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Methods of Applying

NITROGEN
PHOSPHORUS
POTASSIUM

for Cotton

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Methods of Applying Nitrogen, Phosphorus, and Potassium for Cotton

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CAN THE FERTILIZER nitrogen needs of cotton be met by preplant application? Is a starter application of fertilizer for cotton necessary for top yields?

Questions like these were of little interest a generation ago, but the advent of high analysis fertilizers, bulk handling, mechanization, and labor shortage has changed all that. Now these questions are of major economic importance for the cotton producer as he seeks to increase speed of planting and reduce costs of production.

To provide information about effectiveness of preplant applications and necessity of starter applications of fertilizer, the study reported here was begun by Auburn University Agricultural Experiment Station.

Results of fertilizer placement experiments in Texas had indicated a reduction in stand of cotton when fertilizer was placed with the seed *(2)*. In Georgia, experiments comparing rates of complete fertilizer (N-P-K) showed no difference from method of application at one location but at another location yields were higher when all fertilizer was broadcast rather than banded *(5)*. Zaslovsky and Mokady *(7)* indicated that a band application of P is not always advantageous because broadcasting may result in contact with a greater volume of roots and, therefore, more efficient uptake. Welch *et al. (6)* found that one-half banded and one-half broadcast was the best method of applying a high rate of P for corn on Illinois soils low in P. For low rates of P on soils

testing low, they indicated that banding was favored, as would be expected on soils with high P fixing properties.

Maples and Keogh *(3)* compared broadcast and banded placement of fertilizer on Arkansas soils deficient in P and K. On sandy areas, soluble salts from banded fertilizer caused seedling injury in dry weather and broadcasting was better. Only on poorly drained soils was banded application superior, which may have been a result of reduced root growth and consequently less contact with broadcast fertilizers. Overton and Parks *(4)* compared rates and methods of applying fertilizer for cotton in Tennessee. On sandy loam or silt loam soils testing low or medium in P or K, there was a response to increasing rates of fertilizer but no response to methods of application.

Uniform distribution of fertilizer would be an important consideration in broadcasting, particularly on soils of low fertility. In the experiments reported in this publication, methods of application were precisely controlled. Under practical field conditions spreading patterns may vary as a result of such factors as slope of ground, nature of fertilizer, equipment, and weather conditions *(1)*.

NITROGEN EXPERIMENTS

Methods

Field experiments on cotton were conducted at Prattville, Brewton, and Monroeville Experiment Fields and the Sand Mountain Substation. Soil type at each location was as follows:

Location	*Soil type*
Prattville Experiment Field	Lucedale sandy loam
Brewton Experiment Field	Norfolk sandy loam (formerly Kalmia)
Monroeville Experiment Field	Magnolia sandy loam
Sand Mountain Substation	Hartsells sandy loam

The rates of N were 0, 30, 60, and 90 pounds per acre, applied according to three schedules: (1) all broadcast ahead of planting, (2) 15 pounds drilled and remainder broadcast, and (3) 15 pounds drilled and remainder sidedressed. Different rates were used at the Sand Mountain Substation, 0, 60, 90 and 120 pounds N per acre. At this location, in addition to the 15-pound rate drilled, treatments included 30 pounds drilled and the remainder

either broadcast or sidedressed. Adequate rates of P and K were applied for all N comparisons.

Results

At Prattville Experiment Field the yield was 1,390 pounds seed cotton per acre without applied N and increased with each increment up to 2,640 pounds at 90 pounds N per acre, Table 1. There

TABLE 1. YIELD OF SEED COTTON FROM THE RATES AND METHODS OF APPLICATION OF NITROGEN EXPERIMENT ON LUCEDALE SANDY LOAM SOIL, PRATTVILLE EXPERIMENT FIELD

Nitrogen treatment			Seed cotton yield per acre				
Drilled	Broadcast	Sidedressed	1964	1965	1966	1967	Average
			Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
No nitrogen							
0	0	0	1,440	1,480	1,590	1,080	1,400a[1]
30 pounds N							
0	30	0	2,120	2,110	1,800	1,740	1,940b
15	15	0	2,160	2,060	1,840	1,780	1,960b
15	0	15	2,280	2,100	2,060	1,980	2,100b
60 pounds N							
0	60	0	2,500	2,640	2,390	2,300	2,460c
15	45	0	2,490	2,470	2,370	2,110	2,360c
15	0	45	2,470	2,730	2,530	2,270	2,500c
90 pounds N							
0	90	0	2,670	2,940	2,430	2,530	2,640d
15	75	0	2,650	2,730	2,290	2,230	2,470c
15	0	75	2,710	2,910	2,480	2,450	2,640d

[1] Yields with the same letter are not different at the 0.05 probability level.

