EFFECT OF DELAYED NITROGEN APPLICATIONS ON THE YIELD, TURNOUT, AND CHEMICAL ANALYSIS OF COTTON

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INTRODUCTION

Cotton has been a crop of major economic importance to Oklahoma since statehood. At the present time cotton is the second ranked cash crop in Oklahoma agriculture.

Cotton is adapted to bottom land and deep permeable upland soils of the southern part of Oklahoma. Profitable increases in yields from fertilizer treatments were obtained on sandy textured soils in eastern Oklahoma as early as 1925 (31).

The objective of this study was to determine the feasibility of delayed nitrogen applications on cotton in addition to a starter fertilizer treatment at planting time.

REVIEW OF LITERATURE

Cotton is one of the most interesting plants studied by man. The cotton plant is quite sensitive to many environmental factors such as: moisture, temperature, light, availability of plant nutrients, soil pH, and length of growing season. Cotton, however, is a plant which can generally adjust to quite adverse conditions and produce fruit although yields may be quite limited.

Nutrition of Cotton

Eaton and Ergle (13) measured the elemental content of cotton plants at 5 day intervals in the greenhouse and at 15 day intervals in the field. Their first analysis was made one day after emergence. They found no change in dry weight or magnesium content. The one day old seedlings were high in nitrogen, potassium, calcium, and sodium, but were lower in phosphorus than the seeds. They also measured a continuous increase in dry weight over a period of 150 days, and found that most rapid increase in dry weight was around 105 days of age. Nitrogen and calcium uptake continued to increase to the 150th day when the test ended, however, potash accumulation decreased sharply after the 120th day.

Eaton and Ergle (13) found that during boll formation large amounts of dry matter which included nitrogen, phosphorus, potassium, calcium and magnesium passed from the vegetative tissues into the bolls. At maturity buds and bolls contained 66 percent of the total nitrogen, 79 percent of the total phosphorus, 46 percent of the total potassium, 53 percent of the total magnesium and 34 percent of the total calcium content of the plants. These values differ only slightly from those reported by Olson and Bledsoe (29), and Wadleigh (39). Somewhat similar results were measured by White (41) as early as 1914.

Cooper et al. (10) observed that different fertilizer treatments had no significant effect on the chemical composition of the reproductive parts. White (42) had reported similar observations in 1915. Eaton and Ergle (13) stated that a uniform concentration of minerals in the leaves and stems during heavy fruiting enables the plant to produce uniform fibers over a prolonged period of boll development. Tables presented by Cooper et al., (10) show that the seed of cotton selectively accumulate magnesium, phosphorus, and nitrogen, and selectively exclude calcium, sodium, clorine and silicon. They stated that cotton plants accumulate large quantities of calcium and nitrogen, and classified cotton as a calcium accumulator plant. They further stated that an abundant supply of potassium in the nutrient medium is necessary to secure satisfactory yields of a carbonacious plant which accumulates calcium.

Richards (33) discussed the interplay of compensating ions, e.g., when phosphorus and potassium are both low, carbohydrate formation is also reduced. The low potassium level limits nitrate absorption while reducing nitrogen in turn allows freer absorption of available phosphorus. The net results are what Richards terms "proximately balanced multiple deficiencies." This results in a reduced size plant, largely unaccompanied by other adverse effects.

Anderson (1) concluded in 1894, that the composition of the cotton plant with respect to nitrogen, phosphorus, and potassium is subject to decided variations under varying conditions of soil and fertilization.

He stated that richer soils produced more cotton with higher percentages of these three elements, and the addition of these elements to deficient soils resulted in an increased percentage of these same elements in the plant.

McLean (26) grew cotton in nutrient culture solutions at various nitrogen levels. He found that plants growing at the higher nitrogen levels assimilated more calcium and magnesium. However, the uptake of phosphorus, potassium, and sodium were generally reduced. He also found that the cation exchange capacity of the roots increased with increasing rates of nitrogen.

Wadleigh (39) stated that one of the simplest methods of influencing the biochemical composition of the cotton plant was to vary the nitrogen supply. Wadleigh reported also that increasing the nitrogen supply had the following effects: a slight trend for lengthening the fiber, an increase in the protein content of the seed, and a decrease in oil content of the seed brought about by a decrease in carbohydrate reserves. He also stated that it was important to maintain a high nitrogen level before fruiting to prevent the early bolls from competing with the roots for carbohydrate reserves.

Naftel (27) studied the absorption of ammonia and nitrate nitrogen by plants. He found that cotton seedlings up to three to five weeks of age absorbed more ammonia than nitrate nitrogen. After four to eight weeks the plants absorbed large quantities of both forms of nitrogen with nitrate representing the largest fraction. He stated that both growth and fruiting were greatest when both forms of nitrogen were available.

Dregne (12) studied ammonium sulfate, ammonium nitrate, urea, and anhydrous ammonia as sources of nitrogen for irrigated cotton. He observed no significant difference between the four materials.

The similarity of nitrogen and sulfur deficiency symptoms in cotton has stimulated several investigators to study the relationship of these two elements. Ergle (15) found that soluble nitrogen accumulated excessively in the case of a sulfur deficiency, but sulfur did not accumulate in the case of a nitrogen deficiency. Ergle (16) also found that 70 percent of the sulfate sulfur and no organic sulfur was transferred from old to new leaves. He concluded that cotton needs an almost continuous supply of this element. In his earlier work, Ergle (15) observed that the lower leaves of sulfur deficient cotton plants remained green and that the new leaves became chlorotic while the reverse was true in the case of a nitrogen deficiency.

Ergle and Eaton (17) in studying the phosphorus metabolism of cotton plants, grew cotton plants in nutrient solutions which contained as little as 1 p.p.m. phosphorus and as much as 36 p.p.m. phosphorus. They found large accumulations of carbohydrates in the phosphorus deficient plants. Leaf and stem analyses revealed that low phosphorus caused a reduction of nitrate nitrogen, protein, and total nitrogen content. They stated that a deficiency of phosphorus limits the elaboration of amino acids into the more complex phosphorus containing nucleo-proteins. They observed also that reducing sugars were four times higher in the cotton plants grown in the low phosphorus nutrient solution as compared to those grown in the high phosphorus nutrient solution. Ergle and Eaton concluded that the limited uptake of calcium, magnesium, potassium, and sulfur in phosphorus deficient plants suggests a dependency in nutrient element uptake on high energy phosphate bonds in the carrier molecules.

Ensminger and Pearson (14) and Stelly and Morris (35) studied the residual effect of phosphorus on cotton yields. In both cases cotton responded to residual phosphorus in direct proportion to the previous rates of application.

Sodium and potassium nutrition of cotton has been studied rather intensively in recent years. Lunt and Nelson (25) obtained as much as a 25 percent increase in yield from sodium applications on potassium deficient soils; however, sodium failed to give an increase in yield when the potassium supply was adequate. Lancaster (24) reported that 8 - 12 pounds of K_2O produced the same cotton yield as 116 pounds of Na_2O. Appling and Giddens (2) applied various rates and combinations of sodium and potassium to cotton and found that on potash deficient soils, the level of sodium increased in the lower leaves allowing potassium to translocate into the meristematic tissues. They obtained an increase in cotton yields from sodium alone, but the highest yields obtained were from potassium only. Chang and Dregne (8) reported that sodium reduced the uptake of calcium which resulted in yield reductions. They referred to this observation as a sodium induced calcium deficiency. Cooper and Garman (9) also reported that sodium reduced the uptake of calcium. They measured a Ca/Na + K ratio of 2.01 in plants that did not receive sodium as compared to a ratio of 1.24 in plants that received an application of sodium. The sodium applications also gave higher yields. They view high calcium in the plant as adverse to yield and suggest that nearly equal levels of calcium and potassium be more conducive to maximum yields. Joham (23) was in partial agreement with Garman and Cooper. He reported that sodium reduced the uptake of calcium and further found that a parabolic relationship existed between the ratio of Ca/Na + K, and that a ratio of 0.7 gave maximum yields of cotton.

