 20 percent of toxaphene or 10 percent of DDT, applied at the rate of 20 pounds per acre, have also provided good control of the armyworm.

The fall armyworm is common, particularly in the Southeastern States. Generally it feeds on native grasses, but can also seriously damage cereal crops and legumes. Control measures are similar to those recommended for the armyworm, with the addition of endrin which can be applied in an emulsion (spray) at the rate of 3 to 4 ounces per acre.

The common and scientific names of the major insect pests of wheat are listed below:

Common Name	*Scientific Name*
Angoumois grain moth	*Sitotroga cerealella* (Olivier)
Armyworm	*Pseudaletia unipuncta* (Haw.)
Black grain stem sawfly.	*Cephus tabidus* (F.)
Chinch bug	*Blissus leucopterus* (Say)
European wheat stem sawfly.	*Cephus pygmaeus* (L.)
Fall armyworm	*Laphygma frugiperda* (J.E. Smith).
Greenbug	*Toxoptera graminum* (Rond.)
Hessian fly	*Phytophaga destructor* (Say)
Wheat jointworm	*Harmolita tritici* (Fitch)

Precautions in the Use of Insecticides

Insecticides are poisonous. Use them only when needed and handle them with care. Follow directions and heed all precautions on the container label. They should be kept in closed, well-labeled containers in a dry place where they will not contaminate food or feed, and where children and pets cannot reach them.

Endrin is extremely poisonous and may be fatal if swallowed, inhaled, or absorbed through the skin. It should be applied only by a person thoroughly familiar with its hazards, who will assume full responsibility for its safe use and comply with all the precautions on the label.

Do not feed DDT-treated forage to dairy animals or animals being finished for slaughter and do not apply DDT to sorghums or small grains after heads begin to form.

Application of endrin for fall armyworm control should be limited to small grains, sorghums, and corn. Use only one application per year and do not treat within 45 days of harvest.

Do not feed toxaphene-treated forage to dairy animals or animals being finished for slaughter or allow such animals to graze on treated fields. Do not apply toxaphene to small grains more than once after heads have begun to form. Do not apply within 7 days of harvest for oats, rye, and wheat, and within 14 days of harvest for barley and rice.

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