BULLETIN No. 101. JANUARY, 1899.

ALABAMA

Agricultural Experiment Station

OF THE

AGRICULTURAL AND MECHANICAL COLLEGE,

AUBURN.

EXPERIMENTS WITH COTTON, 1898.

J. F. DUGGAR.

MONTGOMERY, ALA.:
THE BROWN PRINTING COMPANY, PRINTERS
1899.

COMMITTEE OF TRUSTEES ON EXPERIMENT STATION.

I. F. CULVER.....Union Springs.
J. G. GILCHRIST.....Hope Hull.
H. CLAY ARMSTRONG.....Auburn.

STATION COUNCIL.

WM. LEROY BROUN.....President.
P. H. MELL.....Director and Botanist.
B. B. ROSS.....Chemist.
C. A. CARY, D. V. M.....Veterinarian.
J. F. DUGGAR.....Agriculturist.
F. S. EARLE.....Biologist and Horticulturist.
*C. F. BAKER.....Entomologist.
J. T. ANDERSON.....Associate Chemist.

ASSISTANTS.

C. L. HARE.....First Assistant Chemist.
R. G. WILLIAMS.....Second Assistant Chemist.
T. U. CULVER.....Superintendent of Farm.

☞The Bulletins of this Station will be sent free to any citizen of the State on application to the Agricultural Experiment Station, Auburn, Alabama.

*Absent on leave.

EXPERIMENTS WITH COTTON, 1898.

By J. F. Duggar.

SUMMARY.

The growing season of 1898 was extremely dry until June 12, which was unfavorable to securing full effects from fertilizers.

Of fourteen varieties of cotton tested in 1898, the largest yield was made by Russell Big Boll, 382 pounds of lint per acre. Next in yield of lint followed Deering, Peterkin and Smith Improved.

Subsoiling late in February failed to increase the yield.

On gray sandy soil all fertilizers yielded a profit; on this soil the yield was profitably increased by application of nitrogen, phosphoric acid and potash, singly or in combination.

The yield was larger when all of the fertilizer was applied in the center furrow than when two-thirds or all of it was applied in the two listing furrows.

In a comparison of rotted cotton seed, cotton seed meal and nitrate of soda the results were inconclusive.

As a means of decreasing black rust, 50 lbs. of nitrate of potash per acre was fully as effective as 200 lbs. of kainit, each material furnishing an equal quantity of potash.

One hundred pounds of kainit per acre reduced the amount of rust; 60 pounds of kainit per acre was less effective in causing the cotton plants to retain their leaves.

The Rainfall During the Growing Season of 1898.

The following is the condensed record of rainfall at Auburn, April to September inclusive, as observed by Dr. J. T. Anderson, of the Chemical Department:

	Rainfall in inches.
April	5.06
May	.26
June	1.18
July	6.79
August	10.13
September	1.93

The longest period of extremely light rainfall was from April 23 to June 12, during which period only six-tenths of an inch of rainfall is recorded.

From April 4 to July 6 no heavy rains fell, only exceedingly light showers; after July 6 the rainfall was abundant.

It should be added that fall frosts occurred in 1898 at an unusually early date.

Varieties.

The number of varieties compared in 1898 was fourteen. The rows were $3\frac{1}{2}$ feet apart. Thinning was done after counting the plants, so as to leave, wherever practicable, an equal number of plants on each of the sixteen-acre plots. With a perfect stand, the distance between plants averaged about 18 inches.

However, the stand on some plots was so poor that we were compelled to conduct the test with inequalities in stand. In all cases the number of plants per acre is given in the following table. Undoubtedly, the deficiencies in stand placed the varieties with small stalks or short limbs at a disadvantage in the instances where such varieties had a poor stand. It is probably for this reason that King, a variety with very small stalk, stood near the foot of the list in 1898. In previous tests, and in an adjoining field in 1898, it was, with a better stand, decidedly productive.

The field used had been employed in 1897 for an experiment to determine the best distance for planting cotton. The details of that test are recorded in Bulletin No. 89 of this station.

The land was flushed before being fertilized and bedded; a complete fertilizer was drilled at the rate of 500 pounds per acre and at a cost of $3.84 per acre.

