BULLETIN 332
JUNE 1961

Management of Irrigated Cotton

Agricultural Experiment Station
AUBURN UNIVERSITY
E. V. Smith, *Director* Auburn, Alabama

CONTENTS

FIRST PRINTING 5M, JUNE 1961

Management of Irrigated Cotton

Results of Cotton Irrigation Management Studies in Alabama

C. E. SCARSBROOK[1], O. L. BENNETT[2], L. J. CHAPMAN[1], R. W. PEARSON[2], and D. G. STURKIE[1]

MOISTURE DEFICIENCY limits production of cotton nearly every year in Alabama. Although crop failures resulting from drought are rare, maximum cotton yields cannot be produced if the plants suffer for water even for short periods during the fruiting season *(1,2,3)*. The plants produce and mature fruit when moisture is ample, but cease fruiting when moisture is deficient.

When cotton yields are increased by irrigation, requirements for fertilizer, especially nitrogen, become greater *(1,3,5,6)*. Although necessary, this high fertilization leads to problems in irrigated cotton. The large amounts of nitrogen needed for maximum production frequently produce large plants, cause lodging, make harvesting difficult, and create a condition favorable for boll rot organisms *(1,3)*.

Fiber properties of cotton are changed by irrigation *(2,4,5)*. Irrigated cotton is more uniform in quality from year to year than cotton grown with rainfall only. A more uniform product should improve the competitive position of cotton with other fibers.

Because of growing interest in irrigation as a means of improving cotton production, irrigation experiments were begun by Auburn University Agricultural Experiment Station and USDA Agricultural Research Service at several locations in the State.

---

[1] Soil chemist, assistant in agronomy, and agronomist, respectively, Auburn University Agricultural Experiment Station.

[2] Soil scientist, Agricultural Research Service, U.S. Department of Agriculture.

This publication presents results of irrigation experiments during the past 5 years to determine effect of nitrogen, moisture, varieties, topping, spacing, date of planting, and bottom defoliation on yield, fiber properties, and other characteristics of cotton.

EXPERIMENTAL PROCEDURE

Nitrogen and Irrigation Experiment

Purpose of this experiment was to determine some of the factors that limit yields of cotton. Nitrogen and moisture were variables in the experiment. Management practices were designed for maximum yield without regard to economic return.

The experiment was conducted on Greenville sandy loam at the Foundation Seed Stocks Farm, Thorsby. The area was subsoiled, limed to a pH of 6.0 to 6.5, fumigated, and a minor element mixture added. Annual application of 210 pounds per acre each of P_2O_5 and K_2O was made. Coker 100A was grown for 2 years (1956-57) and Deltapine 15 for 2 years (1958-59). An attempt was made to maintain complete boll weevil control, but it was never entirely successful. Control was excellent except when weevils swarmed in from surrounding nonirrigated cotton that had matured. These three moisture treatments were used: (1) not irrigated, (2) irrigated when approximately 65 per cent of available soil moisture was lost from the surface 2 feet of soil (intermediate irrigation), and (3) irrigated when about 30 per cent of available moisture was lost (high irrigation). Furrow irrigation was used. Rainfall and irrigation records are given in Table 1.

Nitrogen and Variety Experiment

The main purpose of this experiment was to determine the upper limits of nitrogen fertilization that can be used on some wilt-resistant cotton varieties without excessive lodging. Work was done on Independence loamy fine sand at the Plant Breeding Unit, Tallassee.

This experiment was conducted in 1958 and 1959 on soil severely infested with the fusarium wilt-nematode complex. The area was fumigated each year and 300 pounds each of P_2O_5 and K_2O was applied. Irrigation was by the sprinkler method.

TABLE 1. IRRIGATION AND RAINFALL RECORDS, TWO ALABAMA LOCATIONS, 1956-59

Month	Rainfall and irrigation per month											
	1956			1957			1958			1959		
	Rainfall	Irrigation		Rainfall	Irrigation		Rainfall	Irrigation		Rainfall	Irrigation	
		Intermediate	High		Intermediate	High		Intermediate	High		Intermediate	High
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
Foundation Seed Stocks Farm, Thorsby												
May	4.05	----	----	6.06	----	----	1.67	0.75	0.75	7.88	----	----
June	1.07	1.75	1.75	5.50	3.00	3.00	6.97	----	----	2.51	1.75	2.75
July	2.44	2.75	6.75	2.81	2.00	6.50	9.73	----	1.50	3.86	3.50	5.00
August	3.62	3.30	3.20	3.10	5.07	3.79	3.15	3.86	3.33	2.73	1.88	5.00
September	3.25	----	----	5.56	----	----	5.16	----	----	4.94	----	----
TOTAL	14.43	7.80	11.70	23.03	10.07	13.29	26.68	4.61	5.58	21.92	7.13	12.75
Tennessee Valley Substation, Belle Mina												
April	7.22	----		1.88	----		7.61	----		4.19	----	
May	2.69	2.00		3.54	----		3.14	----		6.44	----	
June	3.37	2.00		3.50	2.00		2.60	----		5.83	----	
July	2.82	4.00		2.65	4.00		9.06	----		2.62	6.00	
August	3.38	4.00		2.03	6.00		1.78	4.00		6.42	----	
September	2.61	----		6.80	----		5.31	----		2.43	----	
TOTAL	22.09	12.00		20.40	12.00		29.50	4.00		27.93	6.00	

Nitrogen Experiment

This experiment was conducted for 2 years, 1956 and 1959, on Dewey silty clay loam at the Tennessee Valley Substation, Belle Mina. The purpose was to determine response of irrigated cotton to nitrogen fertilization.

The area was fertilized with 100 pounds per acre each of P_2O_5 and K_2O. The variety planted was Empire. Irrigation was by the sprinkler method. Rainfall and irrigation records are given in Table 1.

Cotton Spacing Experiments

The cotton spacing experiments were done on two soil types at two locations — Chesterfield sandy loam on the Agronomy Farm, Auburn, and on Independence loamy fine sand, Plant Breeding Unit, Tallassee.

