MP-470
NOVEMBER 1960

Moisture - Fertility

RELATIONS OF COTTON at College Station, 1957-59

A PART OF THE TEXAS A&M COLLEGE SYSTEM

THE AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
TEXAS AGRICULTURAL EXPERIMENT STATION
R. D. LEWIS, DIRECTOR, COLLEGE STATION, TEXAS

Summary

The data obtained on cotton grown on Norwood silty clay loam in the Brazos River Valley near College Station indicated a favorable response to both nitrogen and irrigation when a proper balance between these factors was maintained. Production ranged from a low of 480 to a high of 1,090 pounds of lint per acre. Excessive nitrogen in 1958, combined with the large amount of late season rain, produced the lowest amount of lint, while 160 pounds of nitrogen under the high moisture treatment produced 1,090 pounds of lint in 1959. Maximum production in 1959 increased from 990 to 1,090 pounds when the moisture level was increased from the lowest level to the highest. These tests show that the minimum level of irrigation gave satisfactory results with the proper fertility balance. The low moisture level, 15 percent available moisture (A.M.), produced as much or more lint as the medium level, 35 percent A.M., under all fertility ranges.

Based on these results, 80 pounds of nitrogen applied at or before planting is recommended. Using a small amount of phosphoric acid (20 to 40 pounds per acre) with or near the seed acts as a balancing medium for earlier maturity of the cotton. Early planted cotton could respond to an application of an additional 40 to 80 pounds of nitrogen as a sidedressing. This sidedressing should not be applied after May 15. The final water should be applied about August 1 and not later than August 15, since late irrigation tends to delay maturity, thereby increasing the hazard of damaged lint by early fall rains.

Contents

Moisture-Fertility Relations of Cotton at College Station, 1957-59

C. M. HOHN, F. L. FISHER and A. G. CALDWELL*

A COTTON PRODUCTION STUDY was conducted jointly by the Departments of Agricultural Engineering and Agronomy during 1957-59 to determine the effects of moisture and fertility differentials and their interactions on lint production. This study was conducted on the A&M Plantation near College Station, on a Norwood silty clay loam, a typical Brazos River Valley soil.

The test design was a restricted randomized block with five replications. Three moisture levels were maintained with 12 different levels of soil fertility within each moisture level.

Procedure

Three ranges of moisture were maintained throughout the growing period, beginning with all plots at maximum water-holding capacity or field capacity at the start of the season. The ranges were:

Low moisture. Irrigated when 85 percent of the available moisture (A.M.) in the upper 30 inches of soil had been depleted by the plants except in 1957 when 80 percent A.M. was depleted;

Medium moisture. Irrigated when 65 percent A.M. had been depleted by the plants except in 1957 when 60 percent A.M. was depleted; and

High moisture. Irrigated when 40 percent A.M. had been depleted by the plants.

The change in the low and medium moisture levels was made after 1 year's work to make the test levels compare with similar work being done under a southern regional project which involved other states.

*Respectively, assistant professor, Department of Agricultural Engineering, and associate professors, Department of Agronomy.

TABLE 1. FERTILITY TREATMENTS APPLIED ANNUALLY

Pounds of nutrients per acre		
N	P_2O_5	K_2O
0	0	0
0	40	0
40	0	0
40	40	0
80	0	0
80	40	0
80	80	0
80	80	120
160	80	120
160	120	120
240	80	120
320	120	120

Soil samples from the upper 30 inches were taken regularly in 6-inch increments with a soil auger. These samples were weighed, dried and the percent moisture on an oven-dry basis was calculated. When these soil moisture percentages indicated a need for irrigation, enough water was applied to bring the 30-inch root zone to field capacity.

Water was applied to each plot through flexible butyl rubber pipe with individual furrow outlet sleeves. The amount of water applied was measured carefully with a water meter installed in the pipeline near the pump.

Each of three moisture levels contained 12 different fertility treatments. These treatments consisted of various amounts of nitrogen, phosphoric acid and potash as shown in Table 1. All of the phosphoric acid and potash and half of the nitrogen was applied at planting time in bands below and to the side of the seed. The remaining nitrogen was applied as a sidedressing when the first squares began to form.

