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OATS;
Experiments on Culture, Varieties, and Fertilization.

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OATS;

EXPERIMENTS ON CULTURE, VARIETIES, AND FERTILIZATION.

BY

J. F. DUGGAR and E. F. CAUTHEN.

SUMMARY:

The total production of oats in Alabama constitutes only a small fraction of this grain consumed in this State. Prices of grain will doubtless be high during the year 1914. These facts indicate the need for a very large and immediate increase in the acreage of oats.

To secure larger yields of oats per acre in Alabama, the following steps are generally advisable:

(a) Sowing oats in the first half of the fall.

(b) The selection for fall sowing of some variety belonging to the Red Rust Proof group of varieties. The varieties of this group tested here have been Red Rust Proof, Appler, Hundred Bushel, Bancroft, Culberson, and Cook. These varieties, on the average, have not differed greatly in yield.

(c) Treatment of the seed oats with formalin to prevent smut.

The open-furrow method for fall sowing is recommended rather than the broadcast method, where there is a probability of occasional winter killing. Where the winters are not severe, all thorough methods of sowing oats have given satisfactory yields.

Sowing in the fall is most essential, throughout most of Alabama, to the production of large yields of oats. On the whole, sowings made at Auburn in October have averaged a larger yield than those made in November. Fall sowings (average date Nov. 9) have afforded a yield greater by 19.6 bushels than sowings made in the early part of February.

In the experiments at Auburn the yield of oats has been profitably increased by nitrogen in almost every form in which it has been tested, including nitrate of soda, sulphate of ammonia, cotton seed meal, calcium cyanamid, stable manure, and the legumes used as fertilizers.

Of the commercial sources of nitrogen the most effective has been nitrate of soda.

Nitrate of soda is best applied as a top dressing in March. The rate recommended is 100 pounds per acre.

Acid phosphate proved more effective and economical for oats than did ground rock phosphate.

A general fertilizer for oats may well consist of 200 to 300 pounds of acid phosphate per acre, and on poor, sandy land 30 pounds of muriate of potash (or equivalent), all applied at the time of planting; and, in addition, 100 lbs. of nitrate of soda in March.

However, in a permanent system of farming most of the nitrogen for oats should be supplied by a preceding crop of legumes, or in the form of stable manure.

INTRODUCTORY.

Alabama farmers grow but little more than a quarter of a million acres of oats annually. The average yield for three years (1911, '12, '13) is reported as 19.2 bushels per acre. The total production of oats in Alabama falls far short of the annual consumption. Hence the need for a great increase in acreage is obvious, provided the yield under good farming can be increased so much above the average yield of the State as to afford a satisfactory profit. That the figures for the average yield in the State may be fully doubled under good farming is incidentally shown in the following pages.

There is special need for making an unusually large increase in the acreage of oats in the fall of 1913. Among the reasons are the following:

Throughout the State of Kansas the corn crop of 1913 has been practically a failure. In Missouri, parts of Illinois, and certain other of the principal corn-growing states of the Northwest, the corn crop, while not a failure, is notably below the average. The extreme drought, which covered a large portion of the principal corn-raising states, is responsible for this shortage in the corn crop of the West. This, of course, means that any Alabama farmer who makes an insufficient corn crop in 1913 will be forced to pay an exceedingly high price for any western corn which he may purchase in 1914. Drought has also cut short the oat crop of the Northwest.

Obviously, the best means by which Alabama farmers having the prospect of an insufficient supply of home-grown corn can avoid the payment of high prices in purchasing grain in 1914 is to sow a large acreage of oats in the fall of 1913.

METHODS OF SOWING OATS.

There are three general methods of seeding oats in Alabama. 1. Sowing the seed broadcast and plowing them under with a turn-plow. 2. Drilling the oats with an ordinary grain drill, after the land has been plowed. 3. Drilling the seed and fertilizer in an "open furrow," that is in a rather deep furrow, left open or unfilled.

Sowing Broadcast.—Many farmers sow the seed broadcast on rough or unplowed land and plow them under with a turn-plow. This method often leaves the surface cloddy and poorly pulverized. Many of the oats are covered too deeply, so that poor and uneven germination results. A better method consists in plowing the land two or three weeks before planting time, with a two-horse plow, turning under completely all litter, which will serve to fertilize the oats. The commercial fertilizer and seed oats are then sown broadcast by hand at the proper time and together harrowed in with a disc harrow. This practice may not cover all the oats deep enough for prompt germination, and may leave a few seed so near the surface that their shallow-rooted plants will be especially liable to winter killing. However, "discing in" is a rapid method of seeding oats and a very satisfactory one where grain drills are not at hand, and where winter killing is not probable.

Seeding With an Ordinary Grain Drill.—The grain drill is a very satisfactory machine with which to plant oats on well plowed land that is not packed and that is free from cornstalks and other litter. Most experiments show an advantage in yield from seeding with a drill over the method of sowing broadcast and plowing in with a turn-plow. The grain drill, spacing the rows of plants 6 to 8 inches apart, plants the seed at a uniform depth and does not require so much seed per acre as broadcast sowing. It economizes time, in that the machine distributes the commercial fertilizer, sows the seed, and covers both—all at one operation.

A satisfactory grain drill must be easy to operate. For Southern grown oats, such as the Red Rust Proof varieties, it must have a good agitator and force feed and sufficiently large grain tubes to permit a free passage of the oats. If the seed are not thoroughly cleaned by the thresher, they should be run through a fanning machine a second time to free them more completely from all chaff

and straw which is liable to choke the grain tubes and thereby prevent a uniform stand.

If the drag chains are removed from the drill a shallow furrow will be left, and the oats will begin their growth in a slight depression, which is a partial protection against winter killing.

The Open-Furrow Method of Drilling Oats.—The open-furrow method of planting oats consists in drilling them in such a way that, when the oats come up, they will be in a trench below the general surface of the ground. The trench may be made with an ordinary shovel plow, the seed sown in the trench by hand and covered with a light drag harrow or weeder, taking care that the harrow does not fill up the trench completely.

