Growing Good Crops of

Oats In Missouri

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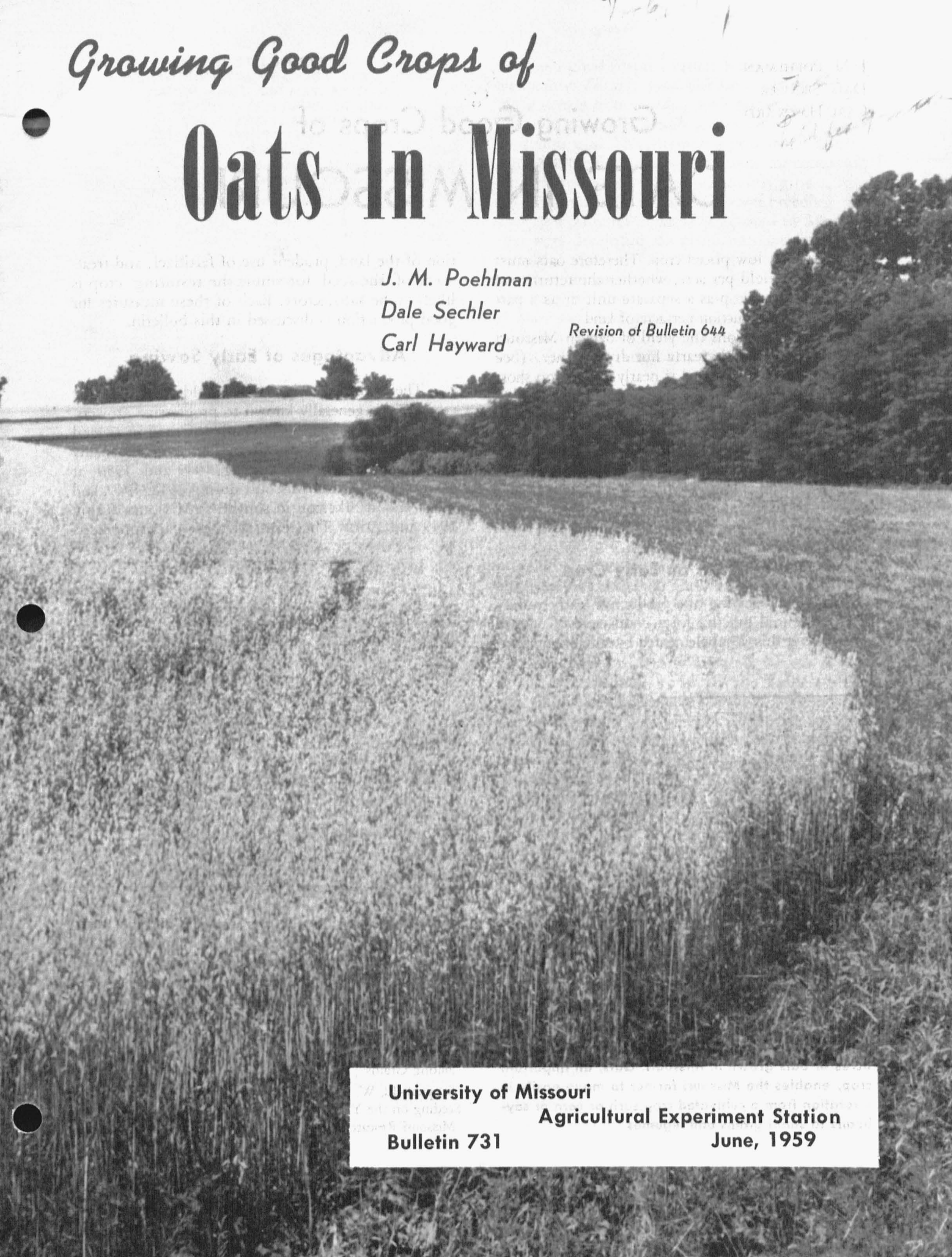
Revision of Bulletin 644



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Growing Good Crops of OATS IN MISSOURI

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 the northern oats.

The limitation of growth by a short season may be partly avoided by an early crop. This is the basis of the more important methods for producing good crops of oats here.

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 suitable preparation of the land, prudent use of fertilizer, and treatment of the seed for smut, the resulting crop is likely to be satisfactory. Each of these measures for good production is discussed in this bulletin.

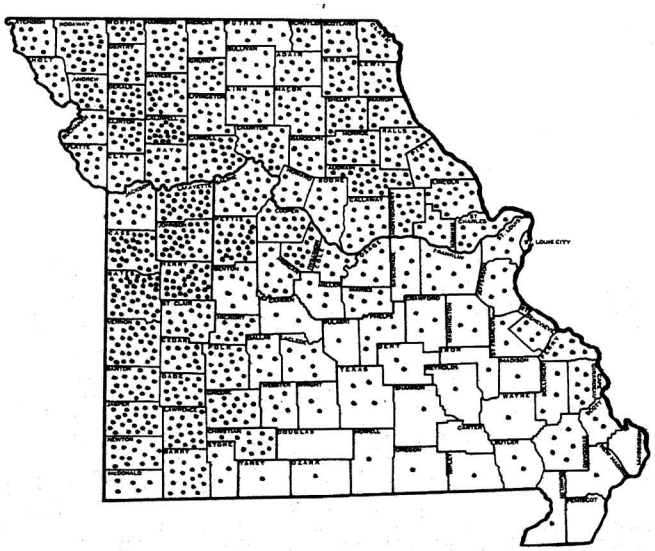

Fig. 1—Distribution of the approximately 1.3 million acres of oats grown in Missouri. Oats, an important crop, enables the Missouri farmer to move easily in a rotation from a cultivated crop such as corn or soybeans to small grains and legumes.