This consisted of

200 lbs. acid phosphate per acre.
200 " cotton seed meal " "
100 " kainit " "

All plots were planted April 15 and the vacant spaces replanted April 27.

Yield per acre, relative earliness, and percentage of lint of 14 varieties of cotton.

Plot No.	Varieties.	No. of plants per acre.	Yield of seed cotton.	Percentage of total crop of first picking.	Percentage of lint.	Yield of lint per acre.
15	Russell Big Boll	8576	1200	64.	31.9	382
7	Deering	10280	957	54.	35.6	341
11	Peterkin	10280	978	44.	34.7	339
17	Smith Improved	10280	1062	69.	31 9	339
1	Truitt	10280	1010	57.	32.6	330
10	Texas Oak	10280	872	52.	36 5	318
13	Hutchinson's Storm Prolific	10280	941	64.	32 8	309
2	Jones' Re-improved	10280	962	57.	31.8	306
14 9 4	Peerless	8096	922	60.	33 5	304
3	Hawkins	7024	866	65.	34.	288
6	Strickland	8144	816	35.	32 1	262
12	Griffin	7296	763	67.	32 8	250
5	King	7728	643	60.	33.5	216
8	*Unknown	560	227	20	30.9	70

* Bought from a seedsman as Welborn. It proved untrue to name and most seeds were not capable of germination; however, the few plants that appeared, about 1-20 of a stand, were left to mature.

It should be remembered that no single test can be taken as finally determining the relative values of different varieties. Results vary from year to year. The past season was unusual, a fact which detracts from the value of these results.

In addition to the varieties in the test just described, Allen's New Hybrid Long Staple and Culpepper Improved were grown alongside the variety test, but on plots which, in previous years, had been cropped in such a way as to render the results in 1898 not comparable with the results obtained on the plots referred to in the table.

In this separate division where Peerless was grown as a check on the other two varieties, the yield of lint per acre was with Peerless 374, with Allen 357, and with Culpepper 334 pounds. The number of plants per acre was respectively, 10,280, 10,280 and 7,616.

In another field a few of the seed of the Jackson Limbless variety were planted. No difference could be seen between these plants and plants of the Welborn Pet variety as grown at this Station in previous tests. The Georgia Experiment Station had already pointed out the similarity of the two varieties.

The limited number of seed planted and the small area of ground occupied do not allow a statement of the yield per acre. By its appearance it was judged to be a good, but not remarkably productive variety.

Subsoiling.

This experiment was conducted on red, rather stiff, shallow soil, inclined to bake and sensitive to drought. Flint stones are abundant.

On February 24, 1898, one plot was broken to the usual depth, about 4 inches, with a one-horse turn plow. In this furrow followed a scooter drawn by one mule, which loosened a part of the soil to an additional depth of $3\frac{1}{2}$ or 4 inches. In this way the soil was loosened to a depth of

about 8 inches without throwing up to the surface the clay of the subsoil, which is doubtless poorer when first exposed to the air than is the surface soil.

On the same date another plot was broken with a one-horse turn plow in the usual way without the subsoiling scooter. Subsequent treatment,—bedding, fertilizing, and planting,—was identical on both plots.

The fertilizer, applied in the center furrow, and mixed with the soil by the use of a scooter plow, was as follows on both plots:

240 lbs. of acid phosphate per acre.
100 " " cotton seed meal " "
48 " " muriate of potash per acre.

388 lbs., total per acre.

The yield of seed cotton per acre was 992 pounds on the subsoiled plot and 970 pounds on the plot not subsoiled.

The difference in favor of subsoiling is insignificant, being only 22 pounds per acre.

It should not be forgotten that the late date at which the land was broken and the light rainfall up to July constituted conditions highly unfavorable to the growth of crops on subsoiled land, the soil having probably never become sufficiently settled until the late summer rains occurred.

Attention is also called to the fact that the process which here, in accordance with local custom, is spoken of as subsoiling, is quite different from and much less thorough than is subsoiling by means of a specially constructed subsoil plow, which loosens a wider furrow and runs deeper than the scooter plow used in this experiment.

"Light soils would probably not be benefitted by subsoiling. If subsoiling is practiced, it should be done early enough in the winter to allow the rains to moisten and settle the deeply stirred soil before planting time."—*Bul. No. 89, Ala. Exp't. Station.*

Experiments with Fertilizers.