TABLE 2. AMOUNT OF RAINFALL AND IRRIGATION APPLIED TO THE COTTON DURING THE GROWING SEASON

Year	Moisture level, inches			Rainfall inches
	Low	Medium	High	
1957	9.5 (3)[1]	12.6 (4)	11.8 (5)	18.5
1958	5.2 (1)	7.9 (2)	7.0 (3)	22.9
1959	5.2 (1)	7.6 (2)	8.3 (3)	18.1

[1]The numbers in parenthesis refer to the number of irrigations.

Deltapine TPSA Regular, a locally adapted cotton variety, was used for this study. It was planted in 40-inch rows with a plant population of 70,000 to 100,000 plants per acre.

The amount of irrigation water applied to each moisture level during the 3-year study, as well as the moisture through rainfall, is shown in Table 2.

TABLE 3. INFLUENCE OF PHOSPHORIC ACID AND POTASH APPLICATIONS ON YIELD AND PERCENTAGE OF LINT FROM COTTON GROWN ON A NORWOOD SILTY CLAY LOAM IN THE BRAZOS RIVER VALLEY, 1957-59

Pounds of nutrients per acre per year			Pounds of lint cotton per acre per year	Percentage of lint
N	P_2O_5	K_2O		
80	0	0	830	36.4
80	40	0	840	36.4
80	80	0	840	36.0
80	80	80	850	36.1

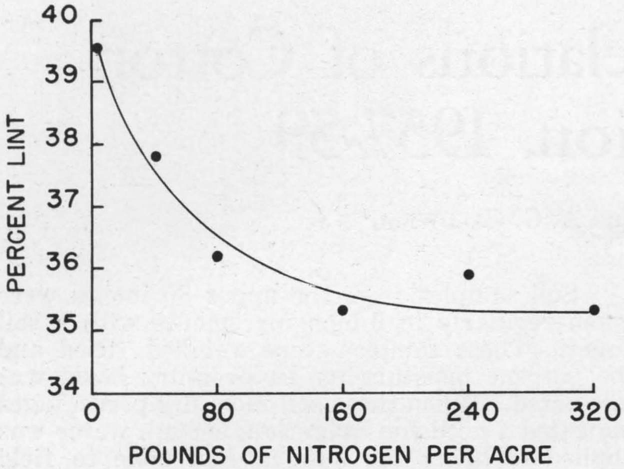

Figure 1. The influence of nitrogen on the lint percentage in cotton.

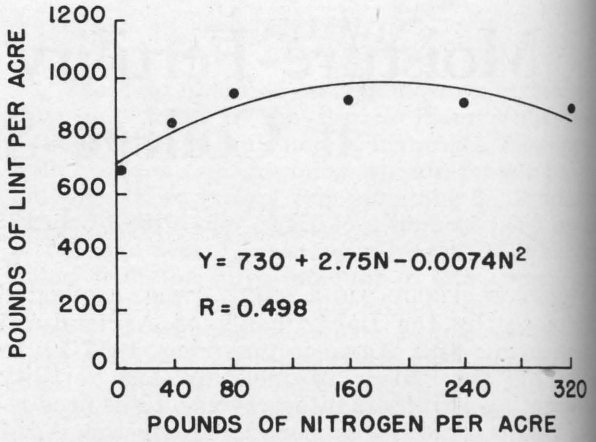

Figure 3. The influence of nitrogen on the yield of lint cotton under medium irrigation level (40 percent available moisture and above).

Results

The data obtained on cotton production during the 3 years of this study indicated two response patterns. Cotton responded to both nitrogen and moisture levels in 1957 and 1959, with approximately 18 inches of rainfall. However, response to these factors was small or completely absent in 1958. The climatic conditions during 1958 were poor for cotton production, starting with a cool, wet spring, followed by wet, cool conditions in late August and September. Insect control was difficult and on some plots the cotton did not mature properly before the cold weather stopped its growth. Some of the higher fertility plots had plants with five to eight immature bolls when the final harvest was made, while other bolls had rotted earlier. The data obtained (Table 3) show that phosphoric acid and potash applications did not influence either lint percentage or lint production which confirms earlier research (4). There was a tendency toward earlier cotton maturation when nitrogen and phosphoric acid were applied together, although phosphoric acid did not influence the total lint production. For example, in 1958 when maturity was delayed by cool, wet growing conditions, 40 pounds of phosphoric acid with nitrogen increased harvested lint by about 50 pounds per acre. This increase was due primarily to earlier maturity.