Advantages of Early Sowing

The favorable influence on yield of sowing the 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.[2] The result of these experiments is

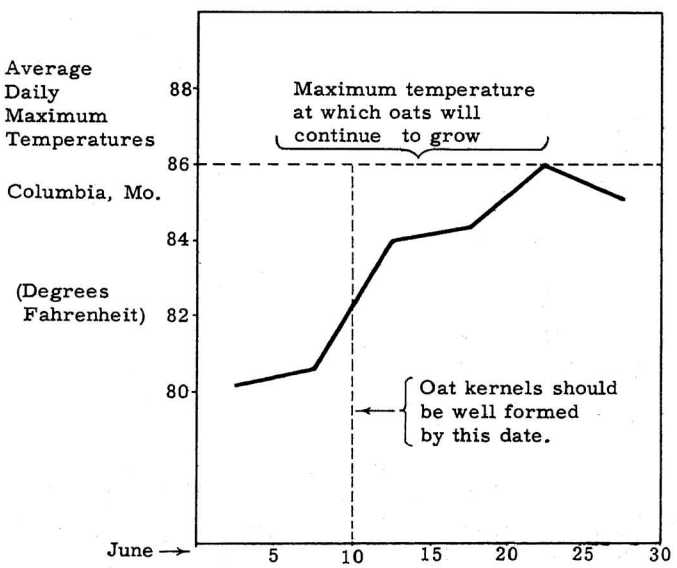

Fig. 2—In Missouri, temperatures of mid and late June often approach or even exceed the maximum (86° F)[1] at which oats will continue to grow. Kernels formed under these conditions are light in weight. Early seeding of an early variety permits fullest kernel development before high temperatures occur.

[1]According to Haberlandt (quoted from Jasny, "Competition among Grains", 1940).

[2]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	Northwest 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.

summarized in Table 1. A progressive decrease in yield and bushel-weight may be noted as seeding was delayed in all three areas. This indicates the necessity 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 drouth. Late maturing varieties suffered greater losses by delay of the seeding date than did the early varieties used in these tests.

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 drouth in early summer.

Choosing a Variety

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

From this succession of new varieties you must choose one to grow on your farm. If your choice is to be made wisely, information about adapted varieties must be available to you. 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 you to use in choosing a variety is its record of performance as compared with that of varieties already accepted in the area where it is to be used.* The Missouri Agricultural Experiment Station has long conducted tests for comparing the performance of varieties commonly grown, with new experimental strains of our own breeding, and with new varieties potentially adapted to Missouri that were developed elsewhere. In considering the record of a variety you should give *yield* first importance, but you should also carefully consider 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 was made first 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 during the period 1920 to 1945. The earliness, vigor, productiveness, and good seed quality of Columbia made it one of the most popular varieties for many years. 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 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,

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.

Fig. 3—Varieties of oats being tested at the University of Missouri South Farms, Columbia. From tests such as these the comparative merits of oats varieties are learned.

Mindo, Andrew, and an experimental strain 04102[3]; *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 already well known that in Missouri the spring season is too short, even with early planting, for full maturity and development of any except the earliest maturing variety.

Breeding for Disease-Resistance Brings Changes in Varieties

Since 1940 many new disease-resistant varieties of spring oats have been developed in the Corn Belt area and many 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 Victoria, an introduction from South America, and Richland, an Iowa variety. These new varieties were resistant to crown and stem rust diseases and to smut. But a new disease, Victoria blight, to which they were susceptible, soon became widespread and caused these new varieties to be discarded.

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 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 which attacked all of the varieties with the "Bond" type of resistance became widespread. These varieties were no longer resistant to the prevailing forms of crown rust, so again a large group of closely related varieties was discarded; only Andrew, and to a lesser extent, Cherokee, both of which possess some tolerance to crown rust, are still grown in Missouri.

In 1951 a new variety of oats, Mo. O-205, from the cross Columbia x Victoria-Richland was distributed in Missouri and other states in the Midwest. Mo. O-205 has been an extremely high yielding variety with a wide adaptation. It has a moderate resistance to crown rust as well as resistance to stem rust, Victoria blight and smut. In 1957, a race of crown rust infecting the varieties with Victoria parentage was widespread in Missouri and it damaged Mo. O-205 more severely than races present earlier. Partly as a consequence, a new variety, Macon, from the cross Columbia x Marion was increased and distributed in the spring of 1959.

Another new variety with crown rust resistance which has been used in oat breeding is Landhafer, introduced from Germany, although it originated in South America. Landhafer is resistant to the forms of crown rust that attack Bond and Victoria. Several varieties of spring oats have been developed with crown rust resistance from this source, including Clintland, Clintland 60, and Minhafer.

[3]A selection of 04102 has since been named Macon and distributed to Missouri growers.

Late in the 1957 season new races of crown rust which attacked varieties with the Landhafer type of resistance were found in the Midwest. These races were also observed to a lesser extent in 1958. The presence of these new races of crown rust indicated that effective use of the "Landhafer" varieties may be short and that again it is necessary to be looking for new varieties with different sources of resistance to this disease.

While the breeding of crown rust resistant spring oats was progressing, advancements in breeding for other diseases were also bringing change. Resistance to stem rust was incorporated into all of the new crown rust resistant varieties. Some such as Boone, Andrew, and Mo. O-205 were resistant to a certain group of stem rust races. Clinton, Cherokee and Clintland were resistant to a different group of stem rust races.

New varieties such as Burnett, Minhafer, Clintland 60 and other new varieties soon to be introduced have resistance to most of the prevalent stem rust races. The resistance in oats to stem rust has been more lasting than with crown rust. But the identification of a new form of stem rust in Canada in 1957 which infects varieties previously resistant indicates that the lasting qualities of present sources of stem rust resistance may be short lived.