Growth and Reproduction as Effected by Nutrient Elements

Growth. Wadleigh (39) stated that one of the simpler methods of influencing the growth behavior of cotton is by varying the nitrogen level. In greenhouse studies with cotton at four nitrogen levels he found that low nitrogen caused terminal growth to stop. McLean (26) observed that high rates of nitrogen increased top growth and that root growth did not keep pace with the tops. In some cases he observed a decrease in the rate of root growth due to high nitrogen treatments.

Ergle and Eaton (17) compared high phosphorus and low phosphorus in sand cultures on growth of cotton. They found that cotton plants grown in a low phosphorus medium were lighter in weight, shorter, produced less fruiting branches, fruiting branches were shorter, and less flowers were produced. In the cotyledonary stage low phosphorus plants were one-half the size of plants receiving an adequate supply of phosphorus. They also observed that the petiole turned red on the phosphorus deficient young plants.

Turner (38) studied the effect of three different levels of potash fertilizer on several different characteristics of the cotton plant. He found that each increase in potash gave an increase in production. The yield increase was apparently brought about by an increase in foliage. He reported that heavy foliage varieties of cotton responded best to potash applications.

Brown and Pope (5) stated that,

> If a particular element is present in the soil in quantity, the application of that element in a fertilizer would have little effect on the growth or fruiting of cotton. On the other hand if the soil supply of an element is low, its absence may serve as a limiting factor such that other elements may have little effect.

They found that proper fertilization on an Oliver silt loam soil had a marked effect on plant growths.

Bloom. Brown and Pope (5) observed that most mature cotton bolls in Louisiana were produced from July blooms, and that August blooms seldom produced bolls. They found that nitrogen alone or potassium alone produced no more blooms than the check plots, however, phosphorus alone gave an increase in the number of blooms and reduced the shedding of squares. They further observed that an application of 1000 pounds of 5-10-4 fertilizer produced considerably more blooms with fewer shed squares than phosphorus alone. Plots receiving 20 tons of manure plus phosphorus and potash produced the highest blooming rate and lowest square shedding rate of any treatment in the experiment. They also reported that proper fertilization gave a 20 percent increase in early blooms. Turner (38) obtained increased yields of cotton from the application of potassium. However, his work is in agreement with Brown and Pope in that potassium had no effect on the number of blooms produced.

Warner (40) agrees with several investigators that increasing the phosphorus percentage in the fertilizer increases the number of early blooms. He found that plots receiving nitrogen and potassium with no phosphorus fruited slowly during the first part of the season and reached their peak in the latter part of the season, while plots receiving phosphorus and potassium reached their blooming peak in the early part of the fruiting period.

Nelson and Ware (28) studied the effect of nitrogen, phosphorus and potassium on the fruiting of cotton. They found that phosphorus and potassium gave an increase in blooming over the check plots, and that small additions of nitrogen further increased the number of blooms.

Higher rates of nitrogen gave no further increase in early blooms.

Boll. Hawkins et al., (21) studied the physiological factors affecting the fruiting of cotton with special reference to boll shedding. They found that the amount of moisture and its relation to plant nutrients affects the fruiting behavior of cotton. They concluded that high osmotic pressures of the cell sap was almost always followed by a low rate of shedding unless induced by lack of moisture and then the reverse is true. Hawkins and his associates correlated rapid vegetative growth with boll shedding. They stated that boll shedding was probably due to an insufficient plant nutrient supply for both rapid vegetative growth and boll development. Wadleigh (39) refers to this shedding as a safety valve.

In studies on the fruiting behavior of cotton Wadleigh showed that after cotton plants had set a sufficient number of bolls to deplete its nitrogenous reserves, all subsequent young bolls abscissed and very soon thereafter young squares abscissed. Finally the terminal buds of fruiting branches aborted. Nelson and Ware (28) found that the number of mature bolls harvested increased with increasing rates of nitrogen up to 100 pounds of nitrogen per acre. They also found the first increment of nitrogen produced slightly larger bolls, however no further increase in boll size was obtained from additional increases in nitrogen rates. This was in agreement with Wadleigh (39).

Turner (38) obtained significant increases in boll size with each increase in potash application.

In Ergle and Eaton's (17) phosphorus metabolism study, plants well supplied with phosphorus had a relative fruitfulness (bolls per 100 grams of plant tissue) four times greater than phosphorus deficient plants.

Brown and Pope (5) concluded from their experiments that proper fertilization produced the largest bolls and the highest percentage of five lock bolls.

Ergle (13) reported that the relative fruitfulness of cotton was unchanged regardless of the sulfur supply. In an earlier study, Ergle (12) showed that cotton requires a continuous supply of sulfur, and a discontinuation in the supply of this element could result in boll abscission.

Maturity. Buie (6) and Warner (40) studied the fruiting habits of cotton, and reported that phosphorus hastened maturity. Buie also reported that nitrogen applications on poor soils caused earlier fruiting. However, on rich soils the application of nitrogen had little effect on maturity. Nelson and Ware (28) also reported that the addition of small amounts of nitrogen hastened fruiting. Nelson and Ware reported that the average percentage of cotton harvested at the first picking did not increase with nitrogen rates although the largest amount of lint harvested at the first picking came from the high nitrogen plots. Brown and Pope (5) found that properly fertilized cotton hastened blooming and shortened the boll period six to eight days.

Yield. Potts (31) obtained yield increases of cotton on sandy loam soils in McIntosh County and Creek County, Oklahoma. The major portion of the increased yield was due to phosphorus. Nitrogen also was beneficial but to a lesser extent than phosphorus. They found nitrogen applications at planting time were superior to applications made at chopping time.

Brimhall and McGeorge (4) worked with irrigated cotton in Arizona. They obtained responses to both nitrogen and phosphorus. Phosphorus did not respond if nitrogen was deficient. However, response was obtained from nitrogen when phosphorus was deficient. They concluded that 100 pounds of nitrogen and 50 to 100 pounds of P_2O_5 was a reasonable and sound recommendation for irrigated cotton in Arizona.

Horn et al., (22) studied the effect of nitrogen, phosphorus, and potassium on cotton at three moisture levels. This work was conducted on a Norwood silty clay loam soil at College Station, Texas. A treatment of 80-80-120 produced maximum yields at both the low and medium moisture levels. The maximum yield at the high moisture level was produced with the 160-80-120 treatment. Burleson (7) conducted cotton fertility experiments on a Harlington clay soil at the Lower Rio Grande Valley Experiment Station. The treatment that gave the greatest net profit on irrigated cotton was 120-120-60 per acre. Christensen and Lyerly (11) studied cotton fertility near El Paso, Texas. The highest yield was produced from an alfalfa rotation. They recommended 60 to 80 pounds of nitrogen for irrigated cotton the third year after alfalfa.