Nitrogen produced the greatest increase in cotton yield, but for best production, nitrogen and moisture had to be kept in balance. The data in Figure 1 indicates that the lint percentage of the cotton was reduced as the application rate of nitrogen was increased. The exact cause of this reduction in lint percentage was not determined, but it is felt that the extra nitrogen delayed maturity which would increase the percentage of immature fibers. In spite of this reduction in lint percentage, the total amount of lint produced was increased by the use of nitrogen. The data shown in Figures 2, 3 and 4 indicate that moisture control is important if maximum benefit is to be obtained from nitrogen fertilizer. A study of the test data indicates that the time to apply irrigation water is important and that

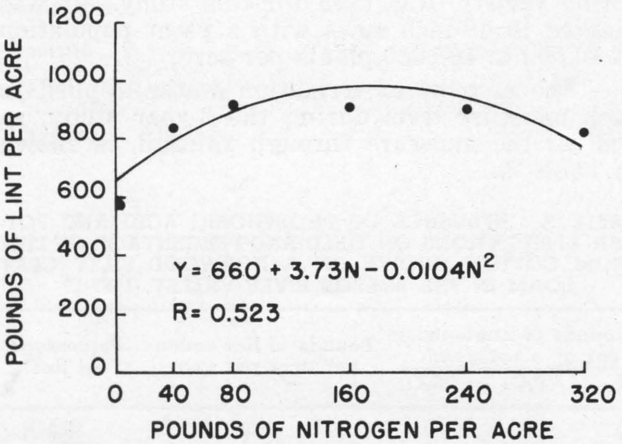

Figure 2. The influence of nitrogen on the yield of lint cotton under a low irrigation level (15 percent available moisture and above).

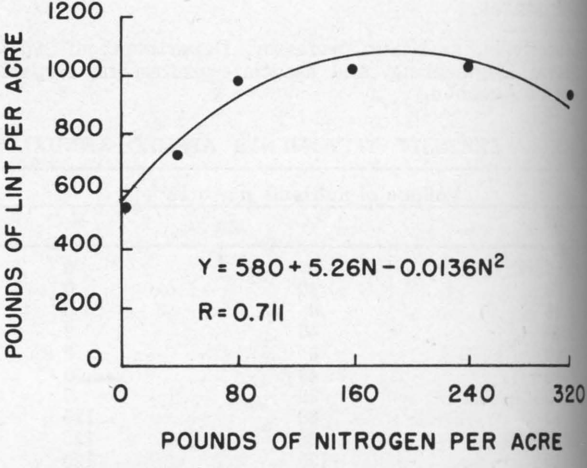

Figure 4. The influence of nitrogen on the yield of lint cotton under a high irrigation level (60 percent available moisture and above).

Figure 5. Cotton which received high moisture and high fertility treatments at harvest (October 26, 1959). Two pickings and three defoliations were made before this photograph was taken. This cotton netted $59.57 per acre. (See Table 4.)

Figure 6. Cotton which received medium moisture and medium fertility treatments. Two pickings and two defoliations were made before this photograph was taken. This cotton netted $40.51 per acre. (See Table 4.)

the improper use of irrigation can reduce lint production. For example, the maximum lint yield under the lowest moisture level was 990 pounds compared with only 980 for the medium moisture level, while the highest moisture level produced a maximum yield of 1,090 pounds. These same moisture levels produced 580, 690 and 530 pounds of lint when no nitrogen was applied with the supplemental irrigation. When neither nitrogen nor irrigation was used, lint production was 470 pounds, while well-fertilized but nonirrigated cotton produced an annual average of 660 pounds of lint during these same 3 years. These data show that lint production was increased 330, 320 and 430 pounds by using low, medium and high irrigation treatments, respectively.

