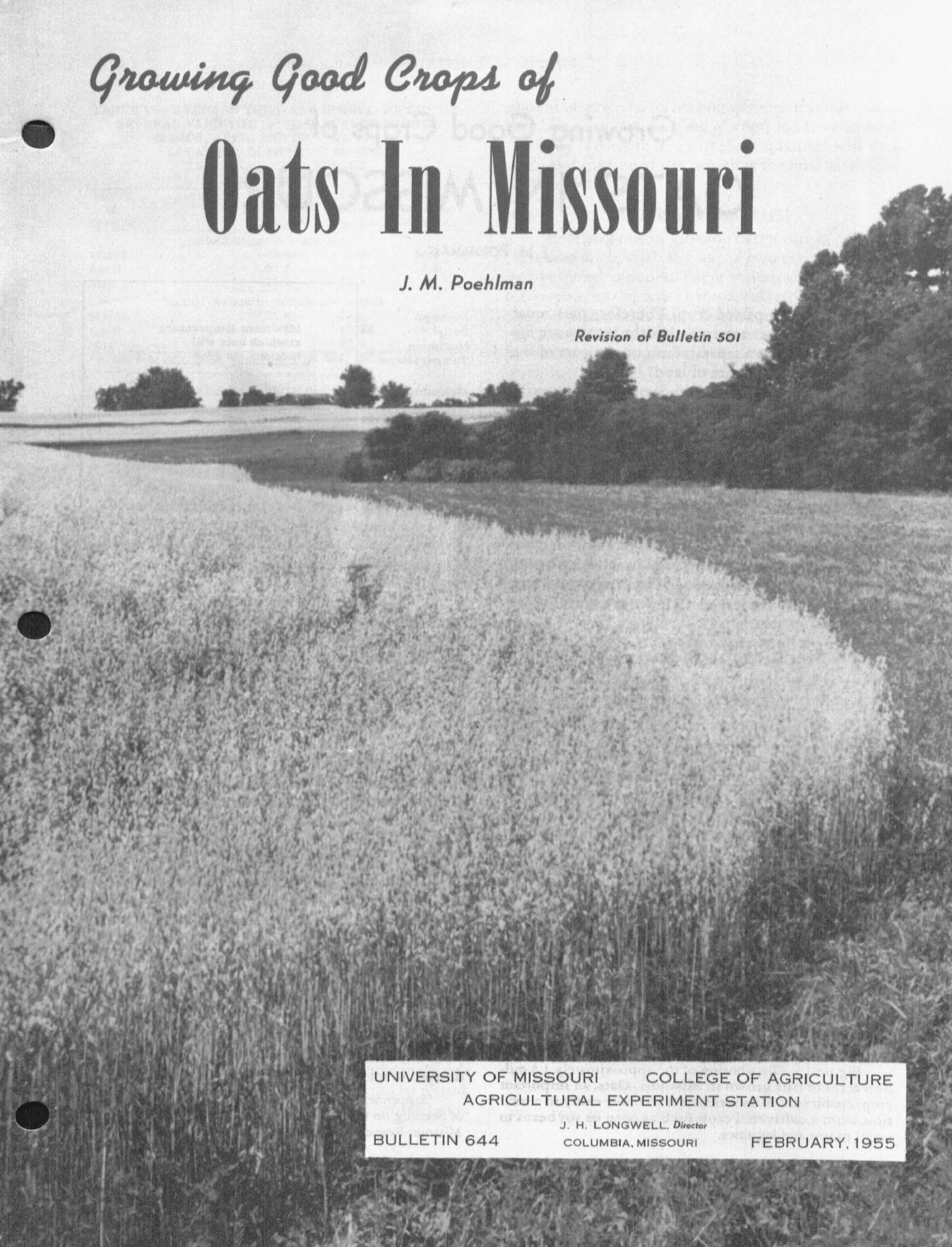
Growing Good Crops of

Oats In Missouri

J. M. Poehlman

Revision of Bulletin 501



UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
J. H. LONGWELL, *Director*
BULLETIN 644 COLUMBIA, MISSOURI FEBRUARY, 1955

Growing Good Crops of
OATS IN MISSOURI

J. M. POEHLMAN

Oats is a low priced crop. Therefore oats must give a high yield per acre, whether the returns are figured for the crop as a separate unit or as a part of the year's production per acre of land.

In many seasons the yield of oats in Missouri is sharply checked by early hot dry weather. (See Fig. 2.) Our spring period is nearly always too short for the best development of the oats grain. That is the reason Missouri oats seldom if ever reach the large yields and heavy weight per bushel found in northern oats.

The limitation of growth by a short season may be partly avoided by an early crop. This favorable possibility is the basis of the more important methods for the production of good crops of oats here, whether they are grown after corn or soybeans in rotations or grown with Korean lespedeza to form a double-crop rotation in one year.

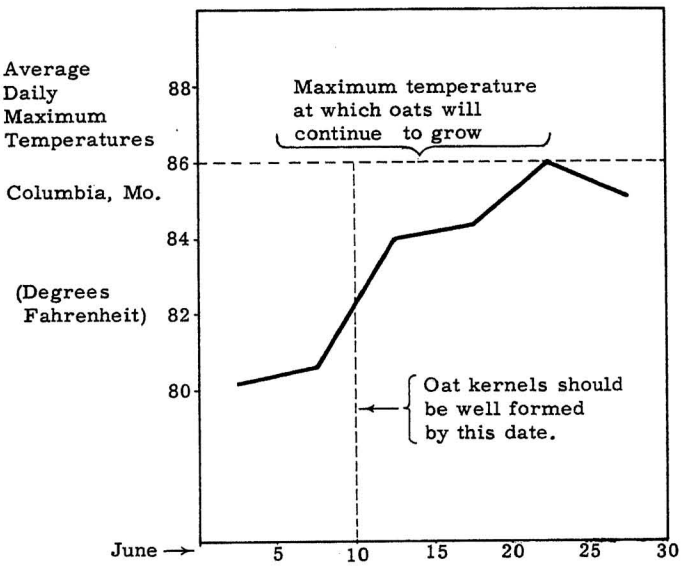


Figure 2.—In Missouri temperatures of mid and late June often approach or even exceed the maximum (86°F.) at which oats will continue to grow. Kernels formed under these conditions are light in weight. Early seeding of an early variety permits fullest kernel development before high temperatures occur.