Effective resistance to smut had been introduced into all of the new varieties also. While new races of smut are also identified from time to time their presence has not yet increased greatly the problem of breeding smut resistant varieties. Some new diseases, or newly recognized diseases such as the virus disease of oats, may necessitate further changes in varieties.

The change in prevailing races of rusts, and other diseases, appears to be a natural consequence of growing widely varieties with the same inherent source of resistance. This is one of the large problems facing plant breeders who are breeding new disease-resistant varieties.

Variety changes have occurred rapidly during the past twenty years, and we may expect a similar rapid turnover of varieties in the next twenty years.

Most of the newly developed, disease resistant varieties also have been higher yielding, stronger strawed, and earlier in maturity than varieties grown earlier. However, many of the new varieties developed in the more northern states are still too late in maturity for best adaptation to Missouri conditions.

Varieties Recommended for Missouri

Oat variety recommendations for Missouri are made annually, hence none are printed here. Current recommendations are published each year by the Agricultural Extension Service and are available from your local county agent, or by writing to the *Department of Field Crops, Missouri Agricultural Experiment Station, Columbia, Missouri.* Staff members of the Department of Field Crops at Columbia and its outlying stations meet in an annual crops conference and select the varieties to be recommended.

Oat variety recommendations are based on comparative performance, *yield, earliness, lodging resistance, bushel-weight,* and *disease resistance,* as determined by tests grown each year at several locations in Missouri. In addition much information on the extent of adaptation, disease resistance, lodging resistance, and other characteristics of varieties is learned from tests conducted in other states in cooperation with the United States Department of Agriculture.

Variety Performance and Characteristics

The results of oat variety tests conducted in Missouri during the 11-year period, 1948 through 1958, are summarized in Tables 3 and 4. Only varieties that are named and are available commercially are reported. In addition many experimental strains were tested each year.

The average yields of the varieties tested during the 11-year period are reported in Table 3. These tests were widely distributed over Missouri to measure the performance of varieties in different areas. Currently five variety tests are planted each year in Missouri; one each in the vicinity of Columbia, Bethany, Marshall, Pierce City and Sikeston.

In Table 4 the performance of groups of oat varieties are compared over periods of years. Mo. O-205 has consistently been the highest yielding variety tested throughout the entire period. Other varieties which have given high yields over long periods are Macon and Andrew. New varieties which have yielded well during the past 3-year and 4-year periods include Newton, Burnett, Clintland and Minhafer. The latter varieties are short and stiff strawed, but with the exception of Minhafer they are later maturing than is desirable in Missouri. Macon has consistently produced the highest test-weight. Clintland and Minhafer have best resistance to crown rust in the recent tests.

Brief descriptions of the varieties currently important in Missouri follow:

Macon. A new, early, Columbia type variety distributed to Missouri growers in 1959. This variety was developed from the cross Columbia x Marion. It is high in yield, with light-colored, heavy grain which is excellent in both feeding and market quality. Macon is similar to O-205 in height but may be

TABLE 3--YIELDS OF OAT VARIETIES TESTED IN MISSOURI DURING THE 11-YEAR PERIOD, 1948 TO 1958.

Variety	'48 (9)*	'49 (9)	'50 (6)	'51 (5)	'52 (2)	'53 (4)	'54 (5)	'55 (5)	'56 (4)	'57 (3)	'58 (4)
					Average yield in bushels per acre						
Macon	66.5	51.0	65.0	45.5	47.7	42.6	61.5	76.1	73.4	71.7	58.6
Mo. O-205	68.3	51.0	69.6	46.3	46.1	40.4	64.4	80.5	75.9	69.2	58.3
Andrew	66.8	50.2	61.2	45.2	48.1	34.9	63.0	74.9	72.5	68.7	52.9
Cherokee	60.3	46.1	59.2	33.5	38.0	32.3	57.7	69.8	69.0	61.0	51.8
Columbia	57.6	45.9	57.9	44.9	46.5	35.4	64.2	63.8	65.7	62.1	51.9
Clinton	56.3	44.8	51.9	38.3	45.2	31.7	56.4	69.5	68.2		
Mo. O-200	60.9	47.5	63.3	42.5	49.0	36.3	59.8	73.8			
Marion	55.0	46.1	66.4	30.0	46.0	37.3	58.4				
Mindo	60.4	46.4	61.4	40.0	46.1						
Boone	49.8	35.7	55.7	22.0							
Nemaha	60.0	38.7	60.3	33.6							
Clintland						30.6	56.3	82.2	72.0	67.5	53.3
Dupree							70.4	66.7			
Cimarron							62.3	52.4			
Waubay							61.1				
Bonham								69.1			
Newton								81.3	73.2	76.8	53.0
Burnett									85.7	61.2	53.8
Fayette									65.6	56.7	48.5
Minhafer									72.3	71.5	52.2
Logan									73.8	60.4	
Putnam									73.6	65.4	
Clarion									71.5		
Beedee									69.6		
Nehawka											58.1
Clintland 60											52.0

* Numbers in parentheses refer to number of tests in that particular year.

TABLE 4--PERFORMANCE OF OAT VARIETIES IN MISSOURI DURING THE 11-YEAR PERIOD, 1948 TO 1958.