Auburn 56 was grown in 1959 with plant populations of 5,000, 10,000, and 30,000 plants per acre. This corresponds to drill row spacings of 30, 15, and 5 inches in 40-inch rows. Fertilizers were applied at the per acre rate of 300 pounds each of N, P_2O_5, and K_2O. Irrigation, applied as needed by visual inspection, was by the sprinkler method on the Independence soil and the furrow method on the Chesterfield soil.

Cotton Management and Variety Experiments

It was anticipated that cotton grown with high rates of nitrogen and moisture would lodge. This would create a condition favorable for boll rot. To solve these expected problems, a cotton management study was begun in 1956 and a variety study in 1957, both on Greenville sandy loam at the Foundation Seed Stocks Farm, Thorsby. Rate of fertilization in both experiments was 300 pounds of N and 210 pounds each of P_2O_5 and K_2O per acre.

In the management study, initial treatments were: (1) bottom defoliation with magnesium chlorate of the lower 2 feet of the plant when three-fourths of the bolls were of mature size; (2) picking all squares to simulate complete loss of fruit to insects to determine effect on plant height; (3) topping to a height of 4 feet when the plants reached 4½ feet; and (4) planting at both the recommended time and 1 month later. Other topping heights were included in the tests in subsequent years. The variety was Coker 100A.

Varieties were added or dropped from the variety experiments based on their lodging performance without regard to wilt-resistance or other characteristics that might make them suitable for the area.

Furrow vs. Sprinkler Irrigation Experiment

Auburn 56 cotton was grown in 1959 on Chesterfield sandy loam at the Agronomy Farm, Auburn, with plant populations of 30,000 per acre. Fertilizers at the rate of 300 pounds per acre each of N, P_2O_5, and K_2O were applied. Irrigation was supplied as needed by furrow or by sprinkler.

RESULTS and DISCUSSION

Yield

The Greenville sandy loam at Thorsby is an excellent soil for cotton. Yields for the 4-year period were exceptionally high even when no nitrogen or irrigation was applied, Table 2.

TABLE 2. EFFECT OF NITROGEN AND MOISTURE ON YIELD OF SEED COTTON ON GREENVILLE SANDY LOAM, THORSBY, ALABAMA, 1956-59[1]

Nitrogen applied, pounds per acre	Yield of seed cotton per acre		
	Not irrigated	Intermediate irrigation	High irrigation
	Lb.	*Lb.*	*Lb.*
1956			
0	1,728	2,495	2,463
60	1,940	3,636	3,448
120	1,868	3,839	3,687
240	1,905	4,136	4,927
1957			
0	2,101	2,198	2,213
60	2,688	3,299	3,322
120	2,615	4,052	3,967
240	2,602	4,010	5,073
1958			
0	2,606	2,745	2,987
120	3,941	3,966	4,395
240	3,771	4,461	4,805
360	3,506	4,304	5,336
1959			
0	2,171	3,480	3,222
120	2,246	4,335	4,181
240	2,151	4,405	4,313
360	2,168	4,331	4,400
480	----	----	4,221
720	----	----	4,302

[1] Coker 100A was the variety in 1956-57 and Deltapine 15 in 1958-59.

With no N added, irrigating at the intermediate moisture level increased yield an average of 578 pounds seed cotton for the 4 years. A further increase in moisture had no effect on yield.

These results show that the rate of N must be in proportion to the rate of moisture if profitable responses are to be obtained from high rates of either. For example, in 1956 and 1957 there was a yield response to only 60 pounds of N without irrigation, to 120 pounds of N with intermediate moisture, and to 240 pounds of N with the highest rate of moisture. Clearly, if maximum returns are to be realized from large amounts of fertilizer and moisture, they must be applied in conjunction with other good management practices.

An important characteristic of cotton grown with high rates of nitrogen and moisture is that a major portion of the crop matures late in the season, Figure 1. Much of the irrigated cotton matures after harvesting nonirrigated cotton. Boll weevils often migrate into irrigated cotton from surrounding nonirrigated fields when cotton has matured. Thus, two serious problems that are

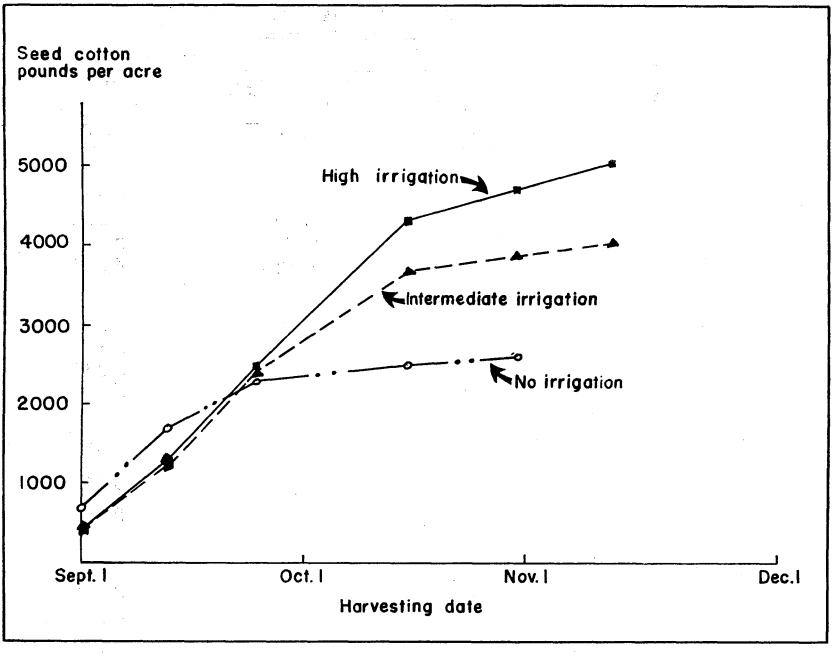

FIG. 1. Irrigated cotton that receives high rates of nitrogen matures later than does nonirrigated cotton, as shown here. Cumulative yields are shown for cotton that received 240 pounds N in 1957 at Foundation Seed Stocks Farm, Thorsby.