Methods for an Early Crop

The *early sowing* of a productive, *early variety* is the essential practice for a good yield of oats in Missouri. If this is supplemented by the suitable preparation of the land, reasonable use of fertilizer, treatment of the seed oats for smut and blight, the resulting crop is likely to be satisfactory. Each of these measures for good production is discussed in this bulletin.

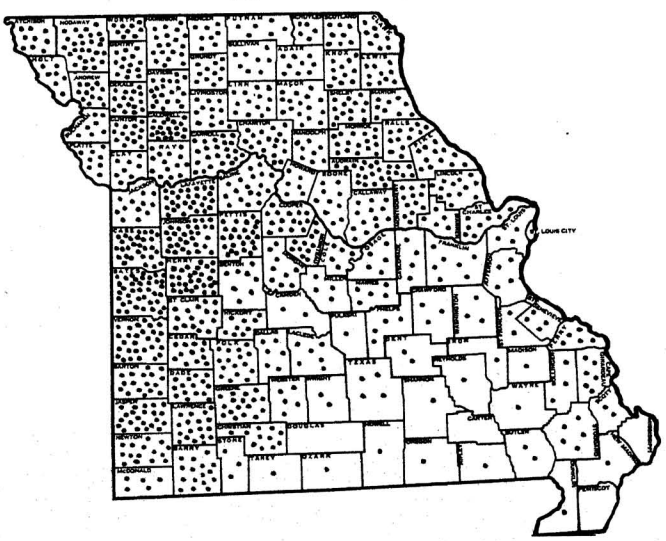


Figure 1.—Distribution of the approximately 1.5 million acres of oats grown in Missouri. Oats, an important crop, enables the Missouri farmer to move easily in a rotation from a cultivated crop such as corn or soybeans to small grains and legumes.

Effect of Early Sowing

The favorable influence on yield of sowing the oats crop early is generally known to progressive growers. It is clearly shown by the results of sowing several varieties of oats in a "date of seeding" test at Bethany in northwest Missouri, during 1949 and 1950; at Columbia in central Missouri during 1948, 1949, and 1950; and at Sikeston in southeast Missouri during 1949 and 1950[1]. The result of these experiments are summarized in Table 1. A progressive decrease in yield and bushel-weight may be noted as seeding was delayed in all three areas. This fact indicates the neces-

[1]Sappenfield, W. P., and J. M. Poehlman. "Effect of Date of Seeding on the yield and Test-Weight of Oat Varieties," Missouri Research Bulletin 499. 1952.

TABLE 1 -- AVERAGE YIELD AND BUSHEL-WEIGHT OF SEVERAL VARIETIES OF OATS SEEDED DURING MARCH, APRIL AND MAY, AT THREE LOCATIONS IN MISSOURI DURING THE THREE-YEAR PERIOD, 1948 TO 1950.

Month of Seeding	Northeast Missouri (Bethany)	Central Missouri (Columbia)	Southeast Missouri (Sikeston)
	Yield in bushels per acre		
March	55.6	57.6	30.3
April	51.3	46.0	19.8
May	25.5	16.9	
	Bushel-weight in pounds per bushel		
March	26.4	33.6	25.5
April	27.3	30.3	19.1
May	20.8	22.7	

*From Mo. Agr. Expt. Sta. Res. Bul. 499, 1952.

sity of starting the crop early enough to permit it to utilize the longest period of moist cool weather and thus reach advanced growth before the onset of heat and drought. Late maturing varieties used in these tests suffered greater losses by delaying the seeding date than did the early varieties.

In southern Missouri oats should be sown in late February if conditions permit good preparation of the land. In central Missouri early March would be suitable for best early seeding. In northern Missouri the crop usually should be sown by March 20 for highest yield.

Oats sown during the periods recommended may be damaged in some years or even killed by cold weather after sowing. But delay because of this possibility will more frequently result in crop damage by drought in early summer.

Choosing A Variety

Improved varieties of oats are fast appearing. Many varieties have been developed in recent years by agricultural experiment stations in the Midwest. Additional strains are being tested, increased, and may soon be distributed. This flow of new varieties is the product of intensive and painstaking work by researchers engaged in breeding better oats.

From this succession of new and varied forms the farmer must choose a variety for his farm. Unless information is available that will permit the selection of adapted strains, the choice may not always be made wisely. The urge to try something new, combined with spectacular publicity about new varieties, oftentimes results in a farmer discarding a good adapted variety for one unsuited to his locality. *The only sound basis for choosing a variety is its record of performance as compared with that of varieties already accepted in the area where the variety is to be used.* In considering its record, *yield* is of first importance. Also, careful consideration should be given to its other important features—*earliness, disease resistance, stiffness of straw,* and *kernel quality.* Varieties favorable in all of these qualities will find wide and continued use, which is the final mark of a good variety.

Earliness Essential

Real progress in growing better oats in Missouri first was made with the use of two early maturing, red-kerneled varieties. These varieties, Fulghum and Columbia, in the order named, successively filled the oats acreage of this state. Fulghum was first tested in Missouri in 1919, and its earliness and high yield were at once noted. Columbia was developed at the Missouri Agricultural Experiment Station from a single plant selected from Fulghum in 1920 and was distributed to farmers in 1932. Earliness, vigor, productiveness, and good seed quality have been its outstanding features. The use of Columbia spread rapidly and by the early "forties" it was grown on 90 percent of the Missouri oats acreage and was one of the most widely grown spring oats varieties in the entire United States. Thus the special adaptation of extremely early maturing varieties of oats to Missouri conditions long has been established. *Earliness is the single adaptive feature most needed in Missouri varieties for consistent production of high yields.*

The need for an early maturing variety of oats in Missouri, if one is to obtain the highest yield, was emphasized again in the "date of seeding" test already described. The varieties used in this experiment were divided into three groups according to their comparative earliness of maturity. The three variety groups and the varieties in each were as follows: *early,* Columbia, Mo. O-200, Mo. O-205, Mindo, Andrew, and an experimental strain 04102; *intermediate,* Marion, Clinton, and Shelby; and *late,* Ajax and Victory. The average yield of each group of varieties at each of the three locations is reported in Table 2. These data emphasize again the fact that in Missouri the spring sea-

TABLE 2 -- AVERAGE YIELD AND BUSHEL-WEIGHT OF EARLY, INTERMEDIATE, AND LATE-MATURITY VARIETIES IN TESTS AT THREE LOCATIONS IN MISSOURI DURING THE THREE-YEAR PERIOD, 1948 TO 1950*

Variety Maturity Group	Northwest Missouri (Bethany)	Central Missouri (Columbia)	Southeast Missouri (Sikeston)
	Yield in bushels per acre		
Early varieties	50.1	48.6	29.7
Intermediate varieties	43.6	45.8	23.8
Late varieties	29.2	36.0	20.1
	Bushel-weight in pounds per bushel		
Early varieties	26.7	31.2	24.5
Intermediate varieties	25.8	30.8	22.5
Late varieties	22.3	27.4	20.5

*From Mo. Agr. Expt. Sta. Res. Bul. 499, 1952.