Seed. Cooper et al. (10) studied the chemical composition of cotton plant tissues and concluded that the composition of seed and other reproductive parts were not generally affected by fertilizer treatment. Several investigators, however, disagree with this conclusion.. Thorpe et al. (37) demonstrated that nitrogen increased the size of cotton seed, increased the percent nitrogen in the seed, and reduced the oil content, however, phosphorus produced no effect on oil content or percent nitrogen. Potassium applications gave a marked increase in oil content accompanied by a slight decrease in nitrogen. Wadleigh (39) found that nitrogen increased the percent protein in the seed and decreased the oil content. Lancaster (24) found potassium increased the oil content of the seed and improved the seed germination. Brown and Pope (5), and Hamilton (19) were in agreement that increasing the nitrogen supply to cotton increased the number of seed per boll.

Lint. There is a diversity of opinion as to the effect of plant nutrients on fiber quality. Sturkie (36) and Reynolds and Kellough (32) were in agreement that moisture levels affect the length of cotton fibers and that nitrogen, phosphorus and potassium have no effect. Pope (30) applied 4-12-4 fertilizer at 200 pound increments ranging from 0 to 1600 pounds per acre and found no trend in the lint index (weight of lint per 100 grams of seed).

Armstrong and Bennett (3) found no significant difference in length of fiber between plots grown on poor soil and good soil within the same variety. They observed that late maturing cotton bolls produced fiber 1/16 to 1/8 inch shorter than early bolls. They also found that bolls with a shorter maturation period had a larger percentage of long fibers.

Hamilton (19) found nitrogen to increase fiber coarseness. However, Brown and Pope (5) found no correlation between fertilizer treatment and fiber fineness. The latter reported a significant increase in mean fiber length. They further reported that the early bolls due to proper fertilization had longer, coarser, stronger, and more resilent fiber.

EXPERIMENTAL PROCEDURE

Two field experiments were established in the spring of 1954. One was located on the Kenneth Hughes farm six miles south and one mile east of Wetumka, Hughes County, Oklahoma. The other experiment was established on the Loyne Marvel farm fourteen miles south and one mile east of Hydro, Caddo County, Oklahoma.

The experiment in Hughes County was continued for three years. The experiment in Caddo County was discontinued after the first season.

Description of Soils Used in the Experiments

The Hughes County experiment was located on a Choteau silt loam soil. This is an imperfectly drained reddish prairie soil derived from old alluvium originating probably from acid, silty prairie soils and reddish prairie soils.

The Caddo County experiment was established on a Dill fine sandy loam soil. This is a reddish brown deep soil developed under grass vegetation from red non calcarous pack sand of the Permian age.

A complete profile description of both soils is given in the Appendix. Chemical characteristics of the Choteau silt loam soil is given in Table I.

Chemical analysis of soils and plants was determined by methods compiled by Harper (20). The soil pH was determined by the glass electrode method and easily soluble phosphorus was extracted with N/10 normal acetic acid.

Field Experimental Procedures

Hughes County - Stoneville 62 cotton was grown on Choteau silt loam soil to determine the feasibility of applying a delayed nitrogen side-dressing to cotton on an upland prairie soil in Eastern Oklahoma. The experimental design was a randomized split block having two rates and two replications of starter fertilizer and five rates and four randomized replications of nitrogen sidedressing.

The fertility treatments and fertilizer materials used are listed in Table II. The plots were 4 rows 132 feet long. The starter fertilizer was applied at planting time in bands two inches to one side and two inches below the level of the seed. Cotton was planted the first week of June each year. The nitrogen sidedressing was applied at the six leaf stage of growth. The field was inspected for insects at five day intervals throughout the growing season. Insect populations did not justify control measures during the three year course of the experiment. The experiment was observed at three week intervals to determine the effect of fertilizer treatments on vegetative growth and the fruiting of cotton plants.

The center 50 feet from the middle two rows of each plot was harvested by hand snapping the bolls. The snapped cotton was weighed in the field. Samples were taken from the harvested material for the purpose of determining percent lint to snapped bolls, percent lint to seed and chemical analysis of the seed. Phosphorus and nitrogen percentages of the seed were determined as outlined by Harper (20).

Caddo County - Lankart 57 cotton was grown on Dill fine sandy loam soil to determine the feasibility of applying delayed nitrogen sidedressing on a deep sandy soil in Western Oklahoma. The experimental design was a split, split block with four replications.

The starter fertilizer was applied at planting time in bands near the row. The nitrogen sidedressing was applied when the cotton was in the four leaf stage. Materials used are listed in Table III.

At the early boll stage petioles of the first mature leaf from the top of 50 random plants in each plot were collected for chemical analysis. Nitrogen, phosphorus, potassium, calcium, magnesium, and sodium content of the petioles was determined as outlined by Harper (20).

The experiment was lost before yield data could be determined.

TABLE I. Some chemical characteristics of the soil on which the field experiment was established in Hughes County, Choteau silt loam

	0 - 6 inches	6 - 18
pH	6.9	6.0
% organic matter	1.32	1.23
Early soluble salts	348 ppm	268 ppm
Exchangeable potassium	0.603 m.e./100 g.	0.611 m.e./100 g.
Exchangeable calcium	4.65 m.e./100 g.	3.73 m.e./100 g.
Exchangeable magnesium	1.31 m.e./100 g.	1.97 m.e..100 g.
Exchangeable sodium	0.13 m.e./100 g.	0.13 m.e./100 g.

TABLE II. The fertility treatments, rates, and materials used in the Hughes County experiment, Choteau fine sandy loam. 1954, 1955, 1956

Symbol	Treatment
0-0-0	No starter fertilizer
12-48-48	200 pounds of a 6-24-24 mixed fertilizer
0 N	No nitrogen sidedressing
20 N	20 pounds nitrogen as NH_4 NO_3 sidedressing
40 N	40 pounds nitrogen as HN_4 NO_3 sidedressing
60 N	60 pounds nitrogen as NH_4 NO_3 sidedressing
80 N	80 pounds nitrogen as NH_4 NO_3 sidedressing

TABLE III. The fertility treatments, rates and materials used in the Caddo County experiment, Dill fine sandy loam, 1954

Symbol	Treatment
7-14-7	150 pounds of a 5-10-5 mixed fertilizer applied at planting time
7-36-36	150 pounds 5-10-5 plus 110 pounds super phosphate (20% P_2O_5) plus 48 pounds (60% muriate of potash
0 N	No nitrogen sidesressing
20 N	20 pounds of nitrogen as NH_4 NO_3 sidedressing
40 N	40 pounds of nitrogen as NH_4 NO_3 sidedressing
60 N	60 pounds of nitrogen as NH_4 NO_3 sidedressing
80 N	80 pounds of nitrogen as NH_4 NO_3

Statistical Analysis

The yield data as well as results of the chemical analyses of the seed and petiole were analyzed statistically. Analysis of variance, coefficient of variation, F values, standard error of the mean, and confidence limits were determined for each measurement of the two experiments. Methods as outlined by Snedecor (34) were used in the statistical analysis.

RESULTS AND DISCUSSION

Hughes County Experiment

Yield results from the Hughes County experiment are presented in Tables IV, V, and VI. These data show the effect of various rates of nitrogen and a comparison of starter vs. no starter fertilizers for the years 1954, 1955, and 1956. Coëfficient of variation, standard error of the mean, and confidence limits are presented with the data. Individual plot data is presented in detail in Tables XX through XXIV.