TABLE 3. EFFECT OF IRRIGATION AND NITROGEN ON THE YIELD OF EMPIRE COTTON ON DEWEY SILTY CLAY LOAM, TENNESSEE VALLEY SUBSTATION, BELLE MINA, ALABAMA, 1956-59

Nitrogen applied, pounds per acre	Yield of seed cotton per acre				
	1956	1957	1958	1959	Average
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Nonirrigated					
0	1,408	1,711	2,178	2,159	1,864
60	1,430	2,149	2,411	3,121	2,278
120	1,360	2,139	2,188	3,045	2,183
Irrigated					
0	2,064	2,110	2,324	2,382	2,220
60	3,094	3,004	2,178	3,073	2,837
120	3,274	3,559	2,139	3,267	3,060

intensified by irrigation are: (1) controlling boll weevils, and (2) harvesting losses resulting from unfavorable weather in the fall.

The maximum yields of about 5,000 pounds of seed cotton are the largest ever recorded in Alabama. They compare favorably with yields from any section of the United States. This illustrates that Alabama has a yield potential similar to that of other cotton growing areas.

The relationship between nitrogen and moisture is further illustrated by the results on Dewey silty clay soil, Table 3. There was a yield response to only the first 60 pounds of N without irrigation; however, the irrigated cotton responded to the second 60-pound increment of N. Yields of irrigated cotton at 0, 60, and 120 pounds of N per acre were 356, 559, and 877 pounds more

TABLE 4. YIELD OF SEED COTTON FROM FIVE VARIETIES GROWN UNDER IRRIGATION AT FIVE RATES OF NITROGEN, TALLASSEE, ALABAMA, 1958-59

Variety	Per acre yield of seed cotton, from five nitrogen rates					
	60 lb.	120 lb.	180 lb.	240 lb.	300 lb.	Average
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
1958						
Auburn 56	3,657	3,905	3,659	3,949	3,875	3,809
Plains	3,677	3,518	3,719	3,131	3,391	3,487
Coker 100A	3,357	3,837	3,797	3,713	3,133	3,567
Stoneville 7	3,588	3,986	3,432	3,781	3,725	3,702
Deltapine 15	3,324	3,485	3,317	3,560	3,011	3,339
1959						
Auburn 56	2,263	2,273	2,417	2,179	2,017	2,230
Plains	1,974	1,833	1,917	1,586	1,423	1,747
Coker 100A	2,065	1,871	1,722	1,640	1,527	1,765
Stoneville 7	2,202	1,985	1,811	1,720	1,630	1,870
Deltapine 15	2,066	2,320	1,952	1,697	1,469	1,901

than from the same levels of N without irrigation. Yields at this location were much lower than those obtained on the Greenville soil.

There was no response to nitrogen on the Independence loamy fine sand, Table 4. This river terrace soil supplied sufficient nitrogen to produce as much cotton as limiting production factors, such as boll weevil control, would permit. This relatively high native nitrogen level has been confirmed by other field experiments at Tallassee. The low yields in 1959 were caused by inadequate boll weevil control. Weevils were resistant to the chlorinated hydrocarbon insecticides being used and infestation reached 100 per cent before the resistance was discovered. Even with the application of insecticides to which the weevils were not re-

TABLE 5. EFFECT OF PLANTING DATE, TOPPING, AND BOTTOM DEFOLIATION ON YIELD AND BOLL SIZE OF COTTON, THORSBY, ALABAMA, 1956-59

Time of planting[1]	Treatment	Seed cotton yield per acre	Bolls per pound of seed cotton
		Lb.	*No.*
1956			
Early	Not topped	4,154	71
Early	Topped 48 inches	3,772	77
Early	Bottom defoliated	3,523	81
Late	Not topped	3,644	64
Late	Topped 48 inches	3,277	66
Late	Bottom defoliated	3,039	72
1957			
Early	Not topped	3,574	59
Early	Topped 42 inches	3,599	61
Early	Topped 48 inches	3,976	58
Early	Bottom defoliated	3,150	67
Late	Not topped	2,795	61
Late	Topped 42 inches	2,812	60
Late	Topped 48 inches	3,019	62
Late	Bottom defoliated	2,340	63
1958			
Early	Not topped	4,019	62
Early	Topped 42 inches	4,066	62
Early	Topped 48 inches	3,772	62
Early	Bottom defoliated	3,415	68
Late	Not topped	3,052	65
Late	Topped 42 inches	3,590	68
Late	Topped 48 inches	3,419	68
Late	Bottom defoliated	3,237	73
1959			
Early	Not topped	3,914	60
Early	Topped 42 inches	4,562	60
Early	Topped 48 inches	3,817	57

[1] Cotton planted 4/15/56 and 5/10/56; 4/16/57 and 5/22/57; 4/14/58 and 5/21/58; 4/14/59.

sistant, it was late in the season before they were under control. A total of 28 dustings or sprayings was applied during the season. This experiment indicates the necessity of keeping insects under control if high yields are to be obtained.

Cotton planted at the recommended date yielded more than plantings made about 1 month later, Table 5. In 3 years, the early-planted cotton averaged 752 pounds more seed cotton than the later planting. An explanation for the higher yield is that with adequate moisture, fertilization, and insect control the cotton produced fruit until frost. Thus, a 1-month delay reduced the amount of time available for fruit production.

Bottom defoliation with magnesium chlorate caused a 3-year average loss of 491 pounds of seed cotton. Immature bolls failed to mature after the defoliant was applied. This was probably the cause of the yield reduction.

Topping nearly eliminated lodging without causing a reduction in yield. In fact, in 1959 there was a large increase in yield from the 42-inch topping. This was the result of reduced boll rot.