	Yield Bu./Acre	Test Weight Lbs./Bu.	Height Inches	Lodging %	Date Headed	Crown Rust %	Smut† Heads/ Row	Groats %
				4 year average, 1948 to 1951				
	(29)*	(27)	(23)	(23)	(16)	(7)	(1)	
Mo. O-205	59.4	31.3	38	17	June 6	15	0	
Macon	57.8	31.6	38	22	June 4	18	0	
Andrew	56.8	29.8	37	22	June 3	28	1	
Mo. O-200	54.1	31.5	37	40	June 2	26	0	
Mindo	52.7	28.8	33	23	June 3	29	1	
Columbia	51.8	30.9	38	33	June 3	26	34	
Cherokee	51.0	29.8	34	22	June 4	20	1	
Marion	50.3	30.1	37	21	June 5	12	0	
Nemaha	48.9	29.9	35	24	June 5	24	4	
Clinton	48.7	29.1	33	15	June 8	44	4	
Boone	41.9	27.1	33	31	June 8	5	0	
				7 year average, 1948 to 1954				
	(39)*	(37)	(29)	(25)	(19)	(8)	(3)	
Mo. O-205	57.3	31.5	37	16	June 4	15	0	
Macon	56.1	32.0	37	26	June 3	20	0	
Andrew	54.7	30.3	36	21	June 2	32	1	
Mo. O-200	52.6	31.8	36	38	June 1	29	0	
Columbia	51.1	31.3	37	32	June 2	29	14	
Marion	49.4	30.6	36	34	June 4	16	0	
Cherokee	49.1	30.6	33	22	June 3	24	1	
Clinton	47.6	29.4	33	14	June 7	47	3	
				11 year average, 1948 to 1958				
	(54)*	(52)	(39)	(37)	(25)	(17)	(7)	
Mo. O-205	61.1	31.5	38	19	June 4	25	0	
Macon	59.9	32.4	38	25	June 2	25	0	
Andrew	58.2	30.7	37	23	June 2	32	1	
Columbia	53.8	31.1	38	32	June 2	52	9	
Cherokee	53.0	30.8	34	24	June 2	25	1	

TABLE 4--CONTINUED

	Yield Bu./Acre	Test Weight Lbs./Bu.	Height Inches	Lodging %	Date Headed	Crown Rust %	Smut† Heads/ Row	Groats %
			4 year average, 1955 to 1958					
	(15)*	(15)	(10)	(12)	(6)	(9)	(4)	
Mo. O-205	71.1	31.7	42	23	June 1	33	0	
Newton	70.7	32.0	40	21	June 3	31	5	
Macon	69.8	33.2	42	22	May 31	30	0	
Clintland	68.8	32.5	39	24	June 4	4	2	
Andrew	67.2	31.5	41	27	June 1	33	1	
Cherokee	63.0	31.4	38	28	June 1	26	1	
Columbia	60.8	30.9	42	32	June 1	49	8	
			3 year average, 1956 to 1958					
	(11)*	(11)	(7)	(9)	(5)	(8)	(3)	(11)
Mo. O-205	67.7	31.2	41	18	June 3	34	0	74.4
Macon	67.6	32.9	42	14	June 1	31	0	75.6
Burnett	67.4	31.5	40	16	June 3	28	0	75.8
Newton	66.8	31.2	39	13	June 5	32	4	74.8
Minhafer	64.8	32.2	40	16	June 2	8	0	76.3
Andrew	64.3	30.9	41	19	June 3	34	1	76.4
Clintland	64.0	32.3	38	16	June 5	6	1	77.3
Cherokee	60.6	31.2	38	21	June 2	28	1	75.2
Columbia	59.7	30.8	41	24	June 2	53	7	75.6
Fayette	57.0	28.8	38	22	June 4	35	0	72.1

* Numbers in parentheses refer to numbers of comparisons.

† Smutted heads per 10 foot length.

slightly weaker in strength of straw. It is resistant to smut; Victoria blight; stem rust races 2, 7, and 7A; and moderately resistant to crown rust including the Victoria infecting race, 216, present in Missouri in 1957.

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[4] and was distributed from the Missouri Agricultural Experiment Station in 1951. O-205 is a Columbia type variety with wide spreading panicles and tall stiff straw. The seed color is dark, but the bushel-weight and groat (grain with hulls removed) percentage is fairly high, indicating that the variety is satisfactory for feed. Mo. O-205 has been discredited on the market as a milling variety but since very little Missouri-grown oats ever reaches the milling oat market—oats generally being fed on the farm where they are grown—it appears that this weakness has been overemphasized. O-205 is resistant to smut; Victoria blight; races 2, 7, and 7A of stem rust; and moderately resistant to crown rust, except perhaps some of the races that infect Victoria such as the race 216.

Minhafer. An early, moderately high yielding variety of oats with an excellent resistance to several diseases. Minhafer originated from the cross Landhafer x (Bond x Rainbow) (Hajira x Joanette) and was distributed from the Minnesota Agricultural Experiment Station in 1957. Minhafer is shorter than Mo. O-205, has moderately stiff straw, and yellow grains of good quality. It is resistant to smut, Victoria blight, common races of stem rust (2, 6, 7, 7A, 8), and to crown rust.

Nehawka. An early, short, stiff-strawed variety developed in Nebraska from a Cherokee selection. It differs from Cherokee in being resistant to race 7 and susceptible to race 8 of stem rust. Seeds are short, plump as in Cherokee but the grain has an ivory color. Nehawka is resistant to smut, moderately resistant to crown rust, has good test weight, and produces good yields.

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 Mo. 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.

Cherokee. An early, short, stiff-strawed variety formerly grown on limited acreages in some areas of Missouri, apparently because it has short, plump grain which makes it popular for hog or poultry feed. Yields of Cherokee are lower than yields of Macon, Mo. O-205 and other varieties. Cherokee is

[4]Poehlman, J. M. "O-205 Oats, an Improved Columbia-Type Variety for Missouri." Missouri Agricultural Experiment Station, Bulletin 637, 1955.

resistant to smut, Victoria blight, races 2 and 8 of stem rust, and is somewhat tolerant to crown rust.