F values indicated no significant difference in yield due to either the nitrogen or starter fertilizer treatments. However, there appeared to be a definite trend all three years in favor of the starter fertilizer application. In 1954 the mean yield of the no starter treatments was 347 pounds of lint cotton per acre as compared to a mean yield of 466 pounds of lint per acre on those plots receiving a 12-48-48 fertilizer treatment at planting time. In 1955 somewhat similar yields were obtained. The no starter plots averaged 376 pounds as compared to 477 pounds of lint on plots that received starter fertilizer. Yields in 1956 were lower than the preceeding two years due to extremely dry weather. This was the third and final year of the experiment. The no starter plots produced a mean yield of 196 pounds of lint per acre while the starter fertilizer plots averaged 266 pounds. Since the plots remained in the same location for the three year period it can be assumed that the plots receiving 48 pounds of P_2O_5 and 48 pounds of K_2O each of

TABLE IV. Effects of delayed nitrogen applications and starter fertilizer on the lint yield of cotton on a Choteau silt loam soil, Kenneth Hughes farm, Hughes County, Oklahoma, 1954

Treatment Pounds per Acre At Planting	Pounds of Nitrogen per Acre					
	0	20	40	60	80	Ave.
		Pounds of Lint Cotton per Acre				
0-0-0	336	380	327	362	329	347
12-48-48	472	460	452	455	490	466
Average	404	420	389	409	410	407

	Starter	Nitrogen
C.V.	1.77%	12.7%
SEM	2.28	25.9

C.L.[1]	0-0-0	437 - 495
C.L.	12-48-48	318 - 376
C.L.	0 lbs nitrogen	345 - 463
C.L.	20 lbs nitrogen	361 - 479
C.L.	40 lbs nitrogen	331 - 449
C.L.	60 lbs nitrogen	350 - 468
C.L.	80 lbs nitrogen	351 - 469

[1] C.L. - confidence limits.

TABLE V. Effects of delayed nitrogen applications and starter fertilizer on the lint yield of cotton on a Choteau silty loam soil, Kenneth Hughes farm, Hughes County, Oklahoma, 1955

Treatment Pounds per Acre at Planting	Pounds of Nitrogen per Acre					
	0	20	40	60	80	Ave.
		Pounds of Lint Cotton per Acre				
0-0-0	377	358	338	407	399	376
12-48-48	496	461	472	495	462	477
Average	437	410	406	451	431	427

	Starter	Nitrogen
C.V.	27.77%	4.9%
SEM	37.48	10.47
C.L.[1]	0-0-0	0 - 852
C.L.	12-48-48	1 - 954
C.L.	0 lbs nitrogen	413 - 461
C.L.	20 lbs nitrogen	386 - 434
C.L.	40 lbs nitrogen	382 - 430
C.L.	60 lbs nitrogen	427 - 475
C.L.	80 lbs nitrogen	407 - 455

[1] C.L. - confidence limits.

TABLE VI. Effects of delayed nitrogen applications and starter fertilizer on the lint yield of cotton on a Choteau silt loam soil, Kenneth Hughes farm, Hughes County, Oklahoma, 1956

Treatment Pounds per Acre	Nitrogen Side Dressing 0	20	40	60	80	Ave.
Starter			Pounds Lint per Acre			
0-0-0	158	214	216	202	194	197
12-48-48	248	261	251	270	302	266
Average	203	237	234	236	248	232

		Starter	Nitrogen
	C.V.	13.16%	19.74%
	SEM	9.617	22.8
	C.L.[1]	0-0-0	88 - 306
	C.L.	12-48-48	157 - 375
	C.L.	0 lbs nitrogen	150 - 256
	C.L.	20 lbs nitrogen	182 - 288
	C.L.	40 lbs nitrogen	179 - 285
	C.L.	60 lbs nitrogen	181 - 287
	C.L.	80 lbs nitrogen	198 - 301

[1] C.L. - confidence limits.

the three years were well supplied with these elements. Visual observations throughout the growing season indicated that plants growing on these high fertility plots withstood the dry weather much better than plants growing on the plots which were never fertilized with phosphorus and potassium. This observation is borne out to some extent by the mean yield difference of 51 pounds of lint cotton per acre in 1956.

Effects of starter fertilizer and varied rates of nitrogen side dressing on the percent lint to seed cotton are presented in Tables VII, VIII, and IX. No statistical significance and no apparent trends existed in these measurements for any one of the three years.

Effect of starter fertilizer and varied rates of nitrogen side dressing on percent lint to snapped cotton for the 1955 and 1956 growing seasons are presented in Tables X and XI. Fertility treatments apparently had only a slight influence on these observations. However, it was noted that the dry weather of 1956 produced a grand mean lint to snapped cotton of only 25.7 percent as compared to a grand mean of 30.2 percent in 1955 when rainfall was more favorable.

Results of the effect of the various fertility treatments on the nitrogen content of the seed produced in 1954 are presented in Table XII. These results were statistically nonsignificant and no trends were noticeable.

The phosphorus content of the seed produced in 1954 is presented in Table XIII. Statistically there was no difference in phosphorus content due to fertilizer treatments. However, the mean phosphorus content of seed from the plots receiving no phosphorus was 0.465 percent compared to a 0.377 percent mean on plots receiving 48 pounds of P_2O_5 at planting time. This trend is the reverse from what might be

TABLE VII. Effects of delayed nitrogen applications and starter fertilizer on the percent lint to seed cotton on a Choteau silt loam soil, Kenneth Hughes farm, Hughes County, Oklahoma, 1954

Treatment Pounds per Acre	Nitrogen Side Dressing 0	20	40	60	80	Ave.
Starter			Percent Lint to Seed Cotton			
0-0-0	40.7	40.7	39.8	39.9	38.1	40.0
12-48-48	39.1	38.6	38.5	39.2	39.1	38.9
Average	39.6	39.6	39.1	39.5	38.6	39.5

	Starter	Nitrogen
C.V.	0.4%	2.13%
SEM	0.050	0.419
C.L.[1]	0-0-0	39.1 - 40.4
C.L.	12-48-48	38.2 - 39.5
C.L.	0 lbs nitrogen	38.7 - 40.6
C.L.	20 lbs nitrogen	38.7 - 40.6
C.L.	40 lbs nitrogen	38.2 - 40.1
C.L.	60 lbs nitrogen	38.6 - 40.5
C.L.	80 lbs nitrogen	37.6 - 39.6

[1] C.L. - confidence limits.

TABLE VIII. Effects of delayed nitrogen applicationa and starter fertilizer on the percent lint to seed of cotton on a Choteau silt loam soil, Kenneth Hughes Farm, Hughes County, Oklahoma, 1955

Treatment	Nitrogen Side Dressing					
Pounds per Acre	0	20	40	60	80	Ave.
Starter			Percent Lint to Seed			
0-0-0	40.0	37.7	39.5	40.7	40.4	39.7
12-48-48	40.8	39.9	39.8	39.7	39.8	40.0
Average	40.4	38.5	39.7	40.2	40.1	39.9

		Starter	Nitrogen
	C.V.	5.06%	3.72%
	SEM	0.636	0.739
	C.L.[1]	0-0-0	31.55 - 47.73
	C.L.	12-48-48	31.79 - 47.97
	C.L.	0 lbs nitrogen	38.69 - 42.11
	C.L.	20 lbs nitrogen	36.82 - 40.24
	C.L.	40 lbs nitrogen	37.94 - 41.36
	C.L.	60 lbs nitrogen	38.47 - 41.89
	C.L.	80 lbs nitrogen	38.34 - 41.76

[1] C.L. - confidence limits.