Topping appears to be a sound practice, especially where cotton is to be machine picked. The uniform height without lodging should result in improved picker efficiency. Another advantage is that the machine operator can more easily see the rows, a difficult task in lodged cotton.

TABLE 6. YIELDS OF COTTON VARIETIES GROWN WITH IRRIGATION AND 300 POUNDS PER ACRE OF NITROGEN, THORSBY, ALABAMA, 1957-59

Variety	Yield of seed cotton per acre			
	1957	1958	1959	Average
	Lb.	*Lb.*	*Lb.*	*Lb.*
Auburn 56	4,142	----	3,338	3,740
Plains	4,270	3,941	3,614	3,942
Empire	4,334	3,903	3,919	4,052
Coker 100A	3,468	3,778	3,614	3,620
Stoneville 7	3,850	4,033	4,446	4,110
Deltapine 15	4,288	3,618	3,779	3,895
Stoneville 3202	4,210	----	----	----
Empire x Acala	4,273	----	----	----
Plains 491-2	3,781	----	----	----
Deltapine S.L.	3,622	----	----	----
Dixie King	3,564	----	----	----
All-in-One	3,404	----	----	----
Pope	2,880	----	----	----
Hi-bred	1,814	----	----	----
Rex	----	3,814	----	----
Acala 4-42	----	3,419	3,595	3,507
Acala 44	----	4,340	4,009	4,175

Several varieties of both wilt-resistant and wilt-susceptible types yield satisfactorily under irrigation and high fertility, Table 6. With a rate of 300 pounds per acre of N, yields in excess of 4,000 pounds of seed cotton were not unusual. However, differences of 1,000 pounds of seed cotton between varieties in a season were common. Such large differences between varieties are rarely observed under nonirrigated conditions.

The main reason for the superiority of Auburn 56 at Tallassee in 1959 was its rapid fruiting characteristics, Table 4. A small crop was made before the weevils destroyed nearly all the young fruit.

TABLE 7. EFFECT OF COTTON PLANT POPULATION ON YIELD, LINT PERCENTAGE, BOLL ROT, BOLL SIZE, MICRONAIRE, AND STAPLE LENGTH, AUBURN AND TALLASSEE, ALABAMA, 1959[1]

Plants per acre, no.	Nitrogen applied, lb. per acre	Yield per acre	Lint	Seed cotton loss from boll rot per acre	Lodged plants	Bolls per lb. seed cotton	Micronaire	Staple length in 32nds in.
		Lb.	*Pct.*	*Lb.*	*Pct.*	*No.*		*No.*
Auburn								
30,000	300	3,424	39.1	164	2	66	4.4	34
10,000	300	3,493	39.3	99	6	63	4.5	34
5,000	300	3,159	38.4	187	34	60	4.5	34
Tallassee								
30,000	120	2,860	35.2	495	6	70	4.1	35
	300	2,523	35.4	500	15	73	4.6	35
10,000	120	3,035	36.3	694	2	68	4.6	35
	300	2,472	36.8	1,163	11	65	4.3	35
5,000	120	2,803	36.5	646	6	70	4.5	35
	300	2,396	37.0	535	36	67	4.6	35

[1] Cotton variety—Auburn 56.

TABLE 8. EFFECT OF FURROW VS. SPRINKLER IRRIGATION ON YIELD OF SEED COTTON, LINT PERCENTAGE, BOLL ROT, LODGED PLANTS, BOLL SIZE, MICRONAIRE, AND STAPLE LENGTH, CHESTERFIELD SANDY LOAM SOIL, AUBURN, ALABAMA, 1959

Method of irrigation	Yield seed cotton per acre	Lint	Seed cotton loss from boll rot per acre	Lodged plants	Bolls per pound seed cotton	Micronaire	Staple length in 32nds in.
	Lb.	*Pct.*	*Lb.*	*Pct.*	*No.*		*No.*
Furrow	3,474	37.6	181	2.1	66	4.4	34
Sprinkler	3,571	37.7	207	2.2	66	4.4	34
None	1,615	37.1	3	0	76	4.1	34

A single year's results of spacing experiments on Chesterfield sandy loam and Independence loamy fine sand indicate that the 10,000 and 30,000 plant populations may give slightly higher yields than 5,000 plants per acre, Table 7.

One year's results on Chesterfield sandy loam soil at Auburn showed no difference in yield when furrow was compared with sprinkler irrigation, Table 8.

Lodging and Boll Rot

Boll rot usually increases in direct proportion to the amounts of nitrogen and moisture added, Tables 7 and 9. These, however, are not a direct cause of the boll rot. Large amounts of nitrogen and moisture used together cause rank growth, which provides conditions generally favorable for growth of boll rot organisms. However, boll rot does not invariably result from rank growth. For example, rank growth always resulted from high rates of nitrogen and moisture, but in 1958 boll rot was much less severe than in other years, Table 9.

TABLE 9. EFFECT OF NITROGEN AND MOISTURE ON BOLL ROT, THORSBY, ALABAMA, 1956-59

Nitrogen applied, pounds per acre	Seed cotton loss from boll rot, per acre		
	Not irrigated	Intermediate irrigation	High irrigation
	Lb.	*Lb.*	*Lb.*
1956			
0	2	33	48
60	2	127	152
120	4	262	247
240	26	361	545
1957			
0	0	10	2
60	29	29	55
120	28	87	118
240	90	187	306
1958			
0	8	7	7
120	40	57	83
240	78	100	93
360	91	93	124
1959			
0	0	34	14
120	0	385	771
240	0	654	954
360	0	679	1,130
480	----	----	1,209
720		----	1,300

TABLE 10. BOLL ROT, LODGING, AND PLANT HEIGHTS OF COTTON GROWN UNDER IRRIGATION AND 300 POUNDS OF NITROGEN, THORSBY, ALABAMA, 1957-59