A better and cheaper way is the use of a common one-horse combined planter and fertilizer distributor equipped with a six-inch shovel plow. This distributor resembles an ordinary cotton fertilizer distributor. It consists of a double box

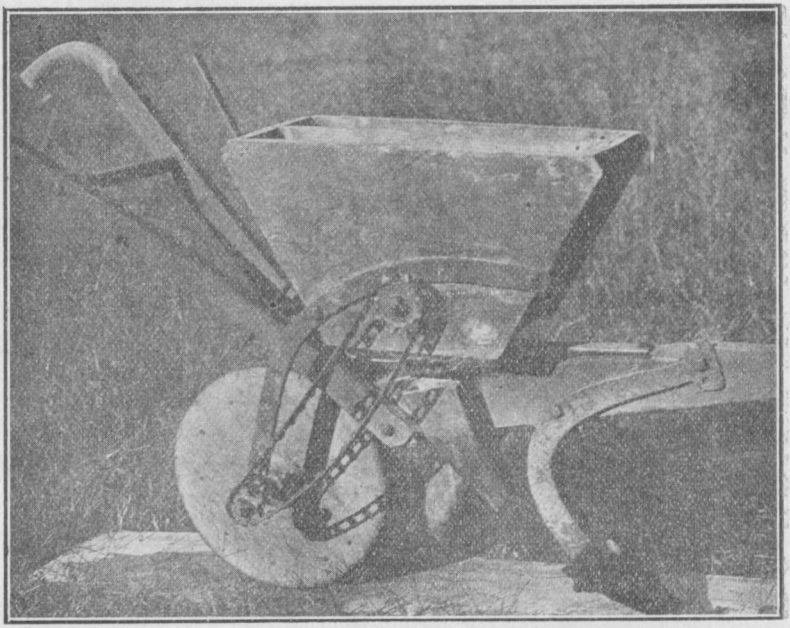

FIG. 1—A common type of single-row, open-furrow planter.

(one for seed and the other for fertilizer) attached to a plowstock, and in each box proper feeding devices to distribute the oats and fertilizer. A four or six-inch shovel or scooter plow is used on the plow-foot. The oat seed drop just behind the plow in the furrow and a small part of the soil moved by the plow falls on the seed, covering them lightly. The plants come up at least one or two inches below the general surface. The winter rains and freezes partly fill the furrow. By harvest time the ridges between the rows of oats are almost obliterated, and the mower or binder easily passes over them.

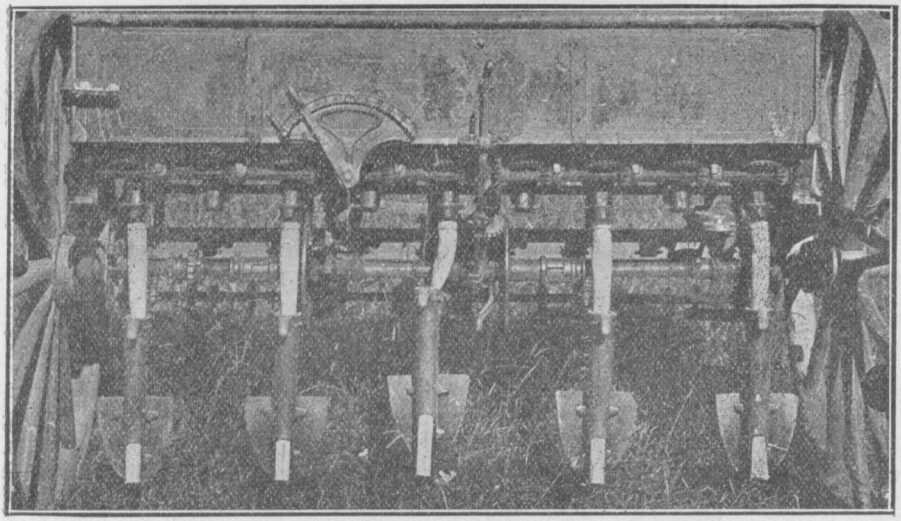

FIG. 2—A five-row open-furrow shovel drill; rear view.

Labor-saving machines for open-furrow drilling.—The chief objection to using the open-furrow method, when a one-horse drill is used, is the small amount of land that a man and mule can plant in a day. To increase the speed and ease and to decrease the cost of open-furrow sowing, a number of two-horse open-furrow grain drills have recently been put on the market. These usually sow either 4 or 5 rows at one time. Tests of several of these machines by this Station, in its local experiment work, indicate that a convenient size is a five-row drill with 14 inches between

the rows. This size is especially advisable for sowing oats between cotton rows that are about three and a half feet wide. Other drills permit the rows to be 16 inches apart. Some of these open furrow drills are equipped with shovels (see fig. 2), and these penetrate deeply. Other drills open the furrows with discs, assisted by a furrow-opener. Disc drills have been found to be less liable to clog where crab-grass, stalks, are present.

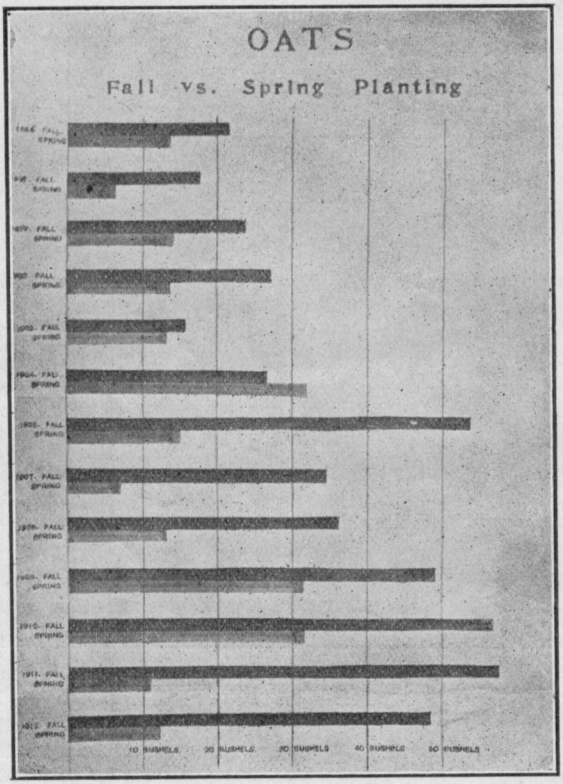

FIG. 3—Showing relative yields at Auburn of fall-sown versus spring-sown Red Rust Proof oats in different years; upper line of each pair represents the yield that year from fall sowing; the lower line of each pair represents yield from sowing oats that year in February.