TABLE IX. Effects of delayed nitrogen applications and starter fertilizer on the percent lint to seed of cotton in a Choteau silt loam soil, Kenneth Hughes Farm, Hughes County, Oklahoma, 1956

Treatment Pounds per Acre	Nitrogen Side Dressing 0	20	40	60	80	Ave
Starter			Percent Lint to Seed			
0-0-0	37.7	38.7	38.1	38.7	38.3	38.30
12-48-48	37.9	39.1	38.0	38.0	39.0	38.40
Average	37.77	38.90	38.03	38.30	38.63	38.35

	Starter	Nitrogen
C.V.	3.83%	4.87%
SEM	0.4633	0.9336
C.L.[1]	0-0-0	32.38 - 44.16
C.L.	12-48-48	32.49 - 44.27
C.L.	0 lbs nitrogen	35.62 - 39.92
C.L.	20 lbs nitrogen	36.75 - 41.05
C.L.	40 lbs nitrogen	35.88 - 40.18
C.L.	60 lbs nitrogen	36.15 - 40.45
C.L.	80 lbs nitrogen	36.48 - 40.78

[1] C.L. - confidence limits.

TABLE X. Effects of delayed nitrogen applications and starter fertilizer on the percent lint to snapped cotton on a Choteau silt loam soil, Kenneth Hughes farm, Hughes County, Oklahoma, 1955

Treatment	Nitrogen Side Dressing					
Pounds per Acre	0	20	40	60	80	Ave.
Starter		Percent Lint to Snapped Cotton				
0-0-0	29.9	28.7	28.9	30.5	30.5	29.7
12-48-48	31.3	29.8	31.1	30.5	30.5	30.6
Average	30.6	29.3	30.0	30.5	30.5	30.2
		Starter		Nitrogen		
	C.V.	8.31%		5.27%		
	SEM	0.7920		0.7953		
	C.L.[1]	0-0-0		19.60 - 39.72		
	C.L.	12-48-48		20.58 - 40.70		
	C.L.	0 lbs nitrogen		28.75 - 32.41		
	C.L.	20 lbs nitrogen		27.40 - 31.06		
	C.L.	40 lbs nitrogen		28.17 - 31.83		
	C.L.	60 lbs nitrogen		28.62 - 32.28		
	C.L.	80 lbs nitrogen		28.67 - 32.33		

[1] C.L. - confidence limits.

TABLE XI. Effects of delayed nitrogen applications and starter fertilizer on the percent lint to snapped cotton on a Choteau silt loam soil, Kenneth Hughes farm, Hughes County, Oklahoma, 1956

Treatment Pounds per Acre	Nitrogen Side Dressing 0	20	40	60	80	Ave.
Starter		Percent Lint to Snapped Cotton				
0-0-0	24.3	25.7	24.8	25.7	25.0	25.1
12-48-48	25.3	25.4	25.2	25.8	26.4	25.6
Average	24.8	25.6	25.0	25.8	25.7	25.4

		Starter	Nitrogen
	C.V.	0.36%	5.97%
	SEM	0.2899	0.7588
	C.L.[1]	0-0-0	21.41 - 28.77
	C.L.	12-48-48	21.92 - 29.28
	C.L.	0 lbs nitrogen	23.05 - 26.55
	C.L.	20 lbs nitrogen	23.80 - 27.30
	C.L.	40 lbs nitrogen	23.20 - 26.70
	C.L.	60 lbs nitrogen	23.98 - 27.48
	C.L.	80 lbs nitrogen	23.95 - 27.45

[1]C.L. - confidence limits.

TABLE XII. Effects of delayed nitrogen applications and starter fertilizer on the nitrogen content of cotton seed grown on a Choteau silt soil, Kenneth Hughes farm, Hughes County, Oklahoma, 1954

Treatment Pounds per Acre	Nitrogen Side Dressing 0	20	40	60	80	Ave.
Starter			Nitrogen Percentage of Seed			
0-0-0	4.19	3.77	3.95	4.28	4.34	4.11
12-48-48	4.04	3.90	3.90	3.93	4.41	4.04
Average	4.12	3.84	3.93	4.11	4.38	4.08

	Starter	Nitrogen
C.V.	4.92%	6.82%
SEM	0.1422	0.1400

C.L.[1]	0-0-0	2.297 - 5.916
C.L.	6-48-48	2.302 - 5.916
C.L.	0 lbs nitrogen	3.790 - 4.436
C.L.	20 lbs nitrogen	3.700 - 4.346
C.L.	40 lbs nitrogen	3.600 - 4.246
C.L.	60 lbs nitrogen	3.777 - 4.423
C.L.	80 lbs nitrogen	4.052 - 4.698

[1] C.L. - confidence limits.

TABLE XIII. Effects of delayed nitrogen applications and starter fertilizer on the phosphorus content of cotton seed grown on a Choteau silt loam soil, Kenneth Hughes farm, Hughes County, Oklahoma, 1954

Treatment Pounds per Acre	Nitrogen Side Dressing 0	20	40	60	80	Ave.
Starter		Nitrogen Percent of Seed				
0-0-0	0.501	0.450	0.484	0.426	0.463	0.465
12-48-48	0.409	0.365	0.379	0.382	0.350	0.377
Average	0.455	0.408	0.432	0.404	0.407	0.421
		Starter		Nitrogen		
	C.V.	52.7%		40.21%		
	SEM	0.0704		0.0848		
	C.L.[1]	0-0-0		Neg.—		
	C.L.	12-48-48		Neg.—		
	C.L.	0 lbs nitrogen		0.2590 - 0.6504		
	C.L.	20 lbs nitrogen		0.2116 - 0.6030		
	C.L.	40 lbs nitrogen		0.2356 - 0.6270		
	C.L.	60 lbs nitrogen		0.2178 - 0.6092		
	C.L.	80 lbs nitrogen		0.2178 - 0.5995		

[1] C.L. - confidence limits.

expected. Although the mean phosphorus percentage is higher on the no phosphorus plots it is noteworthy that plots receiving phosphorus produced more total seed phosphorus per acre when the yield was taken into account.

In no measurement did the rate of nitrogen side dressing produce a significant difference in results or a visual difference in vegetative growth during the growing season. The vegetative growth was much larger each of the three years on the plots that received starter fertilizer.

Caddo County Experiment

Results of petiole analysis from the Caddo County experiment are presented in Tables XIV through XIX. Coefficients of variation, standard error of means, confidence limits, and significant F values are presented with the data. Individual plot data is presented in detail in Tables XXV through XXX.

The calcium content of the leaf petioles was significant at the 95 percent level due to starter fertilizer treatments and to the nitrogen treatments. The mean calcium percentage of the 7-14-7 treatment was 2.26 percent as compared to a mean of 2.40 percent from plots receiving 7-36-36. The mean for no nitrogen side dressing treatments was 2.26 percent calcium and the mean calcium percentages of all plots receiving nitrogen side dressing was 2.35 percent.

Although there was no statistical significance in sodium content of the petioles, a definite trend existed due to starter fertilizer treatment and to the nitrogen side dressing treatments. The mean sodium content of the plots receiving 7-14-7 starter fertilizer was 1.82 percent as compared to 1.54 percent from the plots receiving a 7-36-36 starter.