Figure 3.—Varieties of oats being tested at the University of Missouri South Farms, Columbia. The varieties from left to right are Columbia, Mo. O-200, Cherokee, Mindo, Andrew, and Mo. O-205.

son is too short, even with early planting, for full maturity and development of any except the earliest maturing variety.

Many New Disease-Resistant Varieties

Since about 1940 numerous new disease-resistant varieties have been developed in the Corn Belt area and many of these varieties have been grown in Missouri with varying success. First was a group of related varieties—Boone, Tama, Vicland and others—coming from a cross between the Victoria variety, an introduction from South America, and Richland, an Iowa variety. These new varieties were resistant to the crown and stem rust diseases and to smut. But a new disease, Victoria blight, to which they were susceptible, soon became widespread. The low yield and excessive lodging that resulted from the ravages of the Victoria blight disease caused these new varieties to be discarded from use.

Next followed a large number of varieties which derived their smut and crown rust resistance from Bond, a South American variety, and their stem rust resistance from varying sources, according to the specific cross that was made. Included in this group of varieties were Clinton, Andrew, Mindo, Mo. O-200, Cherokee, Nemeha, and many others grown to a lesser extent in Missouri. About 1950 a new race of crown rust, race 45[2], became widespread which attacked all of the varieties with the "Bond" type of resistance. These varieties are no longer resistant to the forms of crown rust now prevailing, so again a large group of closely related varieties are being discarded.

The change in prevailing races of rusts, and other diseases, appears to be a natural consequence of growing too widely, varieties with the same inherent source of resistance and is one of the large problems facing plant breeders who are breeding new disease-resistant varieties. Most of these new varieties, in addition to being disease-resistant, were also stronger-strawed and produced better quality of grain than the varieties grown earlier. However, many of the new varieties developed in the more northern states were too late in maturity to be well adapted in Missouri.

O-205 and Andrew Recommended

Mo. O-205 and Andrew are the varieties now recommended in Missouri. This recommendation is based on the comparative performance - yield, earliness, lodging resistance, bushel-weight, and disease resistance of these two varieties grown in 38 yield tests in Missouri during the seven-year period, 1948 to 1954. A summary of the results of these tests is reported in Table 3.

A short descriptive summary of each of these varieties follows:

Mo. O-205. A medium-early, stiff-strawed variety that has been outstanding in yield in Missouri. It was developed from the cross Columbia x Victoria-Richland[3] and distributed from the Missouri Agricultural Experiment Station in 1951. O-205 is a Columbia type variety with wide spreading panicles

[2]A new system of identifying and numbering the races of oats crown rust was initiated in 1951. Races of crown rust are now identified with numbers above 200 and several of these races infect varieties with the "Bond" type of resistance.

[3]Poehlman, J. M. "O-205 Oats, an Improved Columbia Type Variety for Missouri." Mo. Agr. Exp. Sta. Bulletin 637, 1955.

TABLE 3 -- SUMMARY OF OATS VARIETY TESTS CONDUCTED IN MISSOURI DURING THE 7-YEAR PERIOD, 1948-'54

Variety	Yield in Bushels per Acre										Avg. Date Headed	Height Inches	Lodging %	Bushel-Weight lb. per bu.
	1948	1949	1950	1951	1952	1953	1954	4-year average 1948-51	7-year average 1948-54	2-year average 1953-54				
	(9)*	(8)	(6)	(5)	(2)	(4)	(4)	(28)	(38)	(8)	(18)	(29)	(24)	(34)
Mo-O-205	63.8	51.0	69.6	46.3	46.1	40.4	64.4	59.7	57.3	52.4	June 5	37	14	31.5
Andrew	66.8	50.2	61.2	45.2	48.1	34.9	63.0	57.0	54.8	49.0	June 2	36	23	30.3
Mo. O-200	60.9	47.5	63.3	42.5	49.0	36.3	59.8	54.3	52.7	48.1	June 2	36	35	31.9
Mindo	60.4	46.4	61.4	40.0	46.1			53.0						
Columbia	57.6	45.9	57.9	44.9	46.5	35.4	64.2	52.0	51.3	49.8	June 3	37	28	31.3
Cherokee	60.3	46.1	59.2	33.5	42.3	34.8	57.7	51.2	49.6	46.1	June 3	34	21	30.4
Nemeha	60.0	38.7	60.3	33.6				49.3						
Clinton	56.3	45.0	51.9	38.3	45.2	31.7	56.4	48.9	47.6	44.0	June 8	33	15	29.4
Clintland						30.6	56.3			43.4				

*Number in parenthesis refers to the number of tests from which data were averaged.

and tall, stiff straw. The grain is similar in shape and color to that of Columbia. It has striping characteristics of the latter variety, but may average slightly darker than Columbia in color. Bushel-weight of O-205 is high and it has a low hull percentage making it a good variety to use for feed. O-205 is resistant to smut, Victoria blight, moderately resistant to crown rust, and resistant to races 2, 7 and 7a of stem rust.

Andrew.—An early, tall-growing, stiff-strawed variety developed at the Minnesota Agricultural Experiment Station from the cross Bond x Rainbow. Andrew is similar in height and lodging resistance to O-205, is slightly earlier, produces a darker green foliage, but is slightly lower in yield and bushel-weight. It is resistant to smuts, Victoria blight, races 2, 7 and 7a of stem rust, and possesses some tolerance to crown-rust.

Other varieties which have been grown in Missouri, although not recommended, are:

Columbia.— Has been the standard early variety for Missouri since 1930, but has weak straw and is susceptible to rust and smut. Since O-205 is superior in these respects and also appears to have much of the Columbia adaptation, it is now recommended in place of Columbia.

Mo. O-200.—This variety is early and produces excellent yields of heavy grain. It is susceptible to the newer races of crown rust and tends to lodge on fertile soils. Therefore it will be dropped from Missouri tests after 1954.

Cherokee.—An early, short, stiff-strawed variety selected from the same cross that produced Clinton. It is popular in some areas of Missouri, apparently because it has short, plump seed which are often partially hulled during the threshing process, a feature which makes the grain popular for hog or poultry feed. This characteristic does not appear to outweigh the lower yield of Cherokee.