The ridge of earth between the rows of plants partially protects the plants from the cold winds. The plants being down in a trench are not lifted or heaved so much by alternate freezes and

thaws as are oats sown broadcast. The rows of oats should be 15 or 18 inches apart.

Yields with broadcast sowing, drilling, and open-furrow planting. —In an eight-year test at this Experiment Station these several methods have been compared with broadcast sowing. The results appear in the following table:

Yields of oats sown broadcast, in deep furrows, and drilled with an 8-inch grain drill.

YEAR	Broadcast	8-inch drill	Drilled in open furrows	Deep furrow filled
	Bushels	Bushels	Bushels	Bushels
1900	19.9		24.3	29.1
1903	26.4		33.7	25.7
1904	16 0		19 2	20.5
1905	34.6	31.0	32.3	31.5
1907	6.8	8.3		
1909	48 3	52.3		49.0
1910	44.8	47.2	47.9	
1911	54.7		50.1	
Average for six years	32.7		34.6	
Average for five years	29.0			31.1
Average for four years	33.6	34.7		
Av. increase over broadcast sowing		1.1	1.9	2.2

In making the above averages only the yields for those years are used in which both methods of sowing have been employed. From this table it may be seen:

(1) That the average yield with the open-furrow method exceeded that from broadcast sowing by 1.9 bushels per acre;

(2) That when oats were sown in deep furrows, which were filled at the time of sowing, but which were otherwise the same as in the open-furrow method, the average yield was 2.2 bushels per acre above the yield from broadcast sowing;

(3) That by using the ordinary grain drill, which spaces the rows 8 inches apart, the average yield was 1.1 bushels greater than that from broadcast sowing;

(4) That on the whole the various methods of sowing, all done in a thorough manner and sufficiently early in the fall, gave

results not widely different in years when the winters were not especially severe.

In 1899-1900 the drilled oats were scarcely injured by cold, while the broadcast plots lost about 25 per cent. of their plants, and yielded far less grain than either method of drilling. In 1904, the broadcast plots lost about 20 per cent. of their plants from winter killing, while the loss from cold in the drilled plots was insignificant; but some plants in the deep, partially filled furrows were injured by sand washing in.

In 1905, there was some loss from cold on all plots, this being estimated at 20 per cent. on the broadcast plots, 10 per cent. on the plots sown in filled furrows, and only 5 per cent. in furrows partially filled.

For well drained soils there are advantages in drilling fall-sown oats in deep furrows, espedially when the winter proves severe; but this method of sowing oats in deep unfilled furrows is probably not adapted to prairie or other very stiff, poorly drained soil, where standing water in the furrows would drown the young plants.

TIME OF SOWING OATS.

The oat plant loves a cool, moist climate. To get the greatest amount of moistute, to escape the hot, dry weather of June that is so often experienced in this latitude, and to afford the maximum time for the full development of the plant, oats should be sown in the fall. Oats sown in the fall ripen two or three weeks earlier than those sown after Christmas. This difference in maturity often means the harvesting of a good crop from fall sowing as compared with a poor crop from spring sowing. Too many Alabama farmers sow their oats in February, and even in March; and, as a result of the late planting, they harvest no crop, or so small a one that they become dissatisfied with oats as a farm product. Except in localities where they frequently winter-kill, the Red Rust Proof varieties make a far greater yield from October or November sowing than from sowings made in January or February. This table and Figure 1 plainly show the results of experiments at Auburn during the past 17 years.

The character of soil, of preparation, and of fertilization was the same for sowings made after Christmas with those made in the fall.

Average results of fall-sown vs. spring-sown oats at Auburn.

DATE OF SOWING	Yield of grain per acre	Yield of straw per acre	Increase of grain from fall sowing
Experiment No. 1.	Bushels	Pounds	Bushels
November 18, 1896	21 7	895	7.9
March 1, 1897	13.8	587	
Experiment No. 2.			
November 23, 1897	18.2	958	11.0
February 9, 1898	6.4	228	
Experiment No. 3.			
November 26, 1897	23.8	994	9.7
February 9, 1898	14.1	440	
Experiment No. 4.			
November 13, 1902	27.2	1328	13 5
February 5, 1903	13.7	1024	
Experiment No. 5.			
November 19, 1903	15.9	384	2.6
February 23, 1904	13.3	416	
Experiment No. 6.			
November 10, 1904	*26.9	1068	—*5.1
February 23, 1905	32 0	1360	
Experiment No. 7.			
November 14, 1905	53.8	1560	38.8
February 16, 1906	15.0	----	
Experiment No. 8.			
November 15, 1907	34.5	1408	27.5
February --, 1908	7.0	320	
Experiment No. 9.			
November 9, 1908	36.2	1320	22.4
February 8, 1909	13.8	660	
Experiment No. 10.			
October 22, 1909	49.1	1752	17.9
February 2, 1910	31.2	970	
Experiment No. 11.			
November 4, 1910	56.9	2074	25.4
January 31, 1911	31.5	1520	
Experiment No. 12.			
October 24, 1911	57.7	----	46.8
February 17, 1912	10.9	----	
Experiment No. 13.			
October 22, 1912	48.5	1212	36.4
February 10, 1913	12.1	512	
Average yield, fall sowing	36.1	----	----
Average yield, Feb'y sowing	16.5	----	----
Average increase, fall sowing	----	----	19.6

*Fully 25 per cent. winter killed.