Variety	Loss of seed cotton from boll rot, per acre				Degree of lodging			Plant height at frost			
	1957	1958	1959	Av.	1957	1958	1959	1957	1958	1959	Av.
	Lb.	*Lb.*	*Lb.*	*Lb.*				*In.*	*In.*	*In.*	*In.*
Auburn 56	1,024	----	1,778	1,401	Med.	----	High	57	----	73	65
Plains	751	694	2,180	1,208	High	High	High	60	68	72	67
Empire	575	261	1,431	756	Med.	Med.	Med.	58	70	69	66
Coker 100A	1,094	443	1,629	1,055	High	High	High	57	72	70	66
Stoneville 7	601	187	1,108	632	Low	Low	Low	65	72	72	70
Deltapine 15	274	436	1,248	653	Low	Low	Low	62	70	73	68
Stoneville 3202	368	----	----	----	Low	----	----	55	----	----	----
Empire x Acala	568	----	----	----	Med.	----	----	59	----	----	----
Plains 491-2	1,117	----	----	----	High	----	----	62	----	----	----
Deltapine S.L.	429	----	----	----	Low	----	----	60	----	----	----
Dixie King	1,255	----	----	----	High	----	----	57	----	----	----
All-in-One	1,161	----	----	----	High	----	----	56	----	----	----
Pope	1,191	----	----	----	High	----	----	52	----	----	----
Hi-bred	1,044	----	----	----	High	----	----	54	----	----	----
Rex	----	379	----	----	----	High	----	----	64	----	----
Acala 4-42	----	513	1,139	826	----	Low	Low	----	76	74	75
Acala 44	----	77	1,247	662	----	Low	Low	----	78	78	78

Varieties differed drastically in lodging and in losses from boll rot, Tables 10, 11, 12. Lodging varied from almost complete lodging to none. The least lodging was exhibited by Stoneville 7, Deltapine 15, Smooth Leaf Deltapine, Acala 4-42, and Acala 44. These varieties are not wilt-resistant and should not be planted on wilt-infested soil. Auburn 56 and Empire lodged less than any of the other wilt-resistant varieties. Although tendency to lodge is a varietal characteristic, lodging of a given variety may

TABLE 11. LODGING OF FIVE COTTON VARIETIES GROWN UNDER IRRIGATION AT FIVE RATES OF NITROGEN, TALLASSEE, ALABAMA, 1958-59

Variety	Lodging percentage from five nitrogen rates per acre					
	60 lb.	120 lb.	180 lb.	240 lb.	300 lb.	Av.
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
1958						
Auburn 56	0	16	21	30	46	23
Plains	3	25	30	66	56	36
Coker 100A	19	21	54	53	83	46
Stoneville 7	0	1	5	0	8	3
Deltapine 15	0	11	35	14	19	16
1959						
Auburn 56	0	7	2	6	12	5
Plains	0	11	14	22	17	13
Coker 100A	1	6	21	51	37	23
Stoneville 7	0	1	5	6	2	3
Deltapine 15	4	4	17	22	11	12

TABLE 12. SEED COTTON LOSS FROM BOLL ROT, TALLASSEE, ALABAMA, 1958-59

Variety	Per acre seed cotton loss from boll rot, five nitrogen rates					
	60 lb.	120 lb.	180 lb.	240 lb.	300 lb.	Av.
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
1958						
Auburn 56	220	458	552	641	718	518
Plains	214	587	648	902	665	603
Coker 100A	270	315	545	524	778	486
Stoneville 7	164	370	518	399	452	381
Deltapine 15	80	255	273	290	260	232
1959						
Auburn 56	197	456	495	522	616	457
Plains	241	554	396	536	832	512
Coker 100A	347	561	763	700	723	619
Stoneville 7	176	416	630	728	734	537
Deltapine 15	238	497	384	525	338	396

vary considerably depending on weather, soil type, and geographical location. For example, Auburn 56 lodged 46 per cent with 300 pounds of N at Tallassee in 1958, whereas with the same treatment at Auburn in the same year there was only 1 per cent lodging. Difference in lodging between varieties is illustrated in Figure 2.

There was no clear general relationship between lodging and boll rot. In some years the greatest amount of boll rot occurred on the most severely lodged cotton. However, in other years lodging and boll rot were not related. Apparently, weather and other conditions have more effect on the growth of boll rot organisms than does lodging. Even without lodging growth may be so rank as to present conditions favorable for boll rot similar to that in lodged cotton.

Widely spaced plants lodged more than thicker plantings, Table 7. At Auburn on plant spacings of 30, 15, and 5 inches, lodging was 34, 6, and 2 per cent. Cotton branches on the thicker spacings intermingled, thus tending to support each other.

High rates of nitrogen should not be used unless lodging is controlled by variety selection or topping. Experience indicates that a given rate of N usually causes less lodging on sandy upland soils than on finer textured bottom land.

There was no difference in boll rot or lodging when sprinkler irrigation was compared to furrow irrigation, Table 8.