Mindo.—A short, stiff-strawed, early variety of oats from Minnesota. Yields and test-weight are below those of O-205 and it is susceptible to the newer races of crown rust. Dropped from Missouri tests after 1952.

Nemeha.—An early, short, stiff-strawed variety that produces large kernels. Yields have always been low in Missouri and it has not been tested since 1951.

Dupree.—A early, high yielding variety. It has very weak straw and is not recommended for that reason.

Clinton.—A short, stiff-strawed variety, that has been popular in states to the north and east of Missouri. It is later in maturity than is generally desirable in Missouri and its yield has been reduced in Missouri in many seasons as a result. It is still grown in varying amounts in north Missouri. Yields of Clinton have declined in recent years as races of crown rust and races 7 and of 7a stem rust, to which Clinton is susceptible, have become widespread. Clinton is resistant to races 2 and 8 of stem rust and many races of crown rust that were common earlier.

Clintland.—A new variety developed at the Indiana Agricultural Experiment Station by adding crown rust resistance from Landhafer to Clinton. It is otherwise similar to Clinton. In eight tests in Missouri in 1953 and 1954 the only years it has been available for testing, it yielded 43.4 bushels per acre in comparison with 44.0 bushels from Clinton, and 52.4 bushels for Mo. O-205. It, like Clinton, is too late in maturity for Missouri conditions.

Clintafe.—Clintafe was developed at the Iowa Agricultural Experiment Station by adding crown rust resistance from Santa Fe to Clinton. It is slightly later than Clinton in maturity. In three tests in Missouri in 1953, Clintafe yielded 19.8 bushels as compared to 31.7 bushels for Clinton and 40.4 for Mo. O-205.

Diseases of Oats

Three major diseases of oats are found in Missouri. They are (1) smut, (2) crown rust, and (3) stem rust. A fourth disease, Victoria blight, became serious for a short time while susceptible varieties were being grown. After the susceptible varieties, Boone, Tama and Vicland, were replaced by newer ones no report

Figure 4.—Heads of oats destroyed by smut. Spores from smut disease are carried to the next crop on the seed. Smut may be controlled by seed treatment, or by growing resistant varieties such as O-205 and Andrew.

of Victoria blight has been called to our attention. Other diseases of oats occur in other areas, and some in lesser amounts in certain seasons in Missouri but they do not appear to be sufficiently widespread to warrant discussion here.

Smut.—The oats smuts have long been common in Missouri. The oats head is destroyed by this disease and black masses of spores are formed instead of kernels. By harvest time these spores have been spread by the wind or washed to the ground, leaving only the naked stems on infected plants. The disease is propagated by the spores which fall on normally developing seeds and are thus carried into the next crop when those seeds are planted the following spring. Loss in yield is the important result of this disease. Control is effected by seed treatment which kills the spores carried on the seed, and by breeding varieties resistant to this disease. Columbia is susceptible, as well as many of the winter oats varieties. Mo. O-205, Andrew and other new varieties described in this bulletin are resistant.

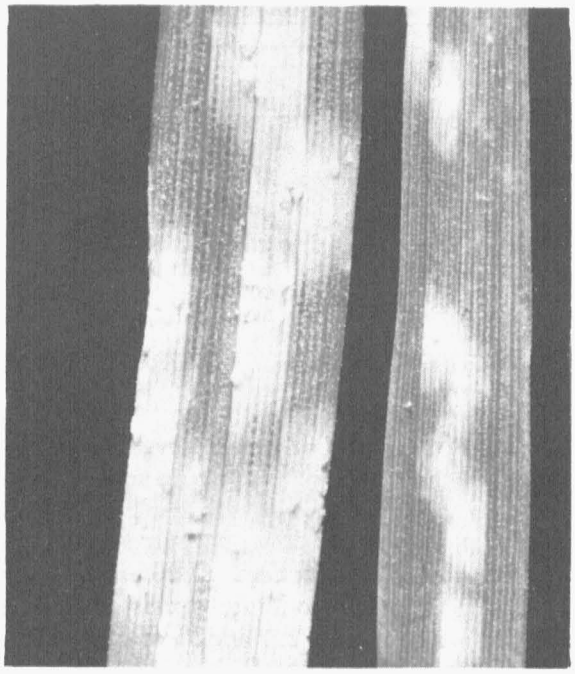


Figure 5.—Crown or leaf rust on leaf of a susceptible variety at left, and a resistant variety at right. Masses of orange-red rust spores develop interfering with normal functions of the leaf. The spores are blown about by the wind producing new infections on oats leaves where they fall.

Rusts.—The oats rusts are of two kinds, *crown or leaf rust,* and *stem rust.* Crown rust appears as small, orange-red pustules on the leaves and stem of the oats plant while stem rust produces brick-red, elongated pustules on the stems and to a lesser extent on the leaves. These pustules consist of masses of spores which are blown about by the wind and fall upon green developing oats, there producing new infections. Wet weather at the heading stage favors the development of rust infections and also delays the maturity of the oats crop, thus prolonging the period of possible infection. An epidemic of either of these diseases occurring before the kernels are well formed, will result in low production of light-weight kernels as well as severe lodging of the oat plant. Early varieties will avoid rust damage in many years in Missouri. But the best control is by breeding resistant varieties.

Both of the rust diseases are composed of numerous physiologic forms or races which in some respects may be considered similar to varieties in crops. Considerably more than 100 of the races of crown rust and 14 races of stem rust have been identified. A variety of oats may be resistant to one race and susceptible to another. The O-205 variety of oats is resistant to races 2 and 7, and a new race 7a, of stem rust but susceptible to race 8.

Figure 6.—Damage that may be caused by crown rust is illustrated by severe lodging of the susceptible variety at right when compared with the resistant variety at left.

Clinton and Clintland are resistant to races 2 and 8 of stem rust but susceptible to race 7 and 7a. The races of rust that occur in an area may shift over a period of years, or new races may arise which infect varieties being grown. For example race 8 of stem rust was widespread when the Clinton variety was first grown. Clinton is resistant to race 8. In recent years race 7 of stem rust has been found more frequently than race 8. Since Clinton is susceptible to race 7, we find that Clinton is now damaged by stem rust in the field. Race 7a was first identified in Missouri in 1954. Similar changes occurred in the races of crown rust as new races became widespread which infected the varieties of "Bond" origin (O-200, Andrew, Clinton, Cherokee, and others) which had been resistant before that time. The development of new races may be reduced somewhat, although not completely, by destroying other host plants for the rust diseases, such as the common barberry, in the case of stem rust, and the buckthorn, in the case of crown rust.