TABLE 2. YIELD OF SEED COTTON FROM THE RATES AND METHODS OF APPLICATION OF NITROGEN EXPERIMENT ON NORFOLK SANDY LOAM SOIL, BREWTON EXPERIMENT FIELD

Nitrogen treatment			Seed cotton yield per acre				
Drilled	Broadcast	Sidedressed	1964	1965	1966	1967	Average
			Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
No nitrogen							
0	0	0	1,220	1,350	1,380	1,530	1,370a[1]
30 pounds N							
0	30	0	1,670	2,100	1,750	2,120	1,910cd
15	15	0	1,560	1,910	1,690	2,080	1,810bc
15	0	15	1,660	1,750	1,600	1,790	1,700b
60 pounds N							
0	60	0	1,460	2,080	1,820	1,950	1,830bc
15	45	0	1,670	2,370	1,780	2,330	2,040d
15	0	45	1,830	2,190	1,720	2,010	1,940cd
90 pounds N							
0	90	0	1,520	2,460	1,940	1,880	1,950cd
15	75	0	1,590	2,500	1,660	1,920	1,920cd
15	0	75	2,070	2,370	1,740	2,060	2,060d

[1] Yields with the same letter are not different at the 0.05 probability level.

was no effect of method of applying N at the 30- and 60-pound per acre rates. All broadcast ahead of planting was just as good as applying part in the drill and either broadcasting or sidedressing the remainder. At the 90-pound rate the combination of 15 pounds drilled and 75 pounds N broadcast yielded less than the other methods of application. There is no logical explanation for this reduction in yield.

Yields at Brewton Experiment Field indicated a response up to 60 pounds N per acre, Table 2. Overall, there were no consistent differences in yields from method of application. For example, at 90 pounds N, the rate recommended for cotton in the Coastal Plains, the three methods of application gave similar yields.

Results at Monroeville Experiment Field show a response only to 30 pounds N, Table 3. Soil conditions and drought may account for the apparent poor response to N.

At Sand Mountain Substation yields ranged from about 1,600 pounds to nearly 3,000 pounds seed cotton per acre as N was increased from none to 90 pounds, Table 4. There was no consistent response to more than 90 pounds at this location. Methods of applying N gave similar results. Broadcasting all the nitrogen was just as satisfactory as applying some in the drill and either broadcasting or sidedressing the remainder.

In the fertilizer placement experiments reported later in this

TABLE 3. YIELD OF SEED COTTON FROM THE RATES AND METHODS OF APPLICATION OF NITROGEN EXPERIMENT ON MAGNOLIA SANDY LOAM SOIL, MONROEVILLE EXPERIMENT FIELD

Nitrogen treatment			Seed cotton yield per acre				
Drilled	Broadcast	Sidedressed	1964	1965	1966	1967	Average
			Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
No nitrogen							
0	0	0	1,740	2,160	2,110	1,770	1,940a[1]
30 pounds N							
0	30	0	1,580	2,530	2,150	2,100	2,090b
15	15	0	1,690	2,400	1,960	2,120	2,040b
15	0	15	1,420	2,510	2,120	2,130	2,040b
60 pounds N							
0	60	0	1,760	2,530	2,040	2,200	2,130b
15	45	0	1,280	2,320	1,970	2,190	1,940a
15	0	45	1,640	2,450	1,960	2,160	2,050b
90 pounds N							
0	90	0	1,450	2,580	2,110	2,090	2,060b
15	75	0	1,390	2,600	2,120	2,140	2,060b
15	0	75	1,580	2,360	2,050	2,190	2,040b

[1] Yields with the same letter are not different at the 0.05 probability level.