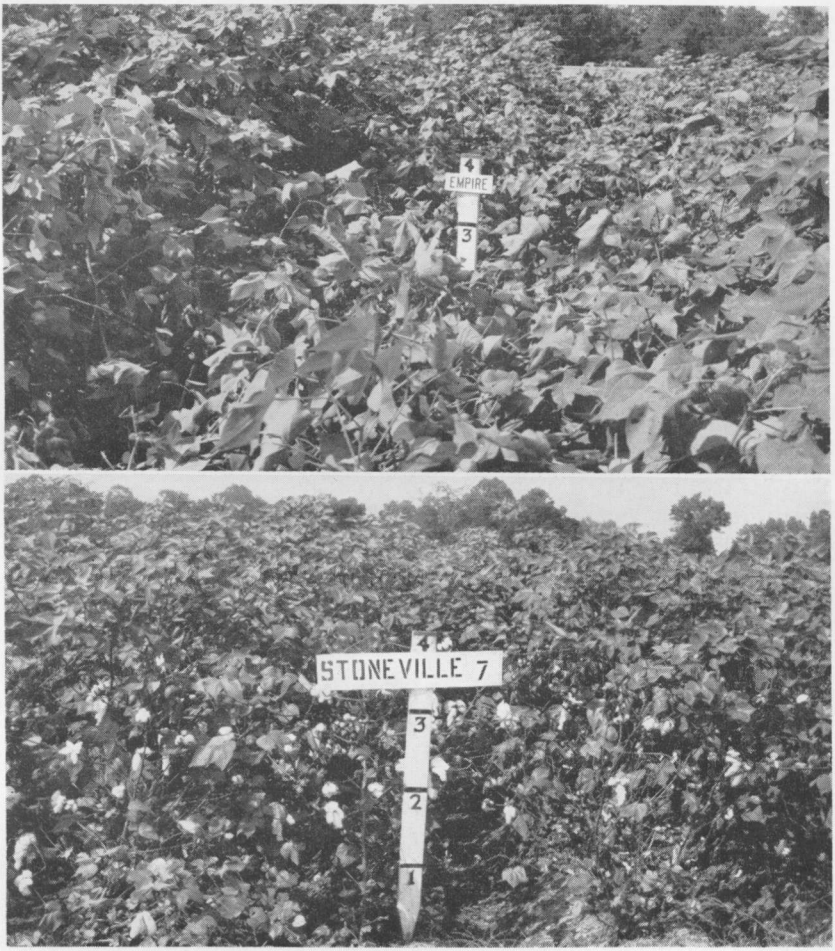

FIG. 2. Effect of variety on lodging is shown above. Empire variety (top) had severe lodging, whereas Stoneville 7 grown under same conditions did not lodge.

Boll Size

Nitrogen had a marked effect in reducing the number of bolls required to produce a pound of seed cotton under irrigated management, but had no effect when moisture was limiting, Table 13. Both levels of irrigation produced about the same size bolls. Much of the increase in boll weights is the result of larger seed. Thus, the lint percentage is lowered.

There was no yield response to nitrogen on the Independence

TABLE 13. EFFECT OF NITROGEN AND MOISTURE ON LINT PERCENTAGE AND BOLL WEIGHTS, THORSBY, ALABAMA, 1956-59[1]

Nitrogen applied, lb. per acre	Lint percentage			Bolls per pound of seed cotton		
	Not irrigated	Intermediate irrigation	High irrigation	Not irrigated	Intermediate irrigation	High irrigation
	Pct.	*Pct.*	*Pct.*	*No.*	*No.*	*No.*
1956						
0	39.6	38.0	39.7	83	96	94
60	38.0	38.1	37.6	86	85	76
120	38.6	37.9	37.3	84	72	75
240	38.1	37.0	36.0	87	67	69
1957						
0	39.3	38.1	38.8	93	82	81
60	38.2	38.1	37.7	77	71	75
120	38.4	36.6	36.7	76	66	69
240	37.1	36.4	35.9	72	64	61
1958						
0	40.4	39.7	40.4	78	84	81
120	38.7	38.5	38.5	81	80	79
240	37.9	37.7	38.1	78	78	77
360	37.9	38.3	37.9	79	77	74
1959						
0	40.2	40.9	40.0	90	95	90
120	38.8	39.4	38.7	89	75	70
240	38.1	39.0	38.7	97	72	71
360	38.6	39.0	38.5	93	70	74
480	----	----	38.4	----	----	69
720	----	----	38.8	----	----	69

[1] Coker 100A was the variety in 1956-57, Deltapine 15 in 1958-59.

soil and likewise no effect of nitrogen on boll sizes, Table 14. Boll size differs widely with varieties under irrigation, Tables 14, 15. This has also been observed under nonirrigated conditions.

Boll size was not affected by topping, but was reduced by bottom defoliation, Table 5. Since the defoliant prevented some bolls from reaching maturity, average boll size was reduced.

Plant Height

Even with ample moisture and fertilizer, there were differences of a foot or more in height from one season to the next with a given variety, Table 10. The Acala varieties were the tallest varieties grown. Auburn 56 variety reached a height of only 50 inches even with irrigation and 300 pounds of N on the Chesterfield soil at Auburn, whereas similar treatments on the Independence soil at Tallassee produced plants 65 inches tall.

TABLE 14. EFFECT OF VARIETY AND NITROGEN ON LINT PERCENTAGE, BOLL SIZE, MICRONAIRE, AND STAPLE LENGTH, TALLASSEE, ALABAMA, 1958-59