Seed Treatment

Seed oats are treated to control two diseases, smut and Victoria blight. Both may be controlled easily and cheaply by a single treatment with any standard Mercurial-type fungicide. These are available under several brand names at local stores. Those which come in the dust form are applied by mixing the fungicide with the oats either in a tight drum or by use of the simple seed treater illustrated in this bulletin. Some of the fungicides may be mixed with water and applied as a slurry. This requires special treating equipment. Always follow the rates outlined by the manufacturer on the container.

Cautions to be followed with these Mercuric dust treatments are:

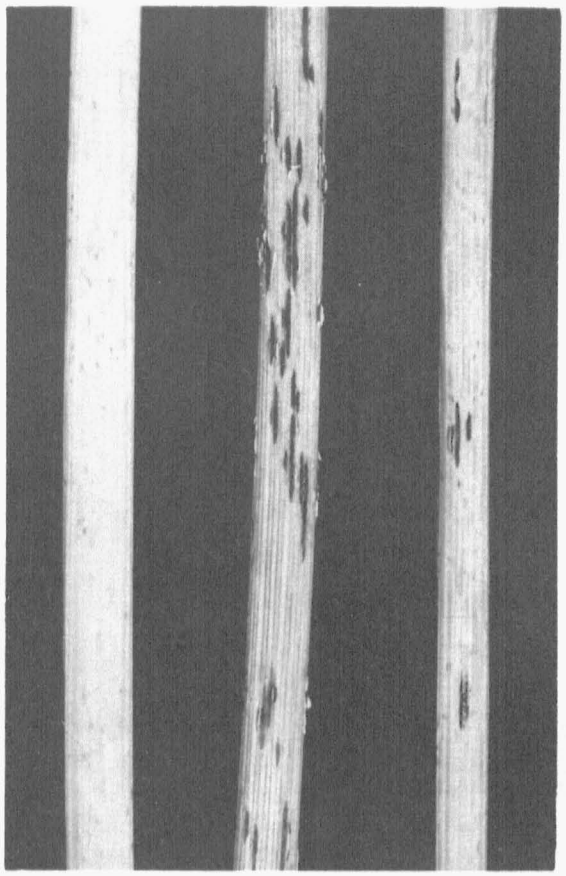


Figure 7.—Stem rust reaction of the O-205 oats variety is illustrated by the infection on these three stems. Left, stem infected with race 7 of stem rust to which O-205 is resistant. Center, stem infected with race 8 to which O-205 is susceptible. Right, stem infected with both races 7 and 8. Both small (resistant type) pustules and large (susceptible type) pustules may be seen on the same stem.

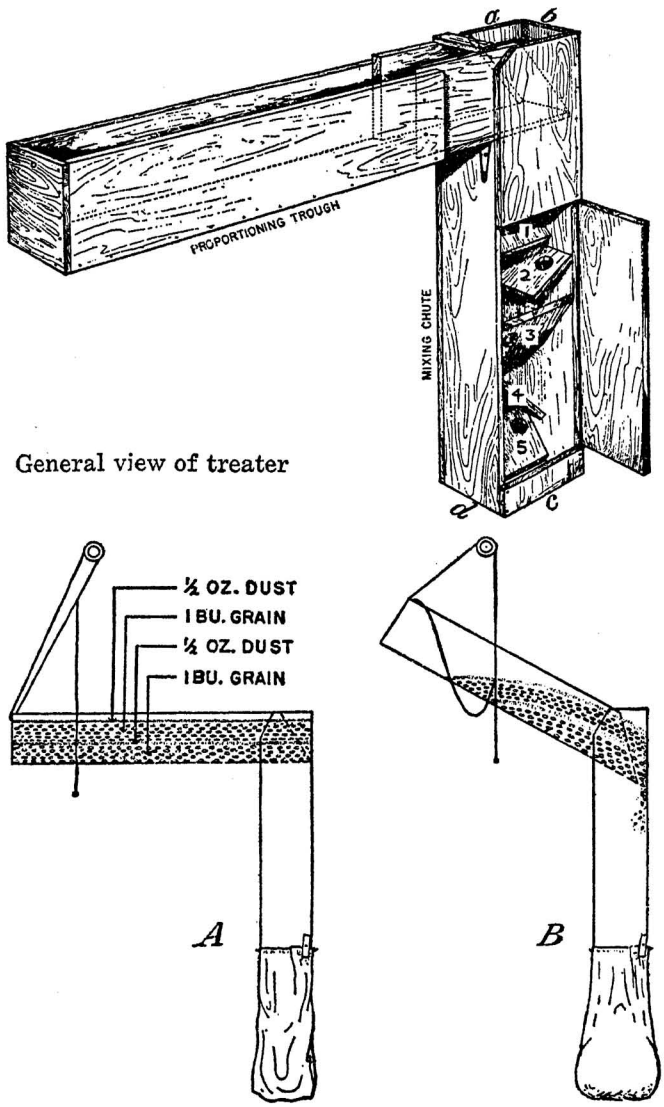
1. Do not breathe these dusts as they are poisonous. Always use a mask and treat seed outside or in a well ventilated place.

2. Do not feed treated seed to livestock as it is poisonous.

3. Do not overtreat the seed as it will injure germination.

If treatment is made for smut only, treatment with formalin is effective. Forty bushels of oats are sprayed with a mixture of one pint of 40 per cent formaldehyde and two pints of water. The treated seed is then covered for several hours. Seed treated with formaldehyde may be fed safely to livestock.

As long as smut and blight resistant varieties of oats, such as O-205 or Andrew, are used, it may not be necessary to treat oats seed. However, if smut is found in one of these new resistant varieties, it would be very important that the smut-infected seed be treated immediately. Presence of smut in a resistant variety



Using the treater: *A*, Manner of filling trough with seed and spreading the dust; *B*, dumping seed through mixing chute.

Figure 8.—Plans for making and using a seed treater (courtesy of the Minnesota Agricultural Experiment Station).

could mean the appearance of a new race of smut to which that variety was susceptible. Treatment of the seed to eliminate the smut immediately might thus prevent the increase and spread of the new race. Susceptible varieties, such as Columbia and the winter oats varieties, Forkedeer, Cimarron, or Winter Fulghum, should be treated regularly.