Columbia. The standard early variety in Missouri for many years. It has weak straw and is susceptible to rust and smut. Columbia has been replaced by new disease-resistant varieties.

Clinton. A short, stiff-strawed variety, that was popular in states to the north and east of Missouri. Its later maturity limited its use in Missouri mostly to the northern part of the state. Clinton is resistant to smut, Victoria blight, and races 2 and 8 of stem rust. It is susceptible to present races of crown rust.

Clintland. A Clinton type variety developed by combining the Landhafer type of crown rust resistance (also present in Minhafer) with the Clinton plant type. Clintland is short, stiff-strawed but like Clinton is a mid-season variety for Missouri with its use limited to the northern part of the state for good production. Clintland is resistant to smut, Victoria blight, races 2 and 8 of stem rust, and crown rust.

Clintland 60. An improved Clintland type, it differs from Clintland chiefly in being resistant to races 6 and 7 of stem rust as well as having the Clintland resistance to races 2 and 8 of stem rust, to crown rust, and to smut. It is similar to Clintland in plant type and maturity.

Burnett. A moderately tall, stiff-strawed variety from Iowa with good yield in most seasons, although it appears to be adversely affected by high temperatures in some seasons. Burnett is resistant to smut; Victoria blight; races 2, 7, and 8 of stem rust (susceptible to 7A), and moderately resistant to crown rust.

Newton. A short, stiff-strawed variety from Indiana, which has produced high yields in Missouri during the limited time it has been tested, but which appears to be adversely affected by heat late in the season. It is similar to Clintland in maturity. Newton is moderately susceptible to smut and crown rust, and is resistant to races 2, 7, and 7A of stem rust.

Buy From A Seedsman You Know

When you have selected the variety you wish to grow, be sure that you buy clean, viable seed of known origin. Buying *Missouri* "Certified Seed" is one sure way to know that you are getting both pure seed and seed of a variety adapted to this state. Missouri "Certified Seed" carries the blue "certification" tag with the name and address of the grower and "Missouri Seed Improvement Association" clearly marked on it.

Above all beware of buying seed from traveling seedsmen from out-state at a high price because they offer special inducements. It is a common practice for the "traveling" seedsmen to import unadapted, often northern grown, varieties and sell seed at excessive prices. While the variety may be good where it is adapted, it almost never produces in Missouri the high quality of seed that the salesman displays, or yields comparable to those that could have been obtained from locally adapted varieties. One of the salesman's gimmicks is to offer to buy your oats, ostensibly for seed, at an attractive price. But the contract you sign, if a *bona fide* contract is offered you, always has enough fine print to eliminate all chances of your realizing this attractive price.

Hybrid Oats

New oats varieties are sometimes represented as "Hybrid oats." Usually this means 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 and sorghum, as oats differs from these crops 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 selections made for several generations following a cross between selected varieties. Varieties developed in this manner are pure; therefore, the seed may be replanted year after year. Nearly all new varieties are of hybrid origin. *But as varieties they must be judged on their performance—yield, earliness, stiffness of straw and disease resistance—not on their "hybrid" origin.*

Diseases of Oats

Four major diseases of oats are found in Missouri. They are *smut, crown rust, stem rust,* and *yellow dwarf* or *red leaf.*

Smut—Smut in oats was long a common disease in Missouri. The oat head is destroyed by this disease and black masses of spores are formed instead of kernels. By harvest time these spores are spread by the wind or washed to the ground, leaving only the naked stems on infected plants. The disease is propagated by spores which fall on normally developing seeds and are thus carried onto the next crop when those seeds are planted the following spring. Loss in yield is approximately proportional to the number of smutted heads. Control is effected by (a) *seed treatment* which kills the spores carried on the

Fig. 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.

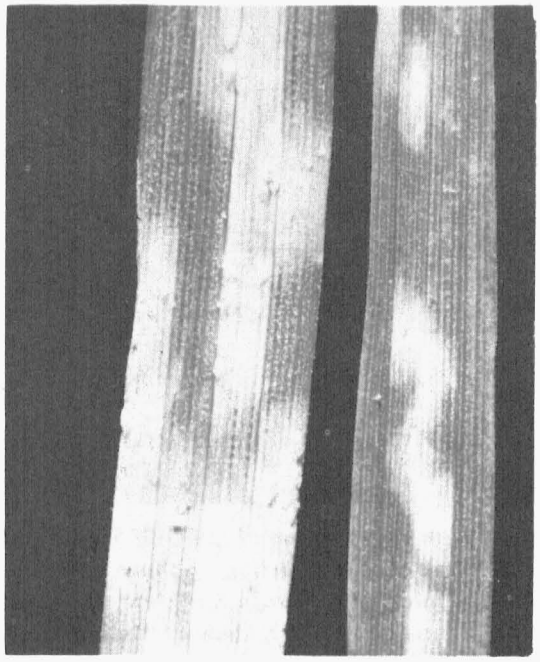

Fig. 5—Crown or leaf rust on leaf of a susceptible variety at left, and a resistant variety at right. Masses of orange-red rust spores develop and interfere with normal functions of the leaf. The spores are blown about by the wind, producing new infections where they fall on leaves of oat plants.

seed, and (b) by *growing varieties resistant to this disease.* Columbia is susceptible, as well as Forkedeer winter oats. Macon, Mo. O-205, Minhafer, Andrew and other new varieties are resistant.

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 plant while stem rust produces brick-red, elongated pustules on the stems and to a lesser extent on the leaves. In these pustules masses of spores are produced. The spores are blown about by the wind, and fall upon green developing oat plants, producing new infections. Warm, wet weather at the heading stage favors rust infections and delays the maturity of the oats crop, thus prolonging the period of possible infection. An epidemic of either of the rust diseases occurring before the kernels are well formed will produce light-weight kernels and low yield and cause severe lodging of the plant. Early varieties will avoid rust damage in many years in Missouri. The best protection from rust is by breeding resistant varieties.