TABLE 4. YIELD OF SEED COTTON FROM THE RATES AND METHODS OF APPLICATION OF NITROGEN EXPERIMENT ON HARTSELLS SANDY LOAM SOIL, SAND MOUNTAIN SUBSTATION

Nitrogen treatment			Seed cotton yield per acre		
Drilled	Broadcast	Sidedressed	1965	1966	Average
			Lb.	*Lb.*	*Lb.*
No nitrogen					
0	0	0	1,690	1,530	1,610a[1]
60 pounds N					
0	60	0	2,530	2,210	2,370b
15	45	0	2,720	2,580	2,650b
15	0	45	2,610	2,670	2,640b
30	30	0	2,560	2,610	2,580b
30	0	30	2,740	2,730	2,730b
90 pounds N					
0	90	0	2,760	2,750	2,760c
15	75	0	2,730	2,890	2,810c
15	0	75	2,850	3,020	2,930c
30	60	0	2,780	2,720	2,750c
30	0	60	2,840	2,850	2,840c
120 pounds N					
0	120	0	2,900	2,900	2,900c
15	105	0	2,780	2,940	2,860c
15	0	105	2,970	2,910	2,940c
30	90	0	2,790	3,190	2,990c
30	0	90	2,830	2,800	2,820c

[1] Yields with the same letter are not different at the 0.05 probability level.

bulletin, Tables 5-10, broadcasting the recommended rate of N can be compared with drilled + sidedressed N at several locations. Results were the same as reported above, indicating that broadcasting all N before planting was a satisfactory practice.

SUMMARY OF NITROGEN RESULTS. Response to rates of N was variable among locations. There was a response to only 30 pounds at Monroeville Field, 60 pounds at Brewton Field, and to 90 pounds N at both Prattville Field and Sand Mountain Substation. Method of applying N had little or no effect on yields. Cotton effectively utilized broadcast N as well as drilled N, and combinations were no better than drilling or broadcasting the fertilizer. If N broadcast ahead of planting had been less efficiently utilized by the cotton plant, then differences would have been expected at the lower rate of application. This did not occur.

Results of these studies on fertile soils that had been well fertilized in the past indicate that the cotton producer can choose method of N application most suited to his management situation. It might not be advisable to apply all the N ahead of planting on very sandy soils or soils of low fertility.

P AND K PLACEMENT EXPERIMENT

Field experiments on cotton were conducted from 1964 to 1966 at six locations in the State, on these soil types:

Location	*Soil type*
Agronomy Farm, Auburn	Chesterfield sandy loam
Prattville Experiment Field	Lucedale sandy loam (formerly Greenville)
Monroeville Experiment Field	Magnolia sandy loam
Wiregrass Substation	Dothan sandy loam (formerly Norfolk)
Sand Mountain Substation	Hartsells sandy loam
Tennessee Valley Substation	Decatur clay loam

TABLE 5. YIELD OF SEED COTTON FROM THE METHOD OF APPLICATION OF PHOSPHORUS AND POTASSIUM EXPERIMENT ON CHESTERFIELD SANDY LOAM SOIL, AGRONOMY FARM, AUBURN[1]

Treatment number	Fertilizer per acre, pounds				Seed cotton yield per acre			
	Total N-P-K	Broadcast N-P-K	Drilled N-P-K	Side-dressed N	1964	1965	1966	Av.[2]
					Lb.	*Lb.*	*Lb.*	*Lb.*
1	90-18-50	0-0-0	20-18-50	70	3,030	2,900	1,830	2,590
2	90-18-50	0-9-35	20-9-15	70	3,000	3,040	1,880	2,640
3	90-27-75	0-18-60	20-9-15	70	3,200	2,620	1,870	2,560
4	90-18-50	0-18-50	0-0-0	90	2,860	2,850	1,720	2,470
5	90-27-75	0-27-75	0-0-0	90	2,850	2,800	1,720	2,460
6	90-0-50	0-0-0	20-0-50	70	3,050	2,640	1,910	2,530
7	90-18-0	0-0-0	20-18-0	70	3,030	2,660	1,830	2,510
8	90-18-50	90-18-50	0-0-0	0		2,950	2,060	

[1] Soil test P was high and K was medium.
[2] Differences were not significant.