Hybrid Oats

New oats varieties are sometimes represented as "hybrid"oats. Usually it is meant that they are of hybrid origin. The term "hybrid" should not be applied to oats varieties with the same meaning with which it is applied to commercial hybrids of corn, as the two crops differ in methods of pollination and breeding. "Hybrid" when applied to seed corn usually refers to first generation seed which must be replaced each year. Oats varieties of hybrid origin have been increased from a late generation selection from a cross between varieties. Varieties developed in this manner are pure; therefore, the seed may be replanted year after year. Mo. O-205, Andrew and other new varieties are of hybrid origin. But as varieties they should be judged on their performance—yield, earliness, stiffness of straw and disease resistance—not on their hybrid origin.

Preparing the Land for Seeding

The value of early seeding of an early variety for successful production of oats has been emphasized. Early seeding should not sacrifice entirely good preparation of the seedbed. The three factors (1) an early variety, (2) early seeding, and (3) a well prepared seedbed, are closely related in their effect on the success of the crop.

Plowing in winter or early spring usually will increase the yield of oats, provided the seedbed is not left too loose when the oats are sown. But the increase will seldom pay for the extra cost in labor if the plowing results in a delay in seeding the oats. Double disking and harrowing does not cause undue delay in seeding and is the usual method of seedbed preparation. Also, a field cultivator may be used in preparing a seedbed following corn, or following Korean lespedeza sod, or following soybeans.

Seed Should Be Drilled

Drilling oats has many advantages over broadcasting. Drilling controls the depth of seeding, putting the seed shallow or deep, depending upon the time of sowing and the moisture condition of the ground. In many seasons dry weather prevails during the early growing period. Oats sown broadcast in dry soil either germinate slowly or, when they germinate, grow unevenly. This results in late and uneven maturity, which reduces the yield and quality of the crop. Also, broadcast seeding covered by a harrow is likely to leave some of the grain exposed or covered so shallow that on sprouting it may be killed by freezing weather. Drilling requires less seed; 6 to 8 pecks per acre is as productive usually as the heavier rate of 8 to 12 pecks commonly used in broadcast seedings. Finally, use of a grain drill with a fertilizer attachment makes possible the efficient use of fertilizer, placing it down in the furrow with the seed, which cannot be accomplished in broadcast seedings.

Figure 9.—Use of fertilizer is one of the best means of increasing the yield of the oat crop. Note the additional growth made by the fertilized oats (left) as compared to the unfertilized oats (right).

Fertilizing the Oats Crop

Fertilization is one of the best methods of increasing the yield of the oats crop in Missouri. The high yield potential of our modern oats varieties is seldom reached in Missouri's soil and climate. Application of balanced fertilizer nutrients will go far toward increasing the yield of the oats crop, even in unfavorable seasons. Such fertilizer applications should consist of a basic application of a fertilizer containing phosphorous and potassium and, in addition, nitrogen; or the nitrogen may be applied as a top-dressing after the oats are seeded. While basic amendments of phosphorous and potassium may be taken care of by plowing down large amounts, as indicated necessary by soil tests, smaller applications are usually still desirable to serve as a starter for the young crop. If oats follows corn which received heavy applications of fertilizer, residual effects will usually reduce the amount one needs to add with the oats.

The amount of nitrogen to be applied will depend upon the organic matter content and the previous cropping history of the soil. One of the deterrents of high nitrogen applications to the oats crop has been the possibility of lodging and the resulting loss in yield. In wet seasons, high applications of nitrogen may stimulate the growth of the oats to such an extent that lodging will result during wind and rain storms. While new varieties possess much better straw than the varieties formerly used, caution should be observed in the use of high rates of nitrogen on soils already high in organic matter, or in wet seasons. The grower may need to balance the maximum yield desired from high fertilization against the possible loss of yield by the lodging that might result if the season should be marked by heavy rainfall, in determining the amount of nitrogen fertilizer to use. There are few seasons, if any, that moderate nitrogen applications will not stimulate the early growth of the oats plant when the soil is still wet and cold, and the nitrification process in the soil is proceeding very slowly.

Oats as a Companion Crop for Legumes

An early variety of oats, sowed early on a well prepared seedbed makes a desirable companion (or

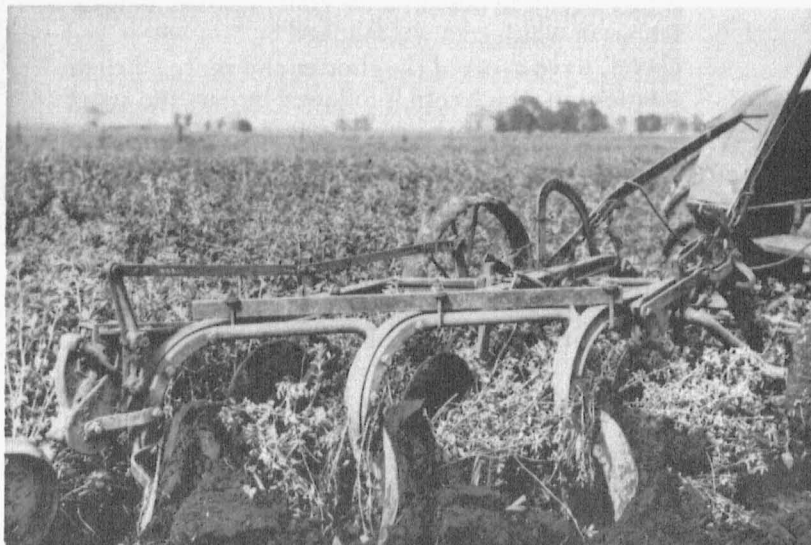


Figure 10.—Plowing under sweet clover in early May before planting corn in the corn-oats and sweet clover rotation. In this rotation the oats crop makes it possible to move easily and quickly from a cultivated crop to a legume. Nonhardy alfalfa may be substituted for sweet clover where weevil or root rot has made it difficult to establish sweet clover.

Figure 11.—Combing oats from the windrow permits an early harvest without the loss from shattering that occurs when standing grain is left for the combine.

nurse) crop in which to establish a legume or grass. This is important with the wide use in Missouri of short rotations in which the oats crop is followed by sweet clover, lespedeza, or other legumes. Heavy fertilization of the oats crop, especially with nitrogen, may increase the density of the stand of oats to such an extent that it will be a less desirable companion crop for these legumes than where moderate applications of fertilizer have been used. Since oats are a low return crop, it may sometimes be desirable to sacrifice the yield of the oats crop in order to better insure the survival of the legume crop seeded with it.