Both of the rust diseases are composed of numerous physiologic forms or races which may be considered similar to varieties in crops. Considerably more than 100 of the races of crown rust and 15 races of stem rust have been identified. A variety of oats may be resistant to one race and susceptible to another race of the same rust. The Macon variety of oats is resistant to races 2 and 7A but susceptible to race 8 of stem rust. Clintland is resistant to race 8 but is susceptible to races 7 and 7A of stem rust. Minhafer and Clintland 60 are resistant to all of these races.

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 races 7 and 7A have been found more frequently than race 8. Since Clinton and Clintland are susceptible to races 7 and 7A, we find them damaged by these races of stem rust.

Similar changes occurred in the races of crown rust. Race 216 was widespread in Missouri for the

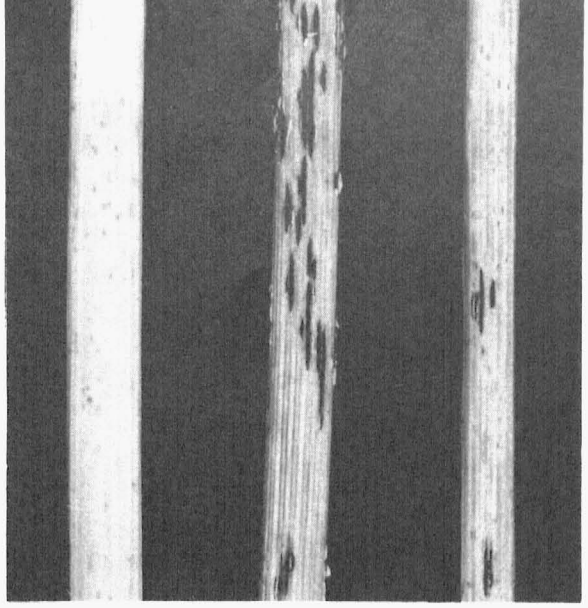

Fig. 6—Stem rust reaction of the O-205 oats variety is illustrated by the infection on these three stems. Left, stem infected with race 7 of stem rust to which O-205 is resistant. Center, stem infected with race 8 to which O-205 is susceptible. Right, stem infected with both races 7 and 8. Both small (resistant type) pustules and large (susceptible type) pustules may be seen on the same stem.

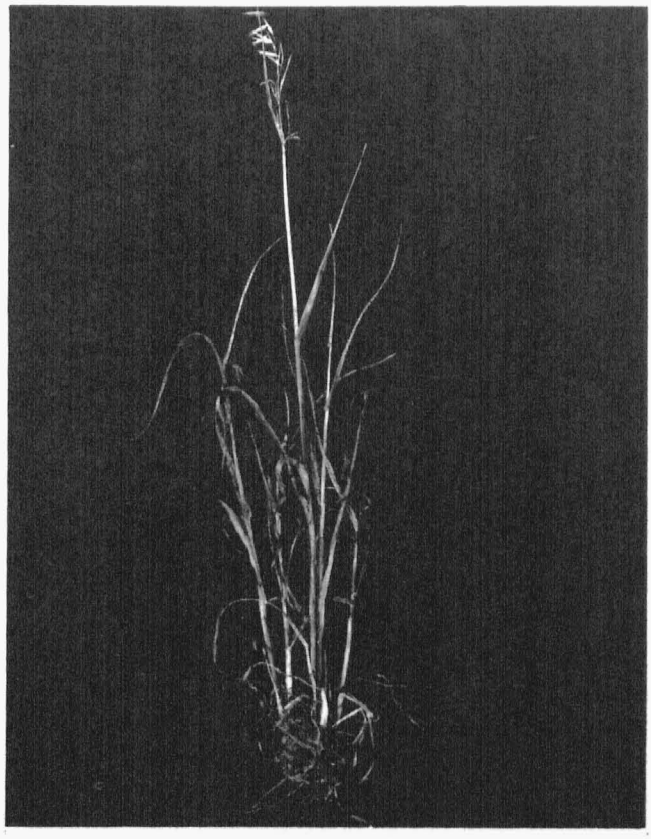

Fig. 7—Yellow dwarf infected plant of oats. This disease appears after aphids have fed on the oat plant. Leaves turn red to yellow and then die; side tillers are killed, and the head is blasted as shown by the reduction in number of kernels formed.

first time in 1957. This race caused more damage to Mo. O-205 than any previous race. Macon has greater resistance to race 216 of crown rust than Mo. O-205. This is one of the reasons Macon was increased and distributed as a new variety. When the Landhafer variety was first grown in the United States it was resistant to all of the races of crown rust previously observed in this country. But since 1957 new races of crown rust which infect Landhafer and varieties such as Clintland and Minhafer, which have the Landhafer type of crown rust resistance, have been identified and have become widespread in some areas. This means that it is now necessary to develop varieties of oats with new types of resistance if we are to continue to grow crown rust resistant varieties in the United States.

Yellow Dwarf—Yellow dwarf or red leaf is caused by a virus which is carried by aphids or green bugs. Leaves on infected plants turn red or yellow and the heads are partially blasted. Yields and test weight may be greatly reduced in years when large numbers of aphids are present early in the season. The disease also occurs on barley and wheat.

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 organic 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 a simple seed treater. Some of the fungicides are mixed with water and applied as a spray or as a slurry. The latter requires special treating equipment. Always follow the rates given on the container.

Cautions you should follow with a mecurial-type dust treatment:

1. Do not breathe the dusts, since 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.
3. Do not overtreat the seed, as it will injure germination.