TABLE 6. YIELD OF SEED COTTON FROM THE METHODS OF APPLICATION OF P AND K EXPERIMENT ON MAGNOLIA SANDY LOAM SOIL, MONROEVILLE EXPERIMENT FIELD[1]

Treatment number	Fertilizer per acre, pounds				Seed cotton yield per acre			
	Total N-P-K	Broadcast N-P-K	Drilled N-P-K	Side-dressed N	1964	1965	1966	Av.[2]
					Lb.	*Lb.*	*Lb.*	*Lb.*
1	90-18-35	0-0-0	20-18-35	70	1,900	2,740	1,940	2,190
2	90-18-35	0-9-20	20-9-15	70	1,970	2,890	2,100	2,320
3	90-27-50	0-18-35	20-9-15	70	1,970	2,590	1,980	2,180
4	90-18-35	0-18-35	0-0-0	90	1,910	2,660	1,890	2,150
5	90-27-50	0-27-50	0-0-0	90	2,010	2,760	2,020	2,260
6	90-0-35	0-0-0	20-0-35	70	1,990	2,770	2,050	2,270
7	90-18-0	0-0-0	20-18-0	70	1,890	2,800	2,090	2,260
8	90-18-35	90-18-35	0-0-0	0		2,770	2,030	

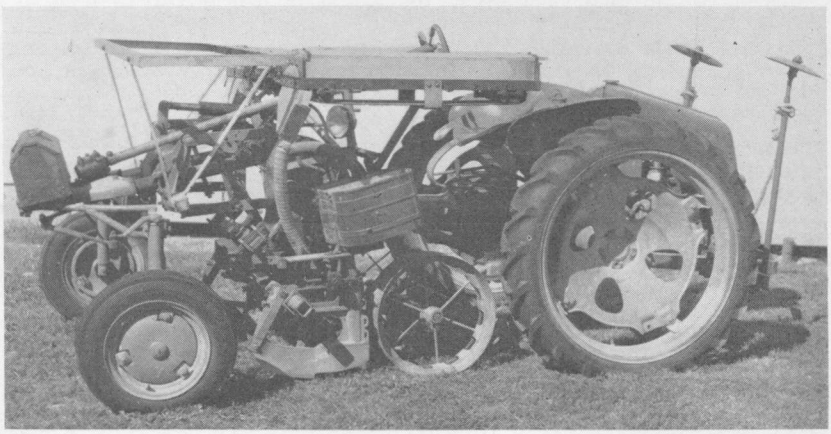
[1] Soil tests for both P and K were high.
[2] Differences were not significant.

Treatments included three rates of P and K fertilizer based on soil tests: the recommended rate, 1½ times the recommended rate, and check treatments with no P or K. Comparisons were made of broadcast and drill applications as well as combinations in which some of the P and K was applied as a starter. Rates and methods of application were (numbers correspond to treatment numbers in Tables 5-10):

Rate	*Application method*
1. Recommended rate	all drilled
2. Recommended rate	starter drilled, remainder broadcast
3. 1½ recommended rate	starter drilled, remainder broadcast
4. Recommended rate	all broadcast
5. 1½ recommended rate	all broadcast
6. Recommended rate of K, no P	all drilled
7. Recommended rate of P, no K	all drilled
8. Recommended rate	all broadcast, including N

The drilled fertilizer included 20 pounds N with the remainder of N sidedressed; therefore, treatments 4 and 5 had all the N sidedressed while treatment 8 had all the N broadcast before planting.

A specially equipped two-row planter (shown in photo) was used in all these experiments. Fertilizer for each row was weighed and distributed uniformly over the length of the plot by means of slow moving fertilizer belts metering the fertilizer to the appli-



This specially equipped, 2-row planter ensured uniform distribution of fertilizer over the length of the plot during the planting operation.

cators during the planting operation. The drilled fertilizer was placed 3 inches to the side and 2 inches below the seed.

The comparisons were made at a different location on each field or substation each year. Soil pH was in the range of 6.0 to 6.5 and N and B (boron) were applied at recommended rates. Conventional methods of land preparation and weed and insect control were followed.