The mean potassium percentage of petioles on the 7-14-7 was 3.67

TABLE XIV. Effects of delayed nitrogen applications and starter fertilizer on the nitrogen content of cotton leaf petioles grown on a Dill fine sandy loam soil, Loyne Marvel farm, Caddo County, Oklahoma, 1954

Treatment	Nitrogen Side Dressing					
Pounds per Acre	0	20	40	60	80	Ave.
Starter		Percent Nitrogen of Petioles				
7-14-7	1.114	1.079	1.189	1.105	1.107	1.119
7-36-36	1.115	1.054	1.105	1.136	1.074	1.097
Average	1.115	1.032	1.147	1.122	1.092	1.103

	Starter	Nitrogen
C.V.	7.52%	41.67%
SEM	0.0187	0.1640
C.L.[1]	7-14-7	0.881 - 1.357
C.L.	7-36-36	0.868 - 1.344
C.L.	0 lbs nitrogen	0.797 - 1.473
C.L.	20 lbs nitrogen	0.728 - 1.404
C.L.	40 lbs nitrogen	0.814 - 1.490
C.L.	60 lbs nitrogen	0.782 - 1.458
C.L.	80 lbs nitrogen	0.752 - 1.428

[1]C.L. - Confidence limits.

TABLE XV. Effects of delayed nitrogen applications and starter fertilizer on the phosphorus content of cotton leaf petioles on a Dill fine sandy loam soil, Loyne Marvel farm, Caddo County, Oklahoma, 1954

Treatment Pounds per Acre	Nitrogen Side Dressing 0	20	40	60	80	Ave.
Starter		Percent Phosphorus of Petioles				
7-14-7	0.095	0.100	0.099	0.099	0.085	0.096
7-36-36	0.114	0.112	0.111	0.118	0.110	0.113
Average	0.105	0.106	0.105	0.109	0.093	0.105

	Starter	Nitrogen
C.V.	12.50%	8.65%
SEM	0.0031	0.0031
C.L.[1]	7-14-7	0.056 - 0.134
C.L.	7-36-36	0.074 - 0.152
C.L.	0 lbs nitrogen	0.040 - 0.168
C.L.	20 lbs nitrogen	0.042 - 0.170
C.L.	40 lbs nitrogen	0.041 - 0.169
C.L.	60 lbs nitrogen	0.043 - 0.173
C.L.	80 lbs nitrogen	0.034 - 0.162

[1] C.L. - confidence limits.

TABLE XVI. Effects of delayed nitrogen applications and starter fertilizer on the potassium content of cotton leaf petioles grown on a Dill fine sandy loam soil, Loyne Marvel farm, Caddo County, Oklahoma, 1954

Treatment	Nitrogen Side Dressing					
Pounds per Acre	0	20	40	60	80	Ave.
Starter		Potassium Percentage of Petioles				
7-14-7	3.49	3.51	3.79	3.71	3.84	3.67
7-36-36	3.88	3.84	3.85	3.89	3.90	3.87
Average	3.69	3.68	3.82	3.80	3.87	3.77
		Starter		Nitrogen		
	C.V.	2.75%		2.48%		
	SEM	0.0227		0.0330		
	C.L.[1]	7-14-7		3.377 - 3.953		
	C.L.	7-36-36		3.581 - 4.157		
	C.L	0 lbs nitrogen		3.612 - 3.748		
	C.L.	20 lbs nitrogen		3.602 - 3.738		
	C.L.	40 lbs nitrogen		3.755 - 3.891		
	C.L.	60 lbs nitrogen		3.727 - 3.863		
	C.L.	80 lbs nitrogen		3.798 - 3.934		

[1] C.L. - Confidence limits.

TABLE XVII. Effects of delayed nitrogen applications and starter fertilizer on the calcium content of cotton leaf petioles grown on a Dill fine sandy loam soil, Loyne Marvel farm, Caddo County, Oklahoma, 1954

Treatment Pounds per Acre	Nitrogen Side Dressing 0	20	40	60	80	Ave.
Starter	Calcium Percentage of Petioles					
7-14-7	2.19	2.39	2.38	2.22	2.14	2.26
7-36-36	2.33	2.44	2.40	2.42	2.39	2.40
Average	2.26	2.42	2.39	2.32	2.27	2.33

F values starter - 11.4*[1]
Nitrogen - 3.4*

	Starter	Nitrogen
C.V.	5.35%	4.67%
SEM	0.0279	0.0385
C.L.[2]	7-14-7	1.907 - 2.617
C.L.	7-36-36	2.040 - 2.750
C.L.	0 lbs nitrogen	2.181 - 2.339
C.L.	20 lbs nitrogen	2.334 - 2.492
C.L.	40 lbs nitrogen	2.310 - 2.468
C.L.	60 lbs nitrogen	2.239 - 2.397
C.L.	80 lbs nitrogen	2.184 - 2.342

[1] Asterisk (*) denotes significance at the 95% level of confidence.

[2] C.L. - confidence limits.

TABLE XVIII. Effects of delayed nitrogen applications and starter fertilizer on the magnesium content of cotton leaf petioles grown on a Dill fine sandy loam soil, Loyne Marvel farm, Caddo County, Oklahoma, 1954

Treatment Pounds per Acre	Nitrogen Side Dressing 0	20	40	60	80	Ave.
Starter		Magnesium Percentage of Petioles				
7-14-7	1.55	1.68	1.80	1.65	1.60	1.66
7-36-36	1.68	1.60	1.59	1.63	1.54	1.61
Average	1.62	1.64	1.60	1.64	1.57	1.64

	Starter	Nitrogen
C.V.	14.47%	11.63%
SEM	0.0527	0.0670
C.L.[1]	7-14-7	1.547 - 1.759
C.L.	7-36-36	1.500 - 1.712
C.L.	0 lbs nitrogen	1.472 - 1.748
C.L.	20 lbs nitrogen	1.499 - 1.775
C.L.	40 lbs nitrogen	1.556 - 1.832
C.L.	60 lbs nitrogen	1.497 - 1.773
C.L.	80 lbs nitrogen	1.432 - 1.708

[1] C.L. - confidence limits.

TABLE XIX. Effect of delayed nitrogen applications and starter fertilizer on the sodium content of cotton leaf petioles grown on a Dill fine sandy loam soil, Loyne Marvel farm, Caddo County, Oklahoma, 1954

Treatment Pounds per Acre	Nitrogen Side Dressing 0	20	40	60	80	Ave.
Starter		Sodium Percentage of Petioles				
7-14-7	1.74	1.77	1.84	1.98	1.77	1.82
7-36-36	1.59	1.47	1.44	1.68	1.50	1.54
Average	1.67	1.52	1.64	1.73	1.64	1.68
		Starter		Nitrogen		
	C.V.	19.07%		11.64%		
	SEM	0.0071		0.0071		
	C.L.[1]	7-14-7		0.0918 - 0.2714		
	C.L.	7-36-36		0.0632 - 0.2428		
	C.L.	0 lbs nitrogen		0.1525 - 0.1815		
	C.L.	20 lbs nitrogen		0.1475 - 0.1765		
	C.L.	40 lbs nitrogen		0.1495 - 0.1785		
	C.L.	60 lbs nitrogen		0.1485 - 0.1775		
	C.L.	80 lbs nitrogen		0.1485 - 0.1775		

[1] C.L. - confidence limits.

percent. The 7-36-36 treatment produced a mean percentage of 3.87. Also there appeared to be a trend towards higher concentrations of potassium in the petioles due to the higher rate of nitrogen.

Phosphorus uptake like potassium was not statistically significant although a trend did exist which indicated that the higher rate of starter fertilizer was conducive to higher concentrations of phosphorus in the petioles.

Neither the nitrogen nor the magnesium content of the leaf petioles indicated any trends due to fertility treatnemts.

Growth observations showed a vegetative response to the 7-36-36 treatment but no visual differences could be observed as a result of the various nitrogen treatments.

CONCLUSIONS

The objective of this study was to determine the feasibility of delayed nitrogen applications to cotton on deep permeable upland soils in both Eastern and Western Oklahoma.