The average of thirteen experiments shows a gain of 19.6 bushels from sowing red oats in November as compared with sowing them in February. This is equivalent to an increase of 126 per cent by sowing in the fall. If the "turning-out" of cattle by common consent in winter prevents the sowing of grain in the fall, is the few months' range worth the sacrifice?

Our experience, often repeated, has shown that the average date of fall sowing in the the preceding table, November 9th, is too late for *maximum* yields of fall-sown oats. The table shows that seedings made in October of three different years gave an an average yield of 51.7 bushels per acre while the seedings made in November of ten different years gave an average of only 31.5 bushels. October sowings withstand cold better than November sowings. While any date from September 1st to November 15th may give satisfactory yields, we recommend October sowing for this latitude. In the Tennessee Valley, if fall planting is practiced, the best time is probably the earlier part of October, and in the extreme southern portion of the State the latter part of October.

We have found it advisable to discontinue entirely the sowing of oats about the first of December. For such fields as must be sown after Christmas we prefer on the uplands in this latitude to sow about February 1. For oats sown after Christmas only the richest lands are suitable; on the other hand, oats sown in the fall may make a profitable crop on land that is quite poor, provided they be judiciously fertilized.

Thus the advantages of fall sowing consist of:

(1) A much larger yield, even after deducting the losses from partial winter killing.

(2) The utilization of poorer land by the fall-sown crop.

(3) The employment of teams at a time when they are not needed in preparation of land for cotton or corn.

(4) Earlier maturity of fall-sown oats, permitting the use of the crop and the use of the land at least two weeks earlier than when oats are sown after Christmas.

YIELDS OF VARIETIES OF OATS.

The varieties of oats commonly grown in Alabama may be classified under four types—Red Rust Proof, Burt, Turf, and Beardless Red oats. Under the type of Red Rust Proof oats are the following varieties: Red Rust Proof (or Texas Red Rust Proof), Appler, Bancroft, Culberson, Thaggard (or Cook), and Hundred Bushel. The Virginia Gray, grown in some of our experiments, belongs to the Turf type. The Fulghum is an example of the Beardless type of Red oats.

The Red Rust Proof group of varieties has exceeded all others

in the production of grain at this Station. This fact is shown in the following table of comparative yields, which is compiled from records of variety tests of oats on the Alabama Experiment Station farm during the past sixteen years. Many of the sowings were made too late in the fall to secure the maximum yield. Rust and lodging in 1907, and partial winter killing in 1905, depressed the yield.

The following table shows the yields of oats each year, the weights being taken after thorough air-drying of the grain:

Yields of principal varieties of oats at Auburn.

Varieties	1898	1900	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.
Red Rust Proof	30.8	13.5	30.0	28.0	48.4	†7.1	30.0	56.0	40.2	34.8	30.6	25.2
Appler			32.7	28.3	52.6	†10.3	22.5		26.5	39.4	43.0	32.7
Bancroft							30.0	61.5	26.0	42.1		
Hundred Bushel								50.5	44.2	32.6		
Culberson			28.0	29.4	48.0	†3.4	20.0	51.0	27.5	43.4	34.6	
Fulghum											23.3	17.8
Burt					52.0	†2.5	23.5	26.7		22.5	24.2	19.6
Turf	13.4	7.5	21.0							7.6		
Cook												26.6

†All varieties were greatly damaged by rust and all lodged badly in 1907.

Since all varieties were not grown in every year covered by this series of experiments, it is possible to get a more accurate comparison, less influenced by seasonal conditions, by reducing the yields of each year to a percentage basis, and then calculating the average of these percentages.

This has been done in the following table:

Relative yields of varieties of oats at Auburn, the yield of Red Rust Proof being taken as 100 each year.

Varieties	1898	1900	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913	Av.
Red Rust Proof	100	100	100	100	100	100	100	100	100	100	100	100	100
Appler			109	101	109	145	75		66	113	141	130	110
Bancroft							100	110	65	121			99
Hundred Bushel								90	110	94			98
Culberson			93	105	99		67	91	68	125	311		95
Cook												106	106
Fulghum											76	71	73
Burt					108	35	78	48		65	79	78	70
Turf	44	56	70							22			48

From figures in the above table we find that the average productiveness of these varieties has been as follows:

	Average percentage indicating relative yields.
RED RUST PROOF GROUP OR TYPE—	
Appler (tested 9 years)	110
Red Rust Proot (tested 10 years)	100
Bancroft (tested 4 years)	99
Hundred Bushel (tested 3 years)	98
Culberson (tested 3 years)	95
FULGHUM (tested 9 years)	73
BURT (tested 7 years)	70
TURF (Va. Gray, or winter type oat) (tested 4 years)	48

While the Appler has on the average exceeded the strain grown under the name of the Red Rust Proof variety, there are years in which the latter variety has been much the more productive of the two. Making allowance for such variations, and what experimenters call "the limits of error," we are justified in concluding that the differences, if any, between the productiveness of the several varieties of the Red Rust Proof group are slight. Any pure strain of any of these varieties is satisfactory.

DESCRIPTIONS OF SOUTHERN VARIETIES OF OATS.