This experiment was conducted on a hilltop where the soil was gray and sandy. The sand was deep and the soil very poor. This field had been planted in cotton in 1896 and in 1897 it was used for a test of varieties of oats. No cowpeas or other renovating plant had grown on this field since 1895. Both the oats and the cotton of preceding years had received moderate quantities of a complete fertilizer mixture.

All fertilizers for the cotton crop of '98 were drilled in the center furrow and mixed by use of a scooter with the soil. April 15 Peerless cotton was planted in all plots. Single plants were left at distances of 15 to 18 inches in the drill, and the rows were $3\frac{1}{2}$ feet apart.

The period up to the time when bolls were formed was very dry and hence very unfavorable to the action of the fertilizers. Black rust was worse on plots having no kainit than on those where kainit was used. The rust-restraining power of kainit explains, at least in part, its favorable effect in this experiment.

Indeed the weather conditions were so decidedly unfavorable that as late as August 6th the plants on the fertilized plots were as large as those on plots where cotton seed meal, acid phosphate, or kainit had been applied singly.

The yield of seed cotton per acre, the increase per acre attributable to fertilizers, the cost of fertilizers per acre, and the profit from fertilizer are given in the table below. In this table allowance is made for the slight difference in yield of the two fertilized plots, and the following prices per ton are assumed for fertilizers: Cotton seed meal, $19; high grade acid phosphate, $12.50; kainit, $13.75. Seed cotton is valued at 1 5-9 cents per pound which is equal to 5 cents per pound of lint and $6.67 per ton of seed.

Results of fertilizer experiments at Auburn, 1898.

Plot No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	Per cent of crop at first picking.	Yield seed cotton.	Increase over unfertilized plots.	Value of increase at 1 5-9 cent per pound.	Cost of fertilizers.	Profit from fertilizers.
	Lbs.			*Lbs.*	*Lbs.*			
20	200	Cotton seed meal	70	889	214	$ 3 33	$ 1 90	$ 1.43
21	240	Acid phosphate	77	853	178	2.77	1.50	1.27
22	00	No fertilizer	80	675	.....	.....	.....	.....
23	200	Kainit	71	783	122	1.77	1 38	.39
24	200	Cotton seed meal	74	1013	346	5 36	3 40	1.96
	240	Acid phosphate						
25	200	Cotton seed meal	65	1192	529	8 23	3 28	4.95
	200	Kainit						
26	240	Acid phosphate	66	1145	486	7 56	2.88	4.68
	200	Kainit						
27	00	No fertilizer	76	655	.....	.....	.....	.....
28	200	Cotton seed meal	65	1177	522	8.12	4.78	3.34
	240	Acid phosphate						
	200	Kainit						

Increase of seed cotton per acre where cotton seed meal was added:

To unfertilized plot.....214 lbs.
To acid phosphate plot.....168 "
To kainit plot.....407 "
To acid phosphate and kainit plot..... 36 "

Average increase with cotton seed meal..206 lbs.

Increase of seed cotton per acre where acid phosphate was added:

To unfertilized plot.....178 lbs.
To cotton seed meal plot.....132 "
To kainit plot.....364 "
To cotton seed meal and kainit plot.....—7 "

Average increase with acid phosphate.....168 lbs.

Increase of seed cotton per acre when kainit was added:

To unfertilized plot	123 lbs.
To cotton seed meal plot	315 "
To acid phosphate plot	308 "
To cotton seed meal and acid phos. plot	176 "
Average increase with kainit	**230 lbs.**

From the analysis above it is evident that this soil needed all three of the fertilizer ingredients, the nitrogen in cotton seed meal, the phosphoric acid in acid phosphate, and the potash in kainit. In every case the use of fertiiizers returned a profit. Doubtless this profit would have been much larger had there been sufficient rainfall in May and June to properly dissolve and distribute the fertilizer. The largest profit resulted from a mixture of cotton seed meal and kainit; this was closely followed in point of profit by a mixture of cotton seed meal, kainit and acid phosphate. Mixtures of two fertilizers, aggregating 400 to 440 pounds per acre, afforded in every case a greater profit than 200 to 240 pounds of a single fertilizer material. Probably the slightly greater effect of cotton seed meal or of kainit as compared with acid phosphate was due to the fact that in preceding years there had been applied more of phosphate than of any other material. This should not be taken to indicate that phosphate is generally less necessary than the other ingredients. On most sandy soils it is certainly equal, if not superior, to the other fertilizers used.