Oats in Crop Rotations

Oats may be seeded easily after a cultivated crop such as corn, soybeans, or sorghum. This is the essential reason for the large acreage of this crop seeded each year. Where the seedbed is prepared by double disking, as in the familiar practice of sowing oats after corn or soybeans, production costs are low. This low production cost combined with the use of oats as a companion crop in which a legume is established, makes it an important crop to the farmer even though it may be low in bushel value. From the older long-rotations in which corn was followed by oats, wheat, and clover, have evolved the shorter and more efficient rotations in which corn is followed by oats and sweet clover, and the continuous one-year rotation of oats-lespedeza.

Corn-Oats and Sweet Clover Rotation or Corn-Oats and Non-Hardy Alfalfa Rotation

The efficiency of the two-year rotation of corn-oats and sweet clover is making this a leading cropping system in Missouri. In this rotation corn is followed by oats in which sweet clover is established. The sweet clover is plowed under the following spring in time again to plant corn. In recent years stands of sweet clover have frequently been reduced by the sweet clover weevil or by root rot. Where there is danger of losing the leguminous crop by these pests, non-hardy alfalfa might well be substituted for the sweet clover. Also, non-hardy alfalfa may be desirable on wet soils, where sweet clover would become so rank as to interfere with the combining of the oats crop. This rotation makes possible the growing of corn on fewer acres selected from those on which erosion will be least severe, furnishes a grain crop in oats which may be easily planted after corn and in which sweet clover or non-hardy alfalfa may be established, and provides for the plowing under of a green leguminous crop immediately prior to planting the corn. If practiced carefully, with the use of fertilizers on one or both crops, this rotation will result in rapidly increasing yields of both corn and oats.

Oats-Lespedeza Rotation

In this rotation oats is seeded on last year's Korean lespedeza sod. This seedbed is prepared by double disking or by use of the field cultivator, followed by harrowing. These operations will put the lespedeza sod in good condition for seeding oats with a grain drill. In this way the one-year rotation of lespedeza and oats may be carried on as long as desired, for under reasonable management the lespedeza will volunteer every year from seed produced and shattered to the ground the previous year.

Using the Oats Crop

Oats may be grazed, or they may be cut while green for hay or silage, or they may be harvested for grain. These many uses of the oats crop, in addition to the place oats fills in a rotation following corn or other cultivated crops, have made oats an important crop in Missouri, even though low in bushel value.

Oats produce excellent feed as pasture. While the total acre returns as pasture may be low, they do provide an abundance of supplemental grazing for short periods in early spring. Oats makes an excellent hay crop if cut when the grain has reached the milk or soft dough stage. If cut earlier oats hay is difficult to cure, or if cut after the grain is more mature, the stem is less palatable and the seed may shatter from the plant. Oats cut at this stage may also be ensiled and yields of 5 to 7 tons of ensilage per acre may reasonably be expected.

Oats harvested for grain makes excellent feed for young livestock, horses, dairy cows, sheep, swine and poultry. Oats contain more protein, fat, calcium and phosphorous than corn. Because of their hulls, oats

are high in fiber, giving bulk to rations for dairy cows and horses. Oats straw may be used also as a roughage.

Harvesting Oats

Oats are usually harvested for grain with the combine-thresher, although occasional fields may still be cut with a binder and threshed. Oats are less suited for harvesting with the combine than other small grains such as wheat or barley because (a) the straw of oats lodges badly once the crop is ripe, and (b) oats shatter worse than do these other grains. The newer varieties of oats have stiffer straw and will stand longer after ripe without lodging than the older varieties. Clinton and the new Clintland are perhaps best in this respect because they have stiff, heavy stems. But even they will shatter when harvesting is delayed and losses ranging up to 15 to 20 percent are not uncommon. There appears to be very little difference in the resistance of different varieties to shattering. It thus appears that we are paying a high cost in yield loss for our economy in labor from combine harvesting.

Much of the loss from lodging after the grain is ripe and from shattering may be avoided by cutting and windrowing the oats when they normally would be harvested with a binder. When dry, the oats are picked up and threshed with a combine. While this procedure requires one additional operation, as compared to combining standing oats, it has these advantages: (1) early drying of the oats straw and grain, (2) prevention of loss in yield from shattering and loss in quality from weathering that occurs when standing grain is left for the combine, and (3) the straw is left clean and in a windrow so that it may be recovered easily if wanted for feed.

Winter Oats in Missouri

The production of fall-sown or winter oats in Missouri is limited to the extreme southern part of the state, (Figure 12), since this crop is less hardy than winter wheat or winter barley.

The only area in which winter oats may be considered a safe crop is the southeast lowland region. Here winter temperatures usually will permit the crop to pass through the winter with only minor loss from winter killing. However, in this area crops of winter oats have never been extensively grown since this is a cash crop area, and oats have a low bushel value. Production of an extremely early variety, such as the new Cimarron variety, might be profitable, however, for it usually could be followed by soybeans in a double cropping system. The returns from the two crops—oats and soybeans—would result in high annual return from the land.

Most of the winter oats production in Missouri is in the Ozark upland counties in south central and southwest Missouri. Winter temperatures in this

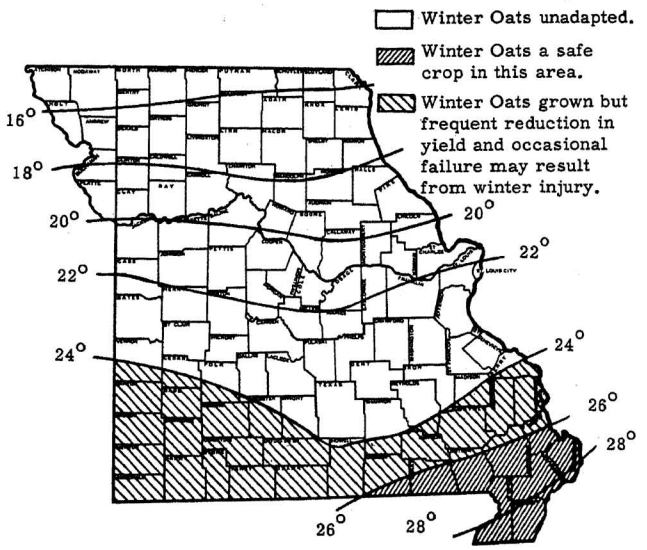


Figure 12.—The areas in which winter oats may be grown in Missouri in relation to the average minimum January temperatures. (Temperature maps furnished by Wayne L. Decker)

region are colder than in the southeast lowlands (Figure 12). Reduced yields or even failure, as a result of winter injury to the crop, are not uncommon. Persistent attempts to grow winter oats there, in spite of the winter hazard, continue as a result of (1) the need for winter pasture which winter oats provide, (2) the utility of oats as a grain feed, especially for dairy cattle and young stock, and (3) the high yield of winter oats in a favorable season as compared to the yields of spring-seeded oats.