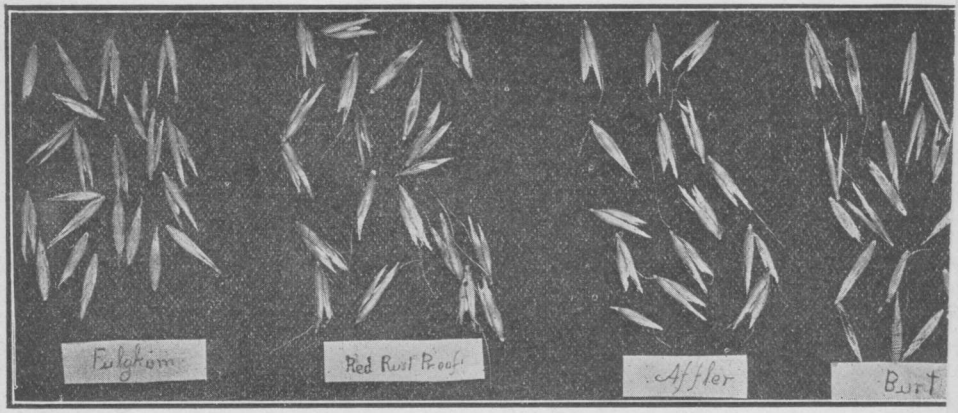

FIG. 4—Grains of Fulghum, Red Rust Proof, Appler, and Burt varieties.

RED RUST PROOF.—Plants, medium height; straw, large and strong; berries or "grain" bearded, beards borne on both grains in most spikelets; beards, large and long, usually inserted low down on the larger grain, that is, half way between the base and the extreme tip, but nearer the tip on the small grain; color

of berries, yellowish brown, darker near the base, and darkening on exposure to moisture. A characteristic of Red Rust Proof oats is the greater length of the slender bristles or hairs at the lower end of the larger grain, which bristles in other varieties commonly grown in the South are either wanting, or occur on only a few of the spikelets, or are shorter than on Red, Appler and Culberson oats. The grains are very large and very plump. This variety is sometimes attacked by rust, but is less injured by this disease than Turf, Burt, and other varieties outside of the Red Rust Proof group.

APPLER.—This is a selection from the Red Rust Proof oats, and it is much like its parent variety. As grown at Auburn, it has been less uniform than the Red, containing a large admixture of black grains and a considerable proportion of spikelets in which only the larger grain was bearded.

CULBERSON.—This appears to be a strain of Red oats. The straw is perhaps a little taller. Both grains are strongly bearded, as a rule. In color, size, and plumpness and in basal bristles the grain is not distinguishable from the Red oat. A slightly larger proportion of Culberson plants than of Red Rust Proof oats survived the severe winter of 1904–5.

FULGHUM.—The Fulghum variety is closely related to the Red Rust Proof group, but is different from the varieties of that group in being as early as the Burt oat and in being almost free from beards. It is, in some respects, a promising variety. It is, apparently, the same oat as the one tested under the name of Beardless Red oats by the senior author in 1892 and 1897. (Bulletin No. 7, South Carolina Experiment Station, and Bulletin No. 137, Alabama Experiment Station). The kernels of the Fulghum are shorter than those of the Red Rust Proof and are not quite so plump; they are a rich buff color. This variety ripens about ten days ahead of the other members of the Red Rust Proof group. The basal bristles are similar to those on grains of Red Rust Proof oats. Additional data are needed on the hardiness of Fulghum plants. In tests covering only two years it failed to equal Red Rust Proof varieties in yield.

BURT.—The majority of spikelets bear one bearded and one beardless grain, but some are doubly bearded and a few are entirely beardless. The grains are more slender than those of Red

Rust Proof oats, and of a paler cream or brownish yellow color. Most spikelets have only short bristles, or none. The straw is taller and weaker than that of Red oats. The variety is tender and is adapted to spring sowing. It matures from eight to ten days earlier than the Red Rust Proof oats.

Because of its tallness and earliness, Burt is often preferred for spring sowing in all parts of Alabama. In the latitude of Auburn and southward, it may usually be safely sown in the fall, if the seed are sown early enough to permit the development of an ample root system, or if the seed are planted in the open furrow. On the Station farm, Burt oats have been sown broadcast for the past twelve years in the fall, and only the winter of 1904–5 was severe enough to destroy the stand completely. However, it may be seen from the table above that the Burt variety does not yield as well as some of the Red Rust Proof varieties. Burt and May are apparently two names for the same variety.

TURF.—This variety is beardless. The grains are slender, light cream or gray in color, of a lighter shade than Burt oats, and the two grains usually break apart in threshing. The percentage of grain is small, there being usually about twice as many pounds of straw as of threshed oats.

Turf oats have been relatively unproductive on the rather poor, sandy soil at Auburn. In our experiments this variety averaged only 48 per cent. as much grain as Red Rust Proof. Sown here in the spring, the Turf oat is an entire failure. It ripens about two weeks later than Red oats sown at the same date in the fall, and hence is especially liable not to fill out, either because of rust or of drought. This oat is only to be considered for grazing or hay, or for grain on the very best land, or in those localities in the extreme northern part of the cotton belt where Red oats are often winter killed. It has been recommended as a good variety to sow for hay with hairy vetch, but this is advisable only on rich land, for on our poor, sandy uplands at Auburn, Turf oats do not throw up seed stems in time to support the slender vetch plants. Here we find that a beardless variety of wheat or the Red Rust Proof oat makes a more satisfactory combination with hairy vetch.

Other so-called varieties that seem to be identical with Turf oats are Virginia Gray, Gray Winter, and Myers' Turf oats.

FERTILIZERS FOR OATS.

On most soils the oat plant pays well for the application of fertilizing materials rich in nitrogen. On poor soils it is usually profitable to apply acid phosphate also. On very sandy or other very poor lands, it may pay to include potash as a third constituent of the fertilizer for this plant.

Nitrate of Soda vs. Cotton Seed Meal or Cotton Seed.—Most of the fertilizer experimets with oats made by the Alabama Experiment Station have been planned to determine in what form the nitrogen should exist in order to constitute the most effective fertilizer for oats.

The first table following shows the results of experiments made on the Experiment Station farm at Auburn, comparing nitrate of soda, cotton seed meal, and cotton seed, all in the presence of unifrm amounts of acid phosphate. Such amounts of each nitrogenous fertilizer were used as to afford approximately the same amount of nitrogen to each plot. All fertilizers and manures except nitrate of soda were incorporated with the soil on the date of sowing the seed.