Field experiments were established on a Choteau silt loam soil in Hughes County and on a Dill fine sandy loam soil in Caddo County.

The Caddo County experiment was discontinued after the first year and the Hughes County experiment was continued three years. Results from these experiments can be summarized as follows.

Hughes County

1. Statistically significant differences in yield were not obtained due to starter fertilizer or nitrogen side dressing treatment for the three years.
2. Ratio of lint turnout to seed cotton or snapped cotton due to fertilizer treatments was not statistically significant.
3. Trends indicated a higher yield due to starter fertilizer for each of the three years.
4. Nitrogen side dressing treatments produced no trends toward increased yields.
5. Starter fertilizer gave a trend towards a larger percentage of lint cotton to snapped bolls.
6. There was no significant difference in phosphorus content of seed due to fertility treatments.

7. There was no significant difference in nitrogen content of seed due to fertility treatments.

Caddo County

1. The higher rate of starter fertilizer significantly increased the calcium content of leaf petioles.
2. Nitrogen side dressing significantly increased the calcium content of leaf petioles.
3. A definite trend indicated that a higher rate of starter fertilizer reduced the sodium content of leaf petioles.
4. A definite trend indicated that the addition of nitrogen as a side dressing reduced the sodium content of leaf petioles.
5. Nitrogen and magnesium content of leaf petioles were apparently unaffected by fertilizer treatments.

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A P P E N D I X

Soils Described July 10, 1956

By

Harry Galloway and Kenneth Snelling

At site of cotton fertility test conducted by Lester Reed and Gaylord Hanes on Kenneth Hughes Farm, 1955.

Sample from SE¼ of Sec. 22, R10E, T8N; 6 miles S. and 1 mile E. of Wetumka in Hughes County; erosional upland with convex surface; gradient 1½%; surrounded on south and east by slopes of 2½% gradient. Drainage good, erosion none to slight.

Profile:

56-OK-32-21-1

A_1 0-20" Grayish-brown (10YR 4/2; 3/2, m) silt loam; fragmental breakage; crushes easily to fine granules; very friable; pH 7.5; numerous roots; grades slowly to horizon below.

56-OK-32-21-2

A_3 20-30" Yellowish-brown (10 YR 5/4; 4/3, m) silt loam; with about 10% of fine faint reddish yellow mottles; weak medium subangular blocky; crushes fine granular; very friable; pH 6.0; good root penetration; grades shortly to horizon below.

56-OK-32-21-3

B_2 30-48" Brownish-yellow (10 YR 7/6; 6/6, m) light clay loam; mottled with a few coarse yellow (10 YR 8/8) streaks; compound subangular blocky and granular; friable, peds become hard when dry; pH 6.0; mottling increases with depth; numerous black concretions below 34"; grades to horizon below.

56-OK-32-21-4

C_u 48-54"+ Mottled pale-brown (10 YR, 7/3) and reddish-yellow (5 YR, 6/8) light clay; with some white streaks; fragmental breakage; nearly massive; numerous black films which seem to follow old bedding planes and small pockets in the clay; pH 6.3.

This appears to be weathered clay or alluvium overlying Wetumka shale of Pennsylvanian and may be unconformable with the material above it. The upper 48" may be developed in valley fill materials moving down from higher lands to the west. The small drainageway below this area would not account for the transportation of enough alluvium to make this area an old alluvial terrace.

This appears to be closest to Choteau silt loam although it is less bleached in the lower A horizon and has no definite A_2 layer as occurs in the Choteau soils of Wagoner County. It has deeper A horizons than normal Bates and appears to have a deeper more productive solum than usual in this series. In many respects it resembles the Vanoss soils developed on high stream terraces in central and east Oklahoma.

Description of Dill Soil Series as Established by the Division of Soil Survey, U. S. Department of Agriculture

The Dill series includes reddish-brown deep soils with red moderately coherent subsoils. They occur in the reddish chesnut soils zone in Southwest Oklahoma, but are developed from sandy formations.

1. Soil Profile (Dill fine sandy loam)

   A. 0-10" Reddish-brown (5 YR 4/3; 3/3 moist) fine sandy loam; very friable; about neutral.

   B. 10-60" Red (2.5 YR 3/5; 2/6 moist) loam; friable; mildly alkaline but noncalcarous.

   C. 60" + Red (2.5 YR 4/7) noncalcarous, mildly alkaline packs and of weakly consolidated sandstone.

2. Range in characteristics; Subsoil texture ranges from sandy loam to fine sandy clay.

3. Topography: Nearly level to gently sloping.

4. Drainage: Rapid throughout.

5. Vegetation: Bluestems and grama grasses.

6. Use: Cotton, sorghum and small grains.

TABLE XX. Effects of delayed nitrogen applications and starter fertilizer on the lint yield of cotton on a Choteau silt loam soil, Kenneth Hughes farm, Hughes County, Oklahoma

Treatment	0-0-0 Rep. 1	0-0-0 Rep. 2	12-48-48 Rep. 1	12-48-48 Rep. 2
		1954		
0 N[1]	360[2]	312	479	466
20 N	408	352	442	479
40 N	258	397	439	466
60 N	351	373	403	507
80 N	264	395	458	523
		1955		
0 N	365	389	446	547
20 N	326	390	386	536
40 N	336	341	394	551
60 N	402	412	408	582
80 N	367	432	404	520
		1956		
0 N	167	150	288	207
20 N	221	206	294	228
40 N	168	264	232	270
60 N	210	193	226	313
80 N	154	234	295	308

[1] Treatment, rates, and materials given in Table II.

[2] Pounds of lint cotton per acre.

Table XXI. Effects of delayed nitrogen applications and starter fertilizer on the percent lint to seed cotton of cotton grown on Choteau silt loam soil, Kenneth Hughes farm, Hughes County, Oklahoma

Treatment	0-0-0 Rep. 1	0-0-0 Rep. 2	12-48-48 Rep. 1	12-48-48 Rep. 2
		1954		
0 N[1]	41.1[2]	39.2	38.6	39.6
20 N	40.6	40.8	39.3	37.8
40 N	39.5	40.0	38.2	38.8
60 N	40.1	39.7	39.5	38.8
80 N	37.4	38.8	38.5	39.6
		1955		
0 N	40.1	39.9	40.4	41.2
20 N	35.1	40.3	37.5	41.2
40 N	40.5	38.5	38.7	40.9
60 N	40.7	40.6	38.8	40.6
80 N	40.6	40.1	38.3	41.2
		1956		
0 N	39.7	35.6	37.8	38.0
20 N	40.3	37.1	38.2	40.0
40 N	37.3	38.9	37.8	38.1
60 N	40.0	37.3	38.9	37.0
80 N	36.5	40.0	38.2	39.8

[1] Treatment, rates and materials given in Table II.

[2] Pounds of lint cotton per acre.

TABLE XXII. Effect of delayed nitrogen applications and starter fertilizer on the percent lint to snapped cotton grown on a Choteau silt loam soil, Kenneth Hughes farm, Hughes County, Oklahoma

Treatment	0-0-0		12-48-48	
	Rep. 1	Rep. 2	Rep. 1	Rep. 2
	1954			
0 N[1]	30.1[2]	29.6	31.5	31.1
20 N	26.4	30.9	27.8	31.8
40 N	30.2	27.5	29.5	32.8
60 N	30.6	30.3	29.5	31.4
80 N	30.9	30.1	29.2	31.8
	1956			
0 N	25.6	23.0	25.2	25.4
20 N	27.1	24.3	25.0	25.8
40 N	23.4	26.1	24.5	28.5
60 N	26.8	24.6	25.6	25.9
80 N	23.5	26.5	26.6	26.2

[1] Treatments, rates, and materials given in Table II.