Results

The tests were located intentionally on soils testing medium to high in P and K. There was no response to P at any location, and yields were increased by the use of K at only two locations, Tables

TABLE 7. YIELD OF SEED COTTON FROM THE METHODS OF APPLICATION OF P AND K EXPERIMENT ON LUCEDALE SANDY LOAM SOIL, PRATTVILLE EXPERIMENT FIELD[1]

Treatment number	Fertilizer per acre, pounds				Seed cotton yield per acre			
	Total N-P-K	Broadcast N-P-K	Drilled N-P-K	Side-dressed N	1964	1965	1966	Av.
					Lb.	*Lb.*	*Lb.*	*Lb.*
1	90-18-35	0-0-0	20-18-35	70	2,510	2,940	2,280	2,580abc[2]
2	90-18-35	0-9-20	20-9-15	70	2,600	2,870	2,260	2,580abc
3	90-27-50	0-18-35	20-9-15	70	2,650	2,960	2,430	2,680c
4	90-18-35	0-18-35	0-0-0	90	2,250	3,040	2,300	2,530ab
5	90-27-50	0-27-50	0-0-0	90	2,300	3,060	2,330	2,560abc
6	90-0-35	0-0-0	20-0-35	70	2,550	3,030	2,300	2,630c
7	90-18-0	0-0-0	20-18-0	70	2,410	2,860	2,050	2,440a
8	90-18-35	90-18-35	0-0-0	0	2,660	2,970	2,220	2,620c

[1] Soil tests for both P and K were high.
[2] Yields with the same letter are not different at the 0.05 probability level.

TABLE 8. YIELD OF SEED COTTON FROM THE METHODS OF APPLICATION OF P AND K EXPERIMENT ON HARTSELLS SANDY LOAM SOIL, SAND MOUNTAIN SUBSTATION[1]

Treatment number	Fertilizer per acre, pounds				Seed cotton yield per acre			
	Total N-P-K	Broadcast N-P-K	Drilled N-P-K	Side-dressed N	1964	1965	1966	Av.[2]
					Lb.	*Lb.*	*Lb.*	*Lb.*
1	120-18-50	0-0-0	20-18-50	100	1,710	2,280	2,320	2,100
2	120-18-50	0-9-35	20-9-15	100	1,800	2,310	1,620	1,910
3	120-27-75	0-18-60	20-9-15	100	1,860	2,420	2,150	2,140
4	120-18-50	0-18-50	0-0-0	120	1,740	2,240	1,970	1,980
5	120-27-75	0-27-75	0-0-0	120	1,680	2,290	2,400	2,120
6	120-0-50	0-0-0	20-0-50	100	1,720	2,480	1,890	2,030
7	120-18-0	0-0-0	20-18-0	100	1,810	2,200	1,960	1,990
8	120-18-50	120-18-50	0-0-0	0	1,630	2,190	2,000	1,940

[1] Soil test for P was high and K was medium.
[2] Differences were not significant.

5-10. Broadcasting the P and K was just as satisfactory as applying all or some of the fertilizer in the drill. Likewise there was no advantage to using 1½ times the recommended rate by the broadcast method. Even where there was a response to K, there was no indication that one application method was superior to the other.

At three locations, first-year treatments included one in which all N, P, and K were broadcast ahead of planting. This treatment was added at the other three locations the second and third years. Yields from this treatment were similar to the other P and K comparisons and also agree with the data reported previously on nitrogen application methods.

Cotton yields in these experiments ranged between 1½ and 2

TABLE 9. YIELD OF SEED COTTON FROM THE METHODS OF APPLICATION OF P AND K EXPERIMENT ON DECATUR CLAY LOAM SOIL, TENNESSEE VALLEY SUBSTATION[1]

Treatment number	Fertilizer per acre, pounds				Seed cotton yield per acre			
	Total N-P-K	Broadcast N-P-K	Drilled N-P-K	Side-dressed N	1964	1965	1966	Av.[2]
					Lb.	*Lb.*	*Lb.*	*Lb.*
1	70-27-50	0-0-0	20-27-50	50	2,780	2,640	1,600	2,340
2	70-27-50	0-18-35	20-9-15	50	2,400	2,750	1,830	2,330
3	70-40-75	0-30-60	20-9-15	50	2,580	2,630	1,650	2,290
4	70-27-50	0-27-50	0-0-0	70	2,470	2,350	1,730	2,180
5	70-40-75	0-40-75	0-0-0	70	2,650	2,810	1,650	2,370
6	70-0-50	0-0-0	20-0-50	50	2,170	2,640	1,770	2,190
7	70-27-0	0-0-0	20-27-0	50	2,650	2,620	1,600	2,290
8	70-27-50	70-27-50	0-0-0	0	2,760	2,620	1,620	2,330

[1] Soil tests for both P and K were medium.
[2] Differences were not significant.