KIND OF FERTILIZER	Amount per acre	Time of application	YIELD AND INCREASE PER ACRE								Av. increase per acre.
			1901		1906		1908		1909		
			Yield	Inc.	Yield	Inc.	Yield	Inc.	Yield	Inc.	
	Lbs.		Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.
Cotton seed meal	200	Fall	24.9	8.	42.2	13.	25.4	6.2	24.9	—.3	6.7
Cotton seed	434	Fall	24.6	7.3	32.1	2.2	23.2	4.	27.5	2.3	3.9
No nitrogen	0		16.9		29.9		19.2		25.2		
Nitrate of soda	100	Spring	36.3	19.4	55.8	25.9	28.	8.8	45.	19.8	18.4
Nitrate of soda	100	Fall	36.0	19.1	54.4	24.5	27.5	8.3	33.	7.8	14.9
Manure	4000	Fall	34.4	17.5	51.5	21.6	21.4	2.2	28.4	3.2	11.1

Cotton Seed Vorsus Cotton Seed Meal.—In four experiments made in as many different years we have compared 200 pounds of cotton seed meal with 434 pounds of cotton seed, both furnishing equal amounts of nitrogen and both being applied at the time of planting in the fall. In every case except one, cotton meal seed has given larger yields, the excess resulting from the use of meal as compared with seed being in different years respectively .7, 10.8, and 2.2 and —2.6 bushels of oats per acre, which would give an average advantage of 2.8 bushels per acre to the meal.

While cotton seed has long been recognized as an excellent fertilizer for oats, especially when used in large amounts, the increased price of cotton seed and the superior effects of an equal value of nitrate of soda on oats make it inadvisable to apply cotton seed to the oat crop if nitrate of soda is available at reasonable price.

From the data in the above table we draw the following conclusions:

(1) Nitrate of soda at the rate of 100 pounds per acre, applied in the spring, was considerably more effective than either 200 pounds of cotton seed meal, or 434 (13 bushels) of cotton seed—the seed and meal being applied at the time of sowing in the fall.

(2) Nitrate of soda was more effective and profitable when applied as a top dressing in March than when applied at the time of sowing the seed in the fall.

(3) A pound of nitrogen in the form of nitrate of soda, even when applied in the fall, was more effective than an equal amount of nitrogen in the form of cotton seed meal, or in the form of cotton seed applied at the same date.

(4) Nitrate of soda at the rate of 100 pounds per acre applied in the spring was more effective than was the application of two tons of horse manure applied in the fall, if we neglect any fertilizing effects of the manure at the end of the first year.

If we represent by the figure 100 the increase due to nitrate of soda applied in the spring, we find that the average effectiveness of the nitrogen in the various nitrogenous fertilizers, applied in the amounts stated in the preceding table, are represented by the following figures or percentages:

Nitrate of soda (applied in the spring)	100
Nitrate of soda (applied in the fall)	81
Cotton seed meal (applied in the fall)	36
Cotton seed (applied in the fall)	21

We have not the analysis of the manure used; hence, we cannot compare the manure on the basis of its percentage of nitrogen with the commercial fertilizers. It should be added that doubtless there was a larger portion of unused fertilizing material left over for the benefit of the next crop where cotton seed was used than where cotton seed meal or nitrate of soda was applied. A still larger residual effect must have resulted in later years from the use of the manure.

But even allowing for some advantage of cotton seed in the second year after is was applied, this advantage cannot be sufficient to make cotton seed nearly as effective a fertilizer for oats as is nitrate of soda.

Cost of Increase.—If we value nitrate of soda at $60 per ton, cotton seed meal at $30, cotton seed at $18, and manure at $3, we find that the cost of fertilizing material needed to produce each bushel of increase was as follows:

(1) With nitrate of sada (applied in the spring)..... 16 cents
(2) With nitrate of soda (applied in the fall)..... 20 cents
(3) With cotton seed meal (applied in the fall)..... 45 cents
(4) With manure (applied in the fall)..... 54 cents
(5) With cotton seed (applied in the fall)..... 101 cents

From the above it is evident that nitrate of soda was by far the most economical fertilizer for oats.

Sulphate of Ammonia and Calcium Cyanamid as Sources of Nitrogen.

Sulphate of ammonia usually contains 18 to 20 per cent of nitrogen. It is a by-product obtained in the making of coke by certain processes. It is manufactured at Ensley, Alabama; at Holt, near Tuscaloosa, Alabama; as well as in other manufacturing regions. Sulphate of ammonia is easily soluble but is somewhat less quickly available than is nitrate of soda, for the reason that it must first be converted in the soil into nitrates.

Calcium cyanamid is a new fertilizer. It is one of the two nitrogenous fertilizers which are now obtained from the nitrogen of the air by means of a powerful electric current. Its manufacture is confined to localities where an immense amounts of inexpensive power is available.

The following table shows the results of experiments in which sulphate of ammonia and calcium cyanamid were compared with nitrate of soda in such amounts as to furnish approximately equal amounts of nitrogen to each plot. Fall application was always made at the time of sowing, the nitrogenous fertilizers, together with a uniform amount of acid phosphate and potash, being then thoroughly incorporated with the soil. Spring application of each nitrogenous fertilizer was made as a top dressing in the early part of March.

This table shows the amouts of each of the nitrogenous fertilizers per acre, the time of application, the yield, and the increase in crop attributable to each form of nitrogen:

Nitrate of soda versus sulphate of ammonia and calcium cyanamid for oats.