Method of Applying Fertilizers.

The land used for this experiment was a rather stiff loam of light reddish color, and very stoney. The field had been in rye in 1897, followed by broadcast Wonderful cowpeas, which were picked and then grazed by cattle. The land was twice broken, rather to destroy Bermuda grass than as a necessary preparation for cotton. In both of these plow-

ings, scooters were used in preference to turn plows, so as to avoid burying deeply any of the grass.

When ready to plant, a complete fertilizer was applied, as follows :

On two plots the fertilizer was all drilled in the "marking off" or center furrow and mixed by using a scooter; on two other plots one-half the fertilizer was applied in each "listing" furrow, that is about 8 to 10 inches on each side of the line of drill, making no special provision for incorporating the fertilizer with the soil; and on two other plots the fertilizer was divided into three equal portions, one part applied in the center furrow without mixing and one portion in each "listing" furrow.

April 25, the same day that fertilizers were applied and beds formed, all plots were planted with King cotton. When the plants were large enough, all plots were so thinned as to leave an equal number of plants on each plot.

The land was apparently uniform.

The fertilizer used on all plots consisted of

240	pounds	acid phosphate	per acre,
120	"	cotton seed meal	" "
120	"	kainit	" "
480	"	Total per acre.	

The rate of application was heavier than usual in order to emphasize any differences that might be due to the methods of applying the fertilizer.

The results are given in the table below:

Fertilizer applied all in center furrow, or in two listing furrows, or in all three furrows.

Plot No.	Fertilizers Applied	Seed cotton per acre.
		Lbs.
1	{⅓ in center furrow ⅓ in each listing furrow	1371
2	All in center furrow (mixed)	1338
3	½ in each listing furrow	1174
4	{⅓ in center furrow ⅓ in each listing furrow	1117
5	All in center furrow (mixed)	1454
6	½ in each listing furrow	1166
	Averages.	
1 & 4	{⅓ in center furrow ⅓ in each listing furrow	**1248**
2 & 5	All in center furrow (mixed)	**1396**
3 & 6	½ in each listing furrow	**1170**

The highest yield on any single plot, 1,454 pounds of seed cotton, or practically one bale per acre, and the highest average yield, 1,396 pounds per acre, were made on the plots on which all the fertilizer was placed in the center furrow. A single experiment cannot establish a truth, but as far as this test goes, it is decidedly in favor of applying all the fertilizer in the center furrow, thus not only economizing labor, but also securing, under the conditions of this experiment, a larger yield. Apparently the absence of the fertilizer from the immediate vicinity of the plants on Plots 3 and 6 was quite unfavorable to yield.

It should not be inferred that the application of as much as 480 pounds of commercial fertilizer per acre should be applied in the center furrow *without mixing.* When large quantities of fertilizers are used it is important to incorporate the fertilizer with the soil by the use of a scooter or of some corresponding implement. It cannot be stated just

what amount of fertilizer makes this mixing imperative, but it is safest to mix thus when 300 pounds or more per acre is the quantity used; with lighter applications, this mixing though doubtless advantageous, may not pay for the extra labor involved.

Cotton Seed vs. Cotton Seed Meal or Nitrate of Soda.

The land used for this experiment was similar to that used for the subsoil experiment previously described. In the recent past all plots had been fertilized and cropped alike.

The crop in 1897 was corn, with a very thin and unsatisfactory stand of peas growing in a drill between the corn rows. On the corn a complete home mixed fertilizer had been used at a moderate rate per acre. The amount of nitrogen left in the soil by the thin growth of peas and by the small amount of residual nitrogen from previous fertization must have been very slight.

The land was flushed and then bedded, applying in the "marking off" or center furrow the fertilizers indicated below.

All plots received

240 pounds acid phosphate per acre and
96 pounds kainit per acre.

Two cotton plots received no nitrogenous fertilizer; two others, 475 ponnds (dry weight) of cotton seed (14 5–6 bushels) per acre, moistened several weeks before being used and in the meantime kept covered with earth to prevent the escape of ammonia.