Variety	Nitrogen applied, lb. per acre	Lint percentage			Bolls per lb. of seed cotton			Micronaire			Staple length in 32nds inch		
		1958	1959	Av.	1958	1959	Av.	1958	1959	Av.	1958	1959	Av.
		Pct.	*Pct.*	*Pct.*	*No.*	*No.*	*No.*				*No.*	*No.*	*No.*
Auburn 56	60	37.6	37.1	37.4	72	71	72	4.1	4.6	4.4	33	35	34
	120	36.6	36.7	36.7	70	77	74	3.7	4.8	4.3	33	35	34
	180	36.4	35.8	36.1	73	74	74	3.8	4.7	4.3	33	35	34
	240	36.8	37.3	37.1	70	82	76	3.9	4.6	4.3	33	35	34
	300	36.2	35.8	36.0	74	79	77	3.7	4.7	4.2	33	35	34
Plains	60	37.8	38.0	37.9	64	74	69	3.9	4.6	4.3	33	35	34
	120	36.8	37.4	37.1	65	77	71	3.8	4.5	4.2	33	35	34
	180	36.9	35.3	36.1	63	80	72	3.4	4.3	3.9	33	35	34
	240	36.6	36.1	36.4	71	77	74	3.7	4.3	4.0	33	35	34
	300	36.3	36.7	36.5	65	83	74	3.5	4.2	3.9	33	35	34
Coker 100A	60	38.0	38.4	38.2	73	80	77	3.9	4.3	4.1	34	35	35
	120	38.5	36.9	37.7	73	76	75	3.9	4.6	4.3	33	35	34
	180	37.2	36.3	36.8	68	74	71	3.8	4.3	4.1	33	35	34
	240	39.0	37.2	38.1	68	79	74	3.8	4.0	3.9	33	35	34
	300	36.1	36.9	36.5	70	73	72	3.7	4.6	4.2	33	35	34
Stoneville 7	60	39.2	38.3	38.8	75	82	79	3.9	4.5	4.2	33	35	34
	120	39.4	38.3	38.9	71	80	76	3.9	4.7	4.3	33	35	34
	180	38.6	38.0	38.3	72	90	81	3.6	4.4	4.0	33	35	34
	240	39.3	38.6	39.0	75	80	78	3.7	4.5	4.1	33	36	35
	300	39.4	39.0	39.2	76	77	77	3.9	4.5	4.2	33	35	34
Deltapine 15	60	40.4	39.6	40.0	75	83	79	3.9	4.7	4.3	33	35	34
	120	39.2	38.6	38.9	76	73	75	3.6	4.9	4.3	34	36	35
	180	39.6	37.7	38.7	78	79	79	3.6	4.9	4.3	33	35	34
	240	39.8	37.0	38.4	74	85	80	3.7	4.3	4.0	33	34	34
	300	40.0	38.9	39.5	80	92	86	3.5	5.0	4.3	33	34	34

Cotton planted a month late was more vegetative in the fall than cotton planted at the recommended time. The late cotton was always as tall or taller at frost than the early cotton.

Picking all the fruit of Coker 100A to simulate complete loss of fruit to insects had no effect on plant height until after August 1. Defruited plants in 1957 reached heights of 68 and 73 inches at frost for the early and late planted cottons at Thorsby. Corresponding heights without fruit picking were 51 and 54 inches. Similarly, all the varieties listed in Table 6 for 1957 were defruited. All reached heights about 1 foot taller than the normal plants. This may not be an accurate measure of the effect on plant size when insects destroy the fruit, because hand picking the fruit may have had some dwarfing effect.

There was no evidence of lodging with any of the varieties

TABLE 15. LINT PERCENTAGES AND BOLL SIZES OF COTTON GROWN WITH IRRIGATION AND 300 POUNDS OF NITROGEN, THORSBY, ALABAMA, 1957-59

Variety	Lint percentage				Bolls per pound of seed cotton			
	1957	1958	1959	Av.	1957	1958	1959	Av.
	Pct.	*Pct.*	*Pct.*	*Pct.*	*No.*	*No.*	*No.*	*No.*
Auburn 56	36.6	----	35.3	36.0	61	----	65	63
Plains	37.6	36.1	36.5	36.7	59	64	65	63
Empire	36.8	35.2	36.0	36.0	49	56	54	53
Coker 100A	36.6	35.7	36.6	36.3	63	66	67	65
Stoneville 7	37.6	38.5	38.8	38.3	68	----	74	71
Deltapine 15	39.2	39.0	38.0	38.7	72	79	72	74
Stoneville 3202	38.7	----	----	----	69	----	----	----
Empire x Acala	35.5	----	----	----	50	----	----	----
Plains 491-2	38.3	----	----	----	57	----	----	----
Deltapine S.L.	38.4	----	----	----	73	----	----	----
Dixie King	37.6	----	----	----	52	----	----	----
All-in-One	35.2	----	----	----	55	----	----	----
Pope	39.2	----	----	----	68	----	----	----
Hi-bred	39.4	----	----	----	54	----	----	----
Rex	----	36.0	----	----	----	62	----	----
Acala 4-42	----	37.1	37.6	37.4	----	56	54	55
Acala 44	----	38.2	37.4	37.8	----	54	52	53

where the fruit was removed. This indicates that weight of green bolls causes plants to lodge. After the bolls open, plants tend to straighten upright unless they are so severely lodged that they become matted.

Lint Percentage

Nitrogen caused a decrease in the lint percentage, Table 13, because of an increase in seed size. With ample moisture this effect on lint percentage was most evident when yield responses from nitrogen were obtained.

All varieties had satisfactory lint percentages, even with exceptionally high rates of N, Tables 14, 15. Stoneville 7 and Deltapine 15 had the highest lint percentages, but bolls were small. The Acala varieties, on the other hand, had intermediate lint percentages but extremely large bolls. Empire also had a low lint percentage but produced large bolls.

Spacing had no effect on lint percentage, Table 7.

Micronaire

Micronaire measures a factor related to both fiber fineness (diameter of the fiber) and maturity (degree of filling of the fiber). Thus, it is a mathematical figure that is influenced by both fineness and maturity. It is one of the most widely used measures of the milling properties of cotton.

TABLE 16. EFFECT OF NITROGEN AND MOISTURE ON MICRONAIRE AND FIBER LENGTH OF COTTON, THORSBY, ALABAMA, 1956-59[1]

Nitrogen applied, lb. per acre.	Micronaire			Fiber length (upper-half mean)		
	Not irrigated	Intermediate irrigation	High irrigation	Not irrigated	Intermediate irrigation	High irrigation
				In.	*In.*	*In.*
1956						
0	3.9	3.5	3.1	1.13	1.10	1.11
60	3.7	3.7	3.3	1.10	1.13	1.19
120	3.8	3.6	3.3	1.11	1.16	1.18
240	3.6	3.6	3.5	1.12	1.16	1.19
1957						
0	3.9	4.4	4.2	1.06	1.07	1.09
60	4.2	4.3	4.2	1.07	1.13	1.13
120	3.9	4.3	4.1	1.12	1.14	1.16
240	3.7	4.1	4.1	1.10	1.16	1.15
1958						
0	3.5	3.5	3.7	1.06	1.08	1.09
120	3.3	3.3	3.4	1.10	1.09	1.10
240	3.2	3.4	3.2	1.08	1.10	1.12
360	3.2	3.5	3.3	1.08	1.08	1.09
1959						
0	3.6	3.8	3.8	1.01	1.08	1.06
120	3.5	3.6	3.9	.99	1.02	1.07
240	3.8	3.7	3.8	1.01	1.01	1.08
360	3.8	3.7	3.8	1.01	1.04	1.08
480	--	--	3.7	----	----	1.06
720	-		3.6	----	----	1.08

[1] Coker 100A was variety in 1956-57; DPL 15 in 1958-59.