	1911		191	
KIND OF FERTILIZER	Time of application and lbs. fert. per acre	Bushels per acre	Time of application	Per acre
Nitrate of soda	Fall and spr'g, 150 lbs.		Fall 150 lbs.	
Yield		39. bus.	Fall	36.3 bus.
Increase		22. bus.	Fall	22.2 bus.
Nitrate of soda			Spring 100 lbs.	
Yield			Spring	34.4 bus.
Increase			Spring	20.3 bus.
Sulphate of ammonia	Fall and spr'g, 220 lbs.		Fall 120 lbs.	
Yield		36.8 bus.	Fall	16.9 bus.
Increase		19.8 bus.	Fall	2.8 bus.
Sulphate of ammonia			Spring 120 lbs.	
Yield			Spring	36.9 bus.
Increase			Spring	22.8 bus
Calcium cyanamid	Fall and spr'g, 220 lbs.		Fall 120 lbs.	
Yield		21.1 bus.	Fall	25.3 bus.
Increase		4.1 bus.	Fall	12.2 bus.
Calcium cyanamid			Spring 100 lbs.	
Yield			Spring	20.7 bus.
Increase			Spring	6.5 bus.
No nitrogen		17. bus.		14.1 bus.

From the above table we draw the following conclusions, which, however, may need to be modified as the experiment is continued through a greater number of years:

(1) Nitrate of soda proved much more effective and economical than either sulphate of ammonia or calcium cyanamid.

(2) Sulphate of ammonia proved next in effectiveness.

(3) The order of effectiveness of these three fertilizers was the same, whether all were applied in the spring or part of each in both spring and fall.

(4) In a single year's test, sulphate of ammonia was much more effective when applied in the spring than in the fall; on the other hand, calcium cyanamid was more effective when applied in the fall than in the spring as a top dressing.

GROUND-ROCK OR RAW PHOSPHATE VS. ACID PHOSPHATE FOR OATS.

For three years this test has been made on a rather stiff grade of loamy upland, which, in previous years, had been rather well fertilized with acid phosphate. For the reason last mentioned the increase due to both acid phosphate and raw phosphate is probably less than would ordinarily be the case on land in poorer condition. The following table shows the yields of each in the three years, and also the increase due to the phosphate.

The phosphate and kainit were always applied in the fall at the time of sowing the seed, while the nitrate of soda was in all cases applied as a top dressing in the spring.

FERTILIZER PER ACRE	1911		1912		1913		
	Yield	Increase	Yield	Increase with phos.	Yield	Increase with phos.	Average Increase
	Bus.	Bus.	Bus.	Bus.	Bus.	Bus.	
320 lbs. acid phosphate 160 lbs. kainit 100 lbs. nitrate of soda	50.1	11.0	35.4	4.3	49.	9.3	**8.2**
320 lbs. raw phosphate 160 lbs. kainit 100 lbs. nitrate of soda	46.5	7.4	32.7	1.6	48.9	9.2	**6.1**
160 lbs. kainit 100 lbs. nitrate of soda	39.1	----	31.1	----	39.7	----	

From the above table it may be seen that the average increase in yield attributable to acid phosphate was 8.2 bushels per acre; and that the average increase due to an equal weight of raw phosphate was 6.1 bushels per acre. The crop with acid phosphate was greater in each of the three years than with an equal amount of raw phosphate.

If we place the cost of 16 per cent acid phosphate at $15 per ton, and that of the ground rock phosphate at $10 per ton, and value oats at sixty cents per bushel, we find that the net profit due to the acid phosphate is $2.52 per acre while that due to the phosphate is $1.06 per acre.

Barnyard Manure for Oats.—These experiments were on upland sandy soil at Auburn:

Manure per acre	KIND OF MANURE	Increase per ton of manure		
		First year oats	Second year oats	Total two years, oats
Tons		Bus.	Bus.	Bus.
21.87	Cattle; from feeding cotton seed meal, etc	1.4	1.2	2.6
15.3	Cattle; from feeding cotton seed, etc.	1.9	1.1	3.0
6.2	Cattle; from feeding cottonseed meal, etc.	1.6	.5	2.1
2.0	Horse manure (1901)	8.8		
2.0	Horse manure (1906)	10.8		
	Horse manure (1908)	1.1		
	Horse manure (1909)	1.6		

From the above table it may be noted that the average increase in the oat crop of the first year for each ton of manure was as follows:

	Increase, bus. oats
Each ton of horse manure (very light application)	5.6
Each ton of cattle manure (heavy application))	1.6

The average increase due to each ton of cattle manure was, in the second year, .9 of a bushel, or a total of 2.5 bushels as representing the increase due to one ton of cattle manure during the first two years. Doubtless this figure would have been greatly increased if the cattle manure had been applied at a more moderate rate or if account had been kept of the effects of the manure in the third and subsequent years.

While oats respond well to stable manure, an excessively large application should be avoided, because this sometimes results in a too luxuriant growth of straw, and consequent falling or lodging of the plant.

General Recommendations for Fertilizing Oats.

As a result of experiments and observations, we make the following recommendations applicable to most soils, except those that are quite rich.

(1) That at the time of sowing oats, a small or moderate amount of acid phosphate (100 to 300 lbs. to the acre) be used, except, perhaps, on prairie soils; and that the phosphate be applied in any convenient way by which it can be mixed with the soil.

(2) That but little potash be used for oats on land in medium condition, and that whatever amount of potash may be used on poor soils be applied at the time of planting and in mixture with acid phosphate. If oats are to be grown continuously on the same land, the need for potash increases.

(3) That among all the commercial fertilizers containing nitrogen, we recommend that preference be given to nitrate of soda, as a fertilizer for either fall-sown or spring-sown oats.

(4) That nitrate of soda be applied as a top dressing in the spring at least two months before the grain is to be harvested. Usually we prefer to apply nitrate of soda during the first half of March to fall-sown oats, and the latter part of March to spring-sown oats.

(5) The best condition under which to apply nitrate of soda is while the plants are dry, but while there is at least a fair supply of moisture in the soil so that this fertilizer may be promptly dissolved and diffused throughout the soil. Especially avoid, if possible, the application of nitrate of soda immediately before wet weather, since heavy rains occuring before the nitrate has been absorbed may leach out and wash from the soil a portion of this soluble fertilizer.