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

As long as you use smut and blight resistant varieties, it is usually unnecessary to treat oats seed. However, if smut is found in one of the resistant varieties it would be very important to treat the

smut-infected seed immediately. Presence of smut in a resistant variety 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 prevent the increase and spread of the new race. A better procedure would be to feed the oats and buy new seed from a smut-free field. Susceptible varieties such as Columbia and the winter oats varieties, Forkedeer and Winter Fulghum, should be treated regularly for control of smut.

Preparing the Land for Seeding

The value of early seeding of an early variety 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 to the success of the crop.

Plowing in winter or early spring usually will increase the oat yield provided you do not leave the seedbed too loose when you sow the oats. 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 to prepare a seedbed following corn, Korean lespedeza sod, or 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 a dry soil either germinate slowly or, when they germinate, grow unevenly. This results in late and uneven maturity, reducing 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 shallowly that on sprouting it may be killed by freezing weather.

Drilling requires less seed, 8 pecks per acre is as productive usually as the heavier rate of 10 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.

Fertilizing the Oats Crop

Fertilizing is one of the best ways to increase the yield of oats in Missouri. The high yield potential of present oat varieties is seldom reached in Missouri's soil and climate. Balanced fertilizer nutrients will increase the yield of the spring seeded oat crop, even in unfavorable seasons. Also, they will help reduce the amount of winter injury in winter oats. Basic mineral applications usually consist of fertilizers containing phosphorus and potassium, following or along with the application of lime. While basic amendments of phosphorus and potassium may be taken care of by plowing down large amounts, as indicated by soil tests, smaller applications applied at the time of seeding 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 you need to add with the oats.

Besides mineral elements, nitrogen is generally included in the starter, or the nitrogen may be applied as a top-dressing after the oats are seeded. The amount will depend upon the organic matter content and 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 have much better straw than those formerly used, caution should be observed in using high rates of nitrogen on soils already high in organic matter, or during wet seasons. The grower may need to balance the maximum yield desired from high fertilization against possible loss of yield by the lodging that might result if there is heavy rainfall, when he decides the amount of nitrogen fertilizer to use. There are few seasons, if any, when moderate nitrogen applications will not stimulate the early growth of the oat 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, seeded early on a well prepared seedbed, makes a desirable companion (or nurse) crop in which to establish a legume or grass. This is important because of 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 so much 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

Fig. 8—Combining oats from the windrow permits an early harvest without the loss from shattering that occurs when standing grain is left for the combine.

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 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 cost combined with the use of oats as a companion crop for legumes 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.

Harvesting Oats

Oats are usually harvested for grain with the combine-thresher, although occasional fields may still be cut with a binder and thresher. 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 other grains. The newer varieties of oats have stiffer straw and will stand longer after ripening than the older varieties. But they will shatter when harvesting is delayed and losses ranging up to 15 to 20 percent from this cause are not uncommon. This means that we are paying a high cost in yield loss for the economy in labor from combine harvesting. There appears to be very little difference in the resistance of different varieties to shattering.

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 windrowed oats are picked up and threshed with a combine. While this procedure requires one extra machine operation, as compared to combining standing oats, it has these advantages: (a) early drying of the oats straw and grain and elimination of green weedy material from the threshed grain, (b) prevention of loss in yield from shattering and loss in quality from weathering that occurs when standing grain is left for the combine, and (c) the straw is left clean and may be recovered easily if wanted for feed.

Using the Oats Crop

Oats may be grazed, or they may be cut green for hay or silage, or they may be harvested for grain. These uses, with the place oats fills in a rotation following corn or other cultivated crops, have made oats an important Missouri crop.

Oats produce excellent feed as pasture. While the total acre returns of spring-seeded oats as pasture are low, they will provide supplemental grazing for short periods in the early spring. Fall pasturing of winter oats is a widespread practice and provides an important part of the total returns for the fall-seeded oats crop. Fall forage production up to one ton per acre is possible in favorable seasons with winter oats. Either spring or fall seeded 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 be expected under good conditions.

Oats harvested for grain make excellent feed for young livestock, horses, dairy cows, sheep, swine and poultry. Oats contain more protein, fat, calcium, and phosphorus 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 as a roughage.

Winter Oats in Missouri

Production of fall-sown or winter oats in Missouri is limited to the southern part of the state, (Fig. 9), since this crop is less hardy than winter wheat or winter barley.

The safest area for growing winter oats is the southeast lowland region. Here winter temperatures cause only minor injuries, if any, to the oats crop. 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 early 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 winter oats production in Missouri is in the Ozark upland counties in south central and southwest Missouri. Winters there are colder than in the southeast lowlands (Fig. 9). While the newer varieties produce well throughout much of this region in most years, reduced yields or even failure from winter injury should be expected along the northern border of this area in some years.

In spite of the winter hazard, production of winter oats continues in this region as a result of (1) the need for fall and winter pasture which winter oats provide, (2) the utility of oats as a grain feed, especially for dairy cattle and young stock, (3) the high yield of winter oats in a favorable season as compared to the yields of spring-seeded oats, and (4) the uncertainty of planting spring oats early enough to produce good yields.

Spring oats seldom produce high grain yields in the Ozark upland area because of the short spring season, infertile soils, and drought. Although winter oats may produce larger grain yields than spring oats, their total feed production from grain is not as large as that produced by wheat or winter barley.