Fiber analyses for the experiments were made by the Fiber Testing Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Knoxville, Tennessee. Micronaire values varied with season, location, and variety, Tables 7, 14, 16. Neither nitrogen nor spacing had an effect on micronaire. The effect of irrigation on micronaire depended on the season. When dry weather occurs during the fiber maturation period, fibers fail to mature, which results in low micronaire values. Under such conditions irrigation will produce cotton with more mature fibers. If moisture is adequate to cause the fibers to mature, irrigation will cause no change in micronaire even though yield may be increased considerably.

Staple Length

The upper half mean length is a measurement made on a machine called a fibrograph. This measurement corresponds closely

to the length of staple as measured by commercial cotton classers.

There was usually a slight increase in fiber length with increasing rates of nitrogen on the Greenville soil, Table 16. On the Independence soil at Tallassee where no yield response was obtained from added N, there was no effect of rates of N on fiber length, Tables 7, 14.

Other Fiber Properties

Other fiber properties measured were strength and elongation. There was no effect of nitrogen, moisture, or plant spacing on these fiber properties.

Seed Germination

Germination percentage was highest with seed produced at the lowest rate of nitrogen at Tallassee in 1958, Table 17. Although this was apparent in all five pickings, it was most prominent in the first picking where there was a reduction of 7.3 per cent as the rate of N was increased from 60 to 120 pounds per acre. The cause of this effect observed in this 1 year's results is not known.

TABLE 17. GERMINATION OF SEED FROM FIVE VARIETIES OF COTTON GROWN WITH FIVE RATES OF NITROGEN, TALLASSEE, ALABAMA, 1958

Variety	Seed germination from five nitrogen rates					
	60 lb.	120 lb.	180 lb.	240 lb.	300 lb.	Average
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Auburn 56	85	77	80	81	77	80
Plains	83	79	73	78	72	77
Coker 100A	83	81	78	82	79	81
Stoneville 7	82	81	72	77	79	78
Deltapine 15	76	72	74	79	73	75
Average	82	78	75	79	76	78

SUMMARY and CONCLUSIONS

1. Yields in excess of 5,000 pounds of seed cotton per acre were produced in the State when adequate moisture and fertilization were combined with other good management practices. Although this illustrates the potential for cotton yields, such production is not necessarily practical farm goals at present.

2. Cotton has shown yield responses to nitrogen rates as high as 360 pounds of N per acre. However, with present varieties

and insect control, about 120 pounds of N is a more practical rate for irrigated cotton.

3. To obtain yield responses from high rates of nitrogen or high rates of moisture, both must be used with other good management practices.

4. Topping cotton to a height of 42 to 48 inches controlled lodging and did not reduce yields.

5. Defoliation of the lower 2 feet of plants with magnesium chlorate when three-fourths of the bolls were of mature size reduced the 3-year average yield by 491 pounds of seed cotton per acre.

6. Planting 1 month later than the recommended date reduced the 3-year average yield by 752 pounds of seed cotton per acre.

7. Cotton with plant populations of 30,000 and 10,000 lodged less than populations of 5,000 plants per acre.

8. With high rates of nitrogen and moisture, serious lodging problems were often encountered.

9. There were marked differences in lodging among cotton varieties when grown with high rates of nitrogen and moisture. Some varieties lodged almost completely, whereas others practically none when 300 pounds of N per acre was applied.

10. No lodging was observed with any of the varieties tested when all fruit was removed from the plants.

11. The severity of boll rot was dependent upon the kind of season as well as the amount of rank growth and lodging.

12. Even with the same nitrogen and moisture rates, some varieties differ a foot or more in plant height from season to season.

13. Nitrogen decreased the lint percentage, but increased boll weights and seed weights, and had no effect on micronaire values.

14. Irrigation increased the fiber length and had a variable effect on micronaire depending on the season.

LITERATURE CITED

(1) BENNETT, O. L., SCARSBROOK, C. E., DOSS, B. D., AND PEARSON, R. W. Interrelations of Nitrogen Fertilization and Irrigation of Cotton. International Congress of Soil Science Proc. (In Press).

(2) HAMILTON, J., STANBERRY, C. O., AND WOOTON, W. H. Cotton Growth and Production as Affected by Moisture, Nitrogen, and Plant Spacing on the Yuma Mesa. Soil Sci. Soc. Amer. Proc. 20:246-252. 1956.

(3) SCARSBROOK, C. E., BENNETT, O. L., AND PEARSON, R. W. The Interaction of Nitrogen and Moisture on Cotton Yields and Other Characteristics. Agron. Jour. 51:718-721. 1959.

(4) SPOONER, A. E., BROWN, D. A., AND WADDLE, B. A. Effects of Irrigation on Cotton Fiber Properties. Ark. Agr. Expt. Sta. Bul. 601. 1958.

(5) STURKIE, D. G. Effects of Some Environmental Factors on the Seed and Lint of Cotton. Ala. Agr. Expt. Sta. Bul. 263. 1947.

(6) WADLEIGH, CECIL H. Growth Status of the Cotton Plant as Influenced by the Supply of Nitrogen. Ark. Agr. Expt. Sta. Bul. 446. 1944.

ACKNOWLEDGMENT

The authors acknowledge the assistance of J. K. Boseck, superintendent of the Tennessee Valley Substation, and J. W. Langford, superintendent of the Plant Breeding Unit, in carrying out the cotton irrigation experiments reported in this publication.