(6) That a fertilizer formula suitable for oats on most poor and medium land in Alabama may well consist of the following

200 lbs. acid phosphate (at the time of sowing).
30 lbs. muriate of potash (at the time of sowing).
100 lbs. nitrate of soda (in March).

(7) We recommend that the system of rotation be so changed as to decrease the need for nitrate of soda, or other forms of purchased nitrogen. This may be done by growing oats on land where cowpeas, velvet beans, crimson clover, or other soil improving plants have recently been grown, or by an increased use of barn yard manure, whether applied in moderate amounts directly to the oats or used on the crop preceding the oats.

A suggested rotation is the following:

First year: Corn, with cowpeas between the rows.

Second year: Fall sown oats, followed by cowpeas ,or soy beans, or peanuts.

Third year: Cotton, with or without a winter cover crop, as crimson clover, etc.

This can readily be changed from a three-year to a four-year rotation by adding a second cotton crop immediately following the first.

OAT SMUT.

Extent of Loss.—Every farmer is familiar with the blackened heads that appear in many fields of oats. These heads show the effect of oat smut. This disease frequently causes a loss of from 6 to 20 per cent, or more, of the normal yield of grain. A few fields have been seen in Alabama in which smut prevented about one-third of the plants from producing any grain. A loss of 25 per cent. represents, on land where the normal crop would have been 40 bushels, a loss of 10 bushels per acre, worth about $6.00. No farmer can afford this loss, which can be entirely prevented at a cost of a few cents per acre.

Means of Spreading.—Oat smut is one of the diseases of plants that may be most easily and completely prevented. This disease is spread by spores—minute, black, dust-like particles—which destroy the grains and make of them a mass of smut. These dust-like particles are the reproductive bodies and serve somewhat the same purpose to the fungus that causes this disease as seeds do to ordinary plants. These tiny spores are blown about the field and lodge on the outside of the oat grain, especially just before harvest time and during threshing; they may be carried to clean oats by a thresher in which smutted oats have been threshed, or by bags or floors with which smutted oats have come in contact.

When the Disease Organism Enters the Plant.—The spores that have lodged on the seed are the means of spreading the disease to the next crop. These organisms grow into the young and tender oat plant soon after it germinates and before it has appeared above the ground. No indication of the disease is noticed until about blossoming time, by which time the fungus has grown up through the entire length of the plant and produced its mass of black spores where the grain should grow.

Preventive Treatment.—Any treatment of the seed which destroys the spores that have lodged on the oat grain will prevent the entrance of the fungus into the oat plant at the time of germination, and hence will prevent the occurrence of smut in a crop grown from seed oats so treated.

Of the several methods of treating seed oats to destroy the spores without preventing germination of the oats, the treatment with formalin is the simplest and the most advisable.

Directions for Treating Seed Oats with Formalin.—To each three gallons of water add one ounce (about 2 tablespoonfuls) of formalin of the usual or standard strength (a 40 per cent. solution of formaldehyde gas). In this solution soak the seed oats 10 or 15 minutes, stirring them so that every grain may become thoroughly wet. Then drain off the surplus water, cover the pile of seed oats with cloth that has been dipped in a stronger solution of formalin. Leave the sacked or bulked oats covered for about 8 to 10 hours to permit the formalin vapors to penetrate the mass of seed more thoroughly; but do not let the oats remain damp long enough for sprouting to begin. Next spread the oats in a thin layer on a floor previously made clean by washing with a strong solution of formalin, and dry them rapidly by frequent stirring with clean implements.

Instead of soaking the seed, as suggested above, the grain may be poured out on a wagon sheet or burlap cloth and sprinkled with the solution of formalin. Sprinkling and stirring the seed must be continued until every seed becomes thoroughly wet. Then the corners of the sheet may be drawn up to cover the pile of treated seed and to prevent the rapid escape of the formalin vapor. After the oats have remained covered for 8 to 10 hours, the corners of the sheet may be thrown back, and the oats spread out thinly over it to dry.

The seed should be sown soon after they become dry, though they may be kept for weeks before sowing, if they are stored in thoroughly fumigated bins or boxes. A very good way is to prepare the seed one day and sow them the next day. In sowing damp seed, a larger amount of oats than otherwise necessary should be sown to allow for the swollen condition of the grain.

Where to Obtain Formalin. Formalin may be obtained from any wholesale druggist and from most retail druggists, or ordered through the latter. The usual price in New York, when several bottles are ordered, is less than 50 cents per pound bottle, containing 14 ounces. The Alabama Experiment Station has obtained its largest orders of formalin from the following firms:

Eimer and Amend, New York City.

Perth Amboy Chemical Co., 100 William St., New York City.

One ounce of formalin in three gallons of water should be sufficient for 2 to 4 bushels. Thus the cost, even if New York

prices are doubled by the retail druggist, would be only 2 to 4 cents per bushel, or 5 to 10 cents per acre.

Every farmer who grows oats should be interested not only in treating his own seed oats, but also in inducing his neighbors to treat their seed oats. For, when once the grain grown in a community is freed of oat smut, so that this disease cannot be spread by threshing machines, it will no longer be necessary to treat seed oats every year. Until then every farmer should treat with formalin every bushel of oats that he sows.

To encourage this neighborhood campaign against smut, the Alabama Experiment Station has issued a short article on oat smut, and any reader who is interested in this subject may secure free of charge a number of copies for distribution among his neighbors. State the number of copies desired.

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" " " 62—Tests of Varieties of Cotton in 1912.
" " " 55—The Fall Campaign Against the Boll Weevil.
" " " 66—Oats; Conclusions from 17 Years' Experiments at Auburn.

NOTE.—All parties interested in results of experiments in feeding hogs should drop a postal to the Alabama Experiment Station asking for *Bulletin No. 168, Fattening Hogs in Alabama.* Financial conditions prevented the issuance of an edition of this expensive bulletin large enough for a copy to be sent to every address on the mailing list. When issued it was sent only to parties known to be especially interested in live-stock.

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