TABLE 10. YIELD OF SEED COTTON FROM THE METHODS OF APPLICATION OF P AND K EXPERIMENT ON DOTHAN SANDY LOAM SOIL, WIREGRASS SUBSTATION[1]

Treatment number	Fertilizer per acre, pounds				Seed cotton yield per acre			
	Total N-P-K	Broadcast N-P-K	Drilled N-P-K	Side-dressed N	1964	1965	1966	Av.
					Lb.	*Lb.*	*Lb.*	*Lb.*
1	90-18-50	0-0-0	20-18-50	70	2,780	2,420	2,570	2,590abc[2]
2	90-18-50	0-9-35	20-9-15	70	2,680	2,600	2,200	2,490abc
3	90-27-75	0-18-60	20-9-15	70	2,700	2,660	2,850	2,740c
4	90-18-50	0-18-50	0-0-0	90	2,690	2,190	2,470	2,450ab
5	90-27-75	0-27-75	0-0-0	90	2,860	2,390	2,580	2,610bc
6	90-0-50	0-0-0	20-0-50	70	2,560	2,470	2,630	2,550abc
7	90-18-0	0-0-0	20-18-0	70	2,390	2,140	2,430	2,320a
8	90-18-50	90-18-50	0-0-0	0		2,100	2,400	

[1] Soil test for P was high and K was medium.
[2] Yields with the same letter are not different at the 0.05 probability level.

bales per acre most years. There appeared to be some early growth stimulation from drilled fertilizer some years, but this did not affect yield.

INTERPRETATION AND APPLICATION OF FINDINGS ON METHODS OF APPLYING P AND K

Experiments on several of the more extensive soil types on which cotton is grown in the State indicate that broadcasting P and K fertilizer for cotton is a satisfactory practice. These experiments were limited to soils testing high or medium in P and K, which are typical of fertility levels of soils on which most cotton is grown in Alabama. A summary of 1968 results from Auburn University's Soil Testing Laboratory[1] showed that 89 per cent of samples tested for cotton were medium or high in P and 94 per cent were medium or high in K.

These findings agree with results from other states and show that broadcasting all fertilizer ahead of planting cotton is as good as other methods for soils with medium or high fertility levels. In this series of experiments there was no apparent stand damage and no yield losses from banding fertilizer. This pattern of response should be expected to differ on soils of low fertility.

CONCLUSIONS

Broadcasting fertilizer N ahead of planting on fertile soils gave similar results to drilling part and sidedressing remainder.

Broadcasting all P and K was a satisfactory practice for soils testing medium or high in these plant nutrient elements.

Rates of fertilizer recommended by soil tests were adequate to give maximum yields on soils representative of those producing much of the cotton grown in Alabama.

No adverse effects from drilled fertilizer placed 3 inches to the side and 2 inches below the seed were encountered.

[1] Alabama Soil Test Summary—1968.

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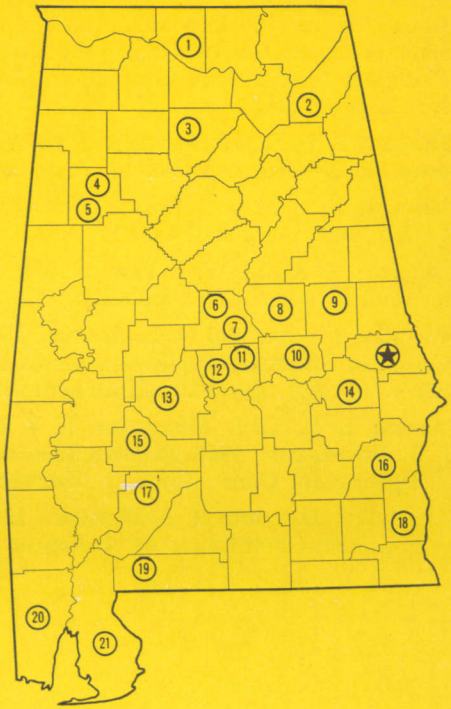
AGRICULTURAL EXPERIMENT STATION SYSTEM OF ALABAMA'S LAND-GRANT UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Thorsby Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
10. Plant Breeding Unit, Tallassee.
11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. Tuskegee Experiment Field, Tuskegee.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Ornamental Horticulture Field Station, Spring Hill.
21. Gulf Coast Substation, Fairhope.