Since it is physically impossible to test the fertilizer application at a continuously increasing rate, a limited number of rates were selected from no application to a rate high enough to cause a cotton production drop. Mathematically, these points can be used to obtain an equation that will describe this response as a continuous function. Various mathematical functions have been used to describe the response of crops to fertilizer application (1, 2). One of the easiest functions to work with and one that generally has given the best description of a crop response to nitrogen is the quadratic equation: $Y = a + bx + cx^2$ (3) where Y = pounds of lint per acre and X = pounds of nitrogen per acre. The equations obtained relating lint production to nitrogen under each moisture level are shown in Figures 2, 3 and 4 and the line drawn on each figure is the line of the equation which best expresses the data. These equations predict the maximum yields discussed earlier and the amount of nitrogen fertilizer required to obtain these maximum yields. They were 180, 185 and 195 pounds per acre, per year, for the low, medium and high moisture treatments, respectively. The maximum economical cotton yield can be calculated using these equations for any given cost-price condition. Assuming that nitrogen cost $0.12 per pound and that other costs are equal to those in Table 4 and

TABLE 4. COSTS AND RETURNS OF COTTON PRODUCTION, 1957-59

Item	Moisture levels		
	Low	Medium	High
Yield (fertilized and irrigated) in lb. of lint per acre	844	820	923
Yield (nonfertilized and nonirrigated) in lb. of lint per acre	470	470	470
Increased production in lb. of lint per acre	374	350	453
Value at 25¢ per lb. for lint cotton	$93.50	$87.50	$113.25
Extra costs due to irrigation and fertilizing	$ 9.38	$ 9.38	$ 9.38
Land leveling and maintenance cost per acre based on $75.00 per acre initial cost and 12½ percent depreciation per year			
Labor for irrigation based on $1.00 per acre per application	$ 1.00	$ 2.00	$ 3.00
Pumping cost based on 20¢ per acre-inch applied	$ 1.32	$ 1.88	$ 1.80
Cost of fertilizer and application cost	$17.60	$15.40	$ 20.20
Extra harvesting cost (picking, harvesting and ginning) based on 9½¢ per lb. of lint	$ 3.55	$ 3.33	$ 4.30
Extra insect control based on $3.00 per application	$15.00	$15.00	$ 15.00
Total of extra costs	$47.85	$46.99	$ 53.68
Net profit due to irrigation and fertilization	$45.65	$40.51	$ 59.57

Figure 7. Cotton which received low moisture and low fertility treatments. This photograph was taken after two pickings and one defoliation were made. Although the plants were not as large as those in Figure 6, the smaller investment in all costs (see Table 4) allowed the cotton to net $45.65 per acre.

that lint cotton sold for $0.25 per pound, the maximum economical yields for each irrigation level are shown in Table 4. These data indicate the importance of controlling the moisture level, since the medium irrigation level reduced lint production and therefore netted profit to the farmer, Figures 5, 6 and 7. Maximum profit from irrigation and fertilization ($59.57) was obtained using both high moisture and nitrogen.

Acknowledgments

The authors wish to acknowledge Farm Foreman II J. B. McCrocklin of the Department of Agricultural Engineering and James W. Allen of the Department of Agronomy for the vital part that they played in field operations associated with this study.

Appreciation also is expressed to Carroll W. Keese, Extension Agricultural Engineer—Irrigation, who was associated with this study in his former capacity as instructor, the Department of Agricultural Engineering, during the 1957 season.

Literature Cited

1. Baum, E. L., et al. "Economic Analysis of Fertilizer Use Data," Iowa State College Press, 1956.
2. Cochran, W. G. and Cox, G. M., "Experimental Design," John Wiley and Sons, 1957.
3. Hildreth, R. J., et al. "An Economic Evaluation of Experimental Response of Coastal Bermudagrass to Nitrogen under Irrigation," Texas Agricultural Experiment Station, Miscellaneous Publication 128, 1955.
4. Smith, J. C., et al. "Fertilizers for Cotton Near College Station," Texas Agricultural Experiment Station, Progress Report No. 1303, 1950.