[2] Percent lint to harvested snapped bolls.

Table XXIII. Effect of delayed nitrogen applications and starter fertilizer on the nitrogen content of cotton seed grown on a Choteau silt loam soil, Kenneth Hughes farm, Hughes County, Oklahoma, 1954

Treatment	0-0-0		12-48-48	
	Rep. 1	Rep. 2	Rep. 1	Rep. 2
0 N[1]	4.29[2]	4.08	4.04	4.04
20 N	3.92	3.62	4.08	4.47
40 N	4.11	3.79	3.83	3.96
60 N	4.58	3.97	4.21	3.64
80 N	4.37	4.31	3.99	4.83

[1] Treatment, rates, and materials given in Table II.

[2] Percent Nitrogen of cotton seed.

TABLE XXIV. Effect of delayed nitrogen applications and starter fertilizer on the phosphorus content of cotton seed grown on a Choteau silt loam soil, Kenneth Hughes farm, Hughes County, Oklahoma, 1954

Treatment	0-0-0		12-48-48	
	Rep. 1	Rep. 2	Rep. 1	Rep. 2
0 N	0.562	0.440	0.398	0.419
20 N	0.445	0.455	0.360	0.369
40 N	0.578	0.389	0.363	0.395
60 N	0.529	0.322	0.367	0.397
80 N	0.600	0.325	0.300	0.429

TABLE XXV. Effect of delayed nitrogen applications and starter fertilizer on the nitrogen content of leaf petioles of cotton grown on a Dill fine sandy loam soil, Loyne Marvel farm, Caddo County, Oklahoma, 1954

Treatment	7-14-7[1]			
	Rep. 1	Rep. 2	Rep. 3	Rep. 4
0 N[1]	0.985[2]	1.052	1.263	1.156
20 N	0.942	1.012	1.137	1.224
40 N	1.270	1.112	1.317	1.059
60 N	1.132	1.121	1.137	1.030
80 N	1.141	1.032	1.061	1.195
Treatment	7-36-36			
0 N	1.097	1.234	1.152	1.137
20 N	1.981	1.137	1.078	1.020
40 N	1.156	1.049	1.185	1.069
60 N	1.098	1.204	1.137	1.098
80 N	1.117	1.010	1.088	1.079

[1] Treatments, rates, and materials given in Table III.

[2] Percent nitrogen of first mature leaf petiole from top of plant at early boll stage.

TABLE XXVI. Effect of delayed nitrogen applications and starter fertilizer on the phosphorus content of cotton leaf petioles grown on a Dill fine sandy loam soil, Loyne Marvel farm, Caddo County, Oklahoma, 1954

Treatment	7-14-7[1]			
	Rep. 1	Rep. 2	Rep. 3	Rep. 4
0 N[1]	0.109[2]	0.097	0.098	0.077
20 N	.077	.109	.112	.102
40 N	.100	.098	.094	.102
60 N	.098	.098	.098	.103
80 N	.77	.087	.077	.098
Treatment	**7-36-36**			
0 N	0.119	0.115	0.095	0.125
20 N	.119	.108	.104	.115
40 N	.112	.118	.101	.112
60 N	.125	.112	.112	.122
80 N	.121	.108	.104	.108

[1] Treatment, rates, and materials given in Table III.

[2] Percent phosphorus of first mature leaf petiole from top of plant at early boll stage.

TABLE XXVII. Effect of delayed nitrogen applications and starter fertilizer on the potassium content of cotton leaf petioles grown on a Dill fine sandy loam soil, Loyne Marvel farm, Caddo County, Oklahoma, 1954

Treatment	7-14-7[1]			
	Rep. 1	Rep. 2	Rep. 3	Rep. 3
0 N[1]	3.92[2]	3.10	3.72	3.20
20 N	3.10	3.34	3.54	4.04
40 N	3.72	3.42	3.84	4.20
60 N	3.52	3.30	3.80	4.20
80 N	3.90	3.88	3.68	3.87
Treatment	7-36-36			
0 N	3.64	3.76	3.94	4.16
20 N	3.88	3.84	3.72	3.90
40 N	4.28	3.60	3.80	3.72
60 N	3.88	4.12	3.54	4.00
80 N	3.72	4.08	3.72	4.08

[1] Treatment, rates, and materials given in Table III.

[2] Percent potassium of first mature leaf petiole from top of plants at early boll stage.

TABLE XXVIII. Effect of delayed nitrogen applications and starter fertilizer on the calcium content of cotton petioles grown on a Dill fine sandy loam soil, Loyne Marvel farm, Caddo County, Oklahoma, 1954

Treatment	7-14-7[1]			
	Rep. 1	Rep. 2	Rep. 3	Rep. 4
0 N	2.16[2]	2.30	2.28	2.02
20 N	2.38	2.20	2.30	2.68
40 N	2.44	2.44	2.28	2.36
60 N	2.38	2.16	2.24	2.08
80 N	2.40	2.19	1.94	2.01
Treatment	**7-36-36**			
0 N	2.28	2.46	2.38	2.20
20 N	2.41	2.42	2.48	2.44
40 N	2.38	2.44	2.49	2.28
60 N	2.46	2.52	2.44	2.26
80 N	2.48	2.20	2.42	2.46

[1] Treatments, rates, and materials given in Table III.

[2] Percent calcium of first mature leaf petiole from top of plant at early boll stage.

TABLE XXIX. Effect of delayed nitrogen applications and starter fertilizer on the magnesium content of cotton leaf petioles grown on a Dill fine sandy loam soil, Loyne Marvel farm, Caddo County, Oklahoma, 1954

Treatment	7-14-7[1]			
	Rep. 1	Rep. 2	Rep. 3	Rep. 4
0 N	1.56[2]	1.70	1.44	1.48
20 N	1.74	1.70	1.48	1.78
40 N	1.84	2.44	1.36	1.56
60 N	1.64	1.64	1.56	1.74
80 N	1.68	1.72	1.36	1.64
Treatment	7-36-36			
0 N	1.56	1.76	1.64	1.74
20 N	1.74	1.60	1.48	1.58
40 N	1.54	1.72	1.59	1.50
60 N	1.72	1.64	1.76	1.38
80 N	1.64	1.46	1.50	1.56

[1] Treatments, rates, and materials given in Table III.

[2] Percent magnesium of first mature leaf petiole from top of plant at early boll stage.

TABLE XXX. Effect of delayed nitrogen applications and starter fertilizer on the sodium content of cotton leaf petioles grown on a Dill fine sandy loam soil, Loyne Marvel farm, Caddo County, Oklahoma, 1954

Treatment	7-14-7[1]			
	Rep. 1	Rep. 2	Rep. 3	Rep. 4
0 N[1]	0.170[2]	0.200	0.170	0.156
20 N	.200	.180	.130	.196
40 N	.200	.170	.190	.174
60 N	.200	.196	.220	.174
80 N	.176	.190	.170	.170
Treatment	**7-36-36**			
0 N	0.124	0.154	0.190	0.170
20 N	.148	.140	.140	.158
40 N	.130	.140	.153	.152
60 N	.152	.140	.190	.190
80 N	.144	.140	.136	.180

[1] Treatments, rates, and materials given in Table III.

[2] Percent sodium of first mature leaf petiole from top of plant at early boll stage.

VITA

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