A third pair of plots received 216 pounds of cotton seed meal, this amount containing the same quality of nitrogen as the 475 pounds of cotton seed. Still another pair of plots received a similar quantity of nitrogen, but in the form of 75 pounds of nitrate of soda.

The variety used was Truitt, the date of planting, April 18, the fertilizers having been applied quite recently.

When the crop was of sufficient size it was so thinned as to leave an equal number of plants (8,800 per acre) on each plot, except on Plot 8, where the original stand was so irregular that only 6,736 plants per acre could be left on that plot. However, a comparison of the yield of this plot with that of its duplicate suggests that the deficient stand was not in this case a disadvantage; hence the figures for Plot 8 are used in the averages in the table below.

Two plots forming a part of this experiment were planted, the one with Wonderful cowpeas, the other with velvet beans, to be plowed under in the spring of 1899 so as to compare the value of these plants as fertilizers for the cotton crop of 1899 with the commercial fertilizers that will be applied to that cotton crop on the other eight plots.

These plants were fertilized with

240 pounds of acid phosphate per acre and
96 pounds of kainit per acre.

It is interesting to note that the yield of unhulled peas on Plot 1 in 1898 was at the rate of 1641 pounds, or more than 18 bushels per acre; the average yield of two cotton plots fertilized like the peas was 888 pounds of seed cotton per acre.

The yields of seed cotton are given in the following table, in which the mixture of acid phosphate and kainit applied on all plots is for convenience referred to as "mixed minerals."

Fertilizing value of nitrogen from cotton seed, cotton seed meal, and nitrate of soda.

Plot No.	Fertilizers. Am't per acre.	Fertilizers. Kind.	Yield of seed cotton per acre	Increase over unfertilized plots.
	Lbs.		*Lbs.*	*Lbs.*
3	475	Rotted cotton seed and mixed minerals.....	992	
4	216	Cotton seed meal and mixed minerals.....	851	
5	.....	No nitrogenous fertilizer; only mixed minerals.	621	
6	75	Nitrate of soda and mixed minerals.....	1010	
7	475	Rotted cotton seed and mixed minerals..	1067	
8	216	Cotton seed meal and mixed minerals..... ...	1075	
9	.....	No nitrogenous fertilizer; only mixed minerals.	1155	
10	75	Nitrate of soda	1350	
		Averages.		
3 & 7	475	Rotted cotton seed and mixed minerals.....	1030	142
4 & 8	216	Cotton seed meal and mixed minerals	963	75
5 & 9		No nitrogenous fertilizer; only mixed minerals.	888	
& 10	75	Nitrate of soda	1180	292

The want of uniformity in the natural fertility of the different plots, which is indicated by the yield, makes it unsafe to draw any positive conclusion as to the relative values of the several fertilizers compared. This question will be further investigated.

However it may properly be noted here that of the large number of comparisons made between cotton seed meal and cotton seed as fertilizers few agree as to the relative values of these two materials. On some soils the nitrogen in cotton seed meal is more effective than is a similar amount of nitrogen in the form of cotton seed. On other soils and in other seasons the opposite result occurs. Cotton seed leave in the soil a larger amount of fertilizer for the following crop than does cotton seed meal.

In 14 experiments conducted under the writer's direction in 1896, on various soils, the average of all results showed that the nitrogen in *crushed* cotton seed was equally as effective as a similar amount of nitrogen in cotton seed

meal. The results of the separate tests varied widely. In the tests just alluded to one pound of cotton seed meal was equivalent on the average to 2.06 pounds of *crushed* cotton seed. In a series of tests in South Carolina one pound of cotton seed meal was equivalent to 2.79 pounds of seed. In neither of these series of experiments was any account taken of the residual, or second years, effects of the two fertilizers.

Special Potash Experiment.

In some years and on certain soils large doses of kainit had exercised such a valuable effect in checking black rust or yellow leaf blight of cotton, that an effort was made in 1898 to ascertain the smallest amount of kainit that would serve to restrain rust. Another object of this experiment was to learn whether muriate of potash was equally valuable for this purpose, and a third aim was to note the effects of applying large quantities of relatively insoluble potash in the form of potash feldspar, or pulverized potash-bearing rock.