Table 5 reports a comparison of grain yields of winter oats, winter barley, winter wheat, and spring oats at Pierce City and Sikeston. Fourteen comparisons were available (eight at Pierce City and six at Sikeston) for the nine-year period, 1950 to 1958. Comparative acre production of protein and total digestible nutrients from each of these crops has been calculated. In these comparisons winter oats yielded 14.2 percent less protein and 25.3 percent less total digestible nutrients than winter barley, and

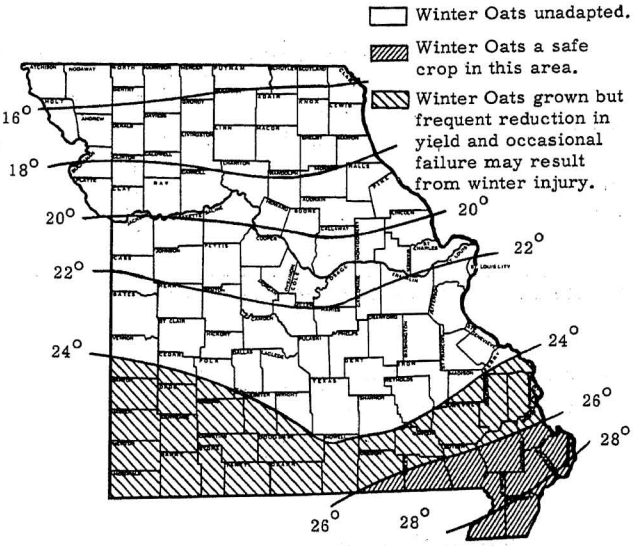

Fig. 9—The areas in which winter oats may be grown in Missouri in relation to the average minimum January temperatures. (Temperature maps furnished by Wayne L. Decker).

24.3 percent less protein and 22.2 percent less total digestible nutrients than winter wheat. The winter oats yielded 5.4 percent more protein and 6.2 percent more total digestible nutrients than spring oats in the same comparisons.

One of the important uses of winter oats is for pasture. No direct 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 barley for fall and early winter pasture. Winter oats do not make as early spring pasture as winter barley. Neither make as early spring pasture as winter wheat.

These results show that in the Ozark upland areas, winter oats will produce less over a period of years than winter barley. Nevertheless, because winter oats tolerate a wider range of soil conditions than winter barley, many farmers prefer winter oats to winter barley and as more winter hardy varieties of oats become available we may expect the winter oat acreage to increase and its area of production to

TABLE 5--COMPARISON OF FEED PRODUCTION BY WINTER OATS, WINTER BARLEY, WINTER WHEAT, AND SPRING OATS AT PIERCE CITY AND SIKESTON, MISSOURI

Crop	Yield Grain Bu./Acre	Yield Grain Lbs./Acre	Yield Protein Lbs./Acre	Yield T.D.N.† Lbs./Acre
Winter oats	49.6	1587	147	1120
Winter barley	39.7	1906	172	1500
Winter wheat	28.7	1722	194	1439
Spring oats	46.1	1475	140	1054

* Average of fourteen comparisons (eight at Pierce City and six at Sikeston) during the period 1950-1958.

† T.D.N. = total digestible nutrients.

TABLE 6--COMPARISON OF WINTER OAT VARIETIES AT PIERCE CITY AND SIKESTON, MISSOURI DURING THE FIVE-YEAR PERIOD, 1954 TO 1958.

Variety	Yield Bu./Acre	Test Weight Lbs./Bu.	Survival Per Cent	Date Headed	Height Inches	Lodging Per Cent
	(7)*	(7)	(2)	(5)	(7)	(3)
Cimarron	61.8	32.3	85	May 8	33	70
Dubois	59.4	34.6	86	May 9	37	27
Bronco	57.0	32.9	86	May 13	38	31
Forkedeer	56.0	32.6	84	May 11	38	32

* Numbers in parentheses refer to number of comparisons.

extend northward. Some progress toward developing more suitable varieties has already been made and further progress is in sight.

Varieties of Winter Oats

Winter hardiness is so important for success of the winter oat crop in Missouri that only the most winter hardy varieties should be planted. Many varieties and experimental strains have been tested in recent years but only a few are suitable here. The performance of four superior varieties is listed in Table 6. Short descriptions of these and several other varieties tested follow:

Dubois. A short stiff-strawed variety from Indiana that has proved to be both high in yield and winter hardy. Dubois is early, produces seed with good test weight, and is resistant to smut. Dubois has become the most widely grown variety of winter oats in Missouri.

Bronco. A variety developed in Texas which is similar in hardiness to Dubois but which has been slightly less productive, has lower test weight, and is later in maturity. Bronco is resistant to smut.

Forkedeer. This variety is slightly less hardy and less productive than Dubois. Forkedeer is susceptible to smut. Formerly Forkedeer was the leading variety in Missouri but it has given way to Dubois in most areas.

Cimarron. This is a short, early and highly productive variety. The straw tends to be weak, and Cimarron is susceptible to smut and various leaf diseases.

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

Arkwin. A relatively new stiff-strawed variety from Arkansas. It is not as winter hardy as Dubois or Forkedeer.

LeConte. A stiff-strawed variety developed in Tennessee. It is not as productive or as winter hardy as Dubois or Forkedeer but may be relatively safe in southeast Missouri.

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

None of the winter oats varieties described here are resistant to the rust diseases but in many years rust may be escaped by the earliness of the winter oat crop.

Winter Oats Production

The production of winter oats will be determined to a large extent by its winter survival. Better survival may be obtained by using good production practices. These include (1) good seed bed preparation, (2) early seeding, and (3) adequate fertilization. Early seeding and liberal use of fertilizer amendments, according to the needs of the field as determined by soil tests, are important in getting the winter oat plants well established with a well developed root system before they go into the winter. This will enhance their winter survival. Seeding during the early part of September will also permit greater forage growth in the fall and a longer fall pasture season. This adds to the total value of the crop.

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This bulletin reports on Department of Field Crops Project 203, Breeding Oats for Missouri.