Generally, it is recognized that spring oats seldom produce high yields in this Ozark upland area because of the short spring season, infertile soils, and drought. But the frequent reduction in yield of winter oats, and the occasional failures, from the effects of winter-injury often are forgotten after a report of an abnormally high yield in a favorable season. Winter oats occupy a place in the rotation that might otherwise be planted to a fall seeded crop like winter barley, winter wheat or winter rye. For this reason it would seem desirable to compare the amount of feed produced from winter oats with the amount produced by other fall seeded crops. Table 4 reports the comparative grain yields of winter oats, winter barley, winter wheat, and spring oats at Pierce City, (southwest Missouri) for the 4-year period, 1950 to 1953, and at Sikeston (southeast Missouri) for the 6-year period, 1948 to 1953. Comparative production of protein and total digestible nutrients from each of these crops has been calculated. The period of years for which the data is available, covered a succession of mild winters so that winter injury was less than might commonly be expected. In three of the years at Pierce City winter oats produced good yields but in one year, 1951, winter injury was severe and the production totaled only 11 bushels per

TABLE 4 -- COMPARISON OF GRAIN YIELDS OF WINTER OATS, WINTER BARLEY, WINTER WHEAT AND SPRING OATS AT PIERCE CITY AND SIKESTON, MISSOURI

Crop	Pierce City (Southwest Mo.) 1950	1951	1952	1953	Average	Sikeston (Southeast Mo.) 1948	1949	1950	1951	1952	1953	Average
					Bushels grain per acre							
Winter oats	40.4	11.1	38.9	53.3	35.9	44.9	38.4	39.6	45.7	44.8	51.8	44.2
Winter barley	36.0	31.9	34.4	39.9	35.6	31.4	48.4	43.1	40.5	41.5	54.3	43.2
Winter wheat	16.7	22.6	24.5	24.7	22.1	24.9	18.1	25.1	17.7	32.0	33.0	25.1
Spring oats	62.5	26.5	37.8	22.5	37.4	41.1	36.8	53.6	22.8	32.0	39.8	37.7
					Pounds grain per acre							
Winter oats	1293	355	1245	1766	1165	1437	1229	1267	1462	1434	1658	1415
Winter barley	1620	1436	1548	1796	1600	1413	2178	1940	1823	1868	2444	1944
Winter wheat	1002	1356	1470	1482	1328	1494	1086	1506	1062	1920	1980	1508
Spring oats	2000	848	1210	720	1195	1315	1178	1715	730	1024	1274	1206
					Pounds protein per acre							
Winter oats	122	33	117	160	108	135	116	119	137	135	156	133
Winter barley	151	134	144	146	144	131	203	180	170	174	227	181
Winter wheat	113	153	166	167	150	169	123	170	120	217	224	171
Spring oats	188	80	114	68	113	124	111	161	69	96	120	114
					Pounds total digestible nutrients per acre							
Winter oats	924	254	890	1220	822	1027	879	906	1945	1025	1185	1163
Winter barley	1274	1130	1218	1413	1259	1112	1714	1527	1435	1470	1923	1530
Winter wheat	838	1134	1229	1239	1110	1249	908	1259	888	1605	1655	1261
Spring oats	1430	606	865	515	854	940	842	1226	522	732	911	862

TABLE 5 -- COMPARISON OF SEVERAL WINTER OATS VARIETIES TESTED IN MISSOURI*

Variety	Yield in Bushels per Acre: 7-year avg.	5-year avg.	3-year avg.	Test Weight lb. per bu.	Date Headed	Height inches	Lodging %	Survival %
	(14)**	(9)	(5)	(5)	(2)	(5)	(1)	(5)
Cimarron		48.6	55.7	33.0	5/8	31	21	64
Wintok	45.4	44.6	53.3	34.6	5/12	34	36	70
Arkwin			51.1	34.3	5/13	37	18	54
Forkedeer	52.1	43.8	50.7	35.2	5/13	37	31	68
LeConte			46.2	36.1	5/12	35	2	57
Winter Fulghum	38.3	33.8	42.5	32.4	5/12	36	33	62

* Tests grown at Pierce City, Sikeston, Perryville and Richhill.
** Number in parenthesis refers to number of test included in the average.

acre. Yields of winter oats were satisfactory in all six years at Sikeston. During the 4-year period at Pierce City winter oats produced 40 percent less grain, 39 percent less protein, and 54 percent less total digestible nutrients than winter barley. At Sikeston, winter oats produced 37 percent less grain, 36 percent less protein, and 51 percent less total digestible nutrients than winter barley.

No comparisons are available between returns from winter oats and winter barley used for pasture. Both crops are highly nutritious and palatable. However the more vigorous and leafy growth of winter barley as compared to winter oats would tend to favor production of winter barley over winter oats.

These results point to the fact that in the Ozark upland areas, where winter oats are subject to winter injury, winter oats will be less productive of feed over a period of years than will winter barley.

Varieties of Winter Oats

When winter oats are grown, only the most hardy varieties available should be used in Missouri. Many varieties have been tested here in recent years. The performance of the superior varieties are listed in Table 5. Each will be described briefly.

Cimarron.—A new, short, early variety from Oklahoma. It has good hardiness and has been superior in yield in our tests. Cimarron may be a good variety to grow in a double cropping system with soybeans in southeast Missouri. It is susceptible to smut.

Wintok.—The most hardy variety available, but probably not as vigorous or as productive over a long period as Cimarron or Forkedeer. It is susceptible to smut.

Arkwin.—A relatively new stiff-strawed variety from Arkansas. It is not as winter hardy as Cimarron, Wintok, or Forkedeer.

Forkedeer.—This is the most widely grown variety in Missouri. It is tall, hardy, and productive, but susceptible to smut.

LeConte.—A stiff-strawed variety developed in Tennessee. It is not as productive or as winter hardy as Cimarron, Wintok, or Forkedeer.

Winter Fulghum.—This variety has been widely grown in south Missouri. It is winter hardy, but lower in yield than other varieties, and susceptible to smut.

Dubois.—A new, short stiff-strawed variety developed in Indiana. In 1954 at Pierce city, it yielded 47.6 bushels as compared to 51.2 bushels for Forkedeer, and 47.6 bushels for Cimmaron. It probably compares with Cimarron and Forkedeer in winter hardiness.