A poor sandy hilltop, known to be very liable to produce rusted cotton was selected. Only six plots were available, which rendered duplication impossible.

This field grew small grain in 1896 and again in 1897, with drilled cowpeas following the grain on all plots. The peas did not make much growth in either year.

In bedding the land in 1898 all fertilizers were applied in the center furrow and were well mixed with the adjacent soil.

On all plots the following fertilizers, which we shall here speak of as the "basal mixture," were applied April 11:

120 pounds cotton seed meal per acre and 240 pounds acid phosphate per acre.

To this "basal mixture" was added, on one plot, kainit at the rate of 200 pounds per acre; on another, 100 pounds of kainit per acre; on a third, 60 pounds of kainit per acre.

On one plot muriate of potash was used at the rate of 50 pounds per acre, thus furnishing the same amount of potash as 200 pounds of kainit.

Peerless cotton was planted April 19.

On all plots except plots 3 and 4, where the stand was irregular, there remained, after thinning, 8,640 plants per acre.

As early as August 14 rust was noticed on all plots except on those fertilized with 200 pounds of kainit or 50 pounds of muriate of potash per acre. August 16 black rust was general on the plot without potash, on the feldspar plot and on the plot with only 60 pounds of kainit per acre; on the plots having 100 or 200 pounds of kainit or 50 pounds of muriate of potash there was then very little rust.

The following table shows the percentage of the original number of leaves retained, as estimated August 25 and September 23.

Plot No.	Potash Fertilizer Per Plot.	Percentage of leaves retained.	
		Aug. 25.	Sept. 23.
1	200 lbs. kainit	70	5
2	100 " kainit	50	5
3	60 " kainit	40	2
4	No potash	20	½
5	1000 " potash feldspar	20	½
6	50 " murate of potash	70	25

It was perfectly evident from the appearance of the plants that an abundant supply of soluble potash did decrease the amount of rust and did tend to retain the leaves on the plant.

The yieds, however, with one exception, did not show the effects of potash as forcibly as did the appearance of the plants.

The yields follow :

Yield of seed cotton obtained with the use of different forms of potash.

Plot No.	Fertilizers.		Yield of seed cotton per acre.
	Am't per acre.	Kind.	
	Lbs.		*Lbs.*
1	200	Kainit and basal mixture	556
2	100	Kainit and basal mixture	492
3	60	Kainit and basal mixture	516
4	.....	No potash; only basal mixture	408
5	1000	Potash feldspar and basal mixture	482
6	50	Muriate of potash	*954

* The yield on Plot 6 is so much larger than that on other plots fertilized with potash that we must ascribe it, in part at least, to undetected want of uniformity in the soil.

The reasons were unfavorable for securing the full benefit of fertilizers. Hence, positive conclusions will not be in order until this experiment is repeated. However, one result is so noticeable that it should not be overlooked. A pound of potash in the form of muriate was fully as effective, in restraining rust as a pound of potash in the form of kainit. This experiment, together with others conducted by the writer in 1897 and 1898, suggest that 100 pounds of kainit per acre exerts a marked rust restraining power. It is still an open question what is the least amount of kainit that will produce this effect.

The potash feldspar used in this experiment was furnished by F. M. Dorsey, Hyssop, Ala., who obtained it from a natural deposit in Coosa county. It was pulverized with crude implements and was not in very fine state of division.

WHERE TO GET SEED.

The seed of the varieties grown here is not offered for sale or distribution. Growing on small plots side by side, the varieties naturally cross and become impure. Our stock of seed was obtained from the following parties:

Allen Hybrid L. S., from J. B. Allen, Port Gibson, Miss.
Strickland, from Curry-Arrington Co., Rome, Ga.
Texas Oak, from M. G. Smith, Lightfoot, Ga.
Hutchinson, from J. N. Hutchinson, Salem, Ala.
Russell, from J. T. Russell, Alexander City, Ala.
"Smith Improved," from E. A. Smith, Conyers, Ga.
Culpepper, from J. A. Culpepper, Luthersville, Ga.
Jones' Re-improved, Hawkins, Griffin, and Duncan, from Mark W. Johnson Seed Co., Atlanta, Ga.
Deering and Peterkin, from H. P. Jones, a seed-grower at Herndon, Ga.