Completed

ESTABLISHING UPDATED GUIDELINES FOR COTTON NUTRITION

Cotton Incorporated Agreement #93-881CA

and

CDFA Agreement #92-589

and

Potash and Phosphate Institute and Great Salt Lakes Chemical Company Agreement #CA-14-F

FINAL REPORT

MARCH 1997

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Project Locations:

UC Shafter Research Station, Shafter, CA; UC West Side Field Station, Five Points, CA; Field Research Laboratory, Dos Palos, CA; and 16 grower cooperator fields throughout the San Joaquin Valley cotton growing areas (Merced, Madera, Fresno, Tulare, Kings, and Kern Counties).

Objectives of the Study

The objectives remain the same as were outlined in the original proposal except that certain modifications were made. Nitrogen guidelines have not been completed at this time, but are currently being developed. Economics as well as sustainable production systems require that nutrient inputs be justified and optimized.

Potassium fertility guidelines have been developed which consider soil supply, quantity of nutrients stored in plant tissues which can be mobilized, and the timing and intensity of demand by reproductive sinks. New guidelines are currently in press.

1. Establish the relationship between tissue nitrate level and leaf function. About 50 percent of the nitrogen in a leaf blade is part of a protein RUDPase which through the process of photosynthesis incorporates carbon dioxide into sugars (carboxylation). Early season levels of nitrate typically occurring under present fertilization practices are believed to be much higher than necessary to maintain leaf function. Before adjustments can be made in either the quantity or timing of nitrogen applications, we must establish the critical level for optimum leaf function.

2. Determine if Yields can be maintained and potential nitrogen losses impacting ground water quality minimized when nitrogen is supplied on an "as needed b" instead of preplant, or split applications between preplant and side dress at the early square stage.

3. Improve the predicative ability of current soil K test procedures. Ammonium extractable K is the soil test currently used to identify potassium sufficiency. Soils with montinorillonitic or vermucillitic clays exhibit K fixation. The current extraction procedure does not adequately consider fixation. Current procedures will be compared to two new possible methods under development These potentially new methods include water extractable K and a resin-K procedure.

4. Develop nitrogen and potassium recommendations which simultaneously consider the soil supply rate, the quantity of nutrients stored in plant vegetative structures which can be mobilized without affecting leaf function, and the demand (timing and intensity) by developing bolls.

Progress of Research

Specific results to date for each of the objectives are as follows. In every case, the following activities were completed every year for the past three years.

1. Critical Nitrate Levels

Plots were established at the UC West Side Research and Extension Center under drip irrigation. Nine combinations of nitrogen application included variation in the quantity of nitrogen and the time during the season when it was applied. Field sampling of nitrogen rate and timing plots has been completed for the first two years. Leaves at three positions on the plants were sampled when they were first fully expanded, the subtending boll was at bloom, bloom plus 21 days, and bloom plus 42 days. This detailed enzyme work to establish the effect of nitrogen rate and timing upon leaf function and longevity has been completed. All plots were sampled for nitrate on the appropriate sample dates, and tissue analysis has been completed. Growth and development data have been collected throughout the season. All in-season samples have been summarized.

Soil samples were collected from a field at the UC West Side Field Station for complete soil analysis. Twenty soil cores were taken from 0-12" and from 12-36" depths.

A drip system was installed including nitrogen metering devices. Statistical design was RCB with 5 treatments and replicated 4 times.

Acala Maxxa cotton was planted and after emergence, thinned to 45,000 plants per acre.

Leaves (blades and petioles) which subtended a first position boll on fruiting branches 3 and 8 were sampled when the leaf was fully expanded, again when the position reached anthesis, again at 3 weeks post anthesis and, finally, at 6 weeks post anthesis. Prior to excising the leaves, carbon assimilation rates (CER) was determined by infrared gas analysis. The leaf blades were analyzed for leaf area index (LAI), specific weigh RUDPase, nitrate, and total nitrogen. Each of these data were collected and determinations made from plots where 0, 75, 180, and 300 lbs/A nitrogen were applied during the growing season. A fifth comparison was made where 300 lbs/A nitrogen was applied by the time of early square,.

All sampling and measurements were completed in a timely manner.

Preplant/early season N application was made using the drip irrigation system, with 56 kg N/ha applied preplant to treatments #5 through #9 in the study.

Treatment description:

Irrigation Treatment #	Preplant N Application?	Within-Season Applied N (kg/ha)	N Fertilizer Application Period and Pattern of foliar Application During Season*
1	NO	0	none
2	NO	59	all season / uptake
3	NO	120	all season/uptake
4	NO	180	all season/uptake
5	YES	59	all season/uptake
6	YES	120	all season/uptake
7	YES	180	all season/uptake
8	YES	180	nodes 5-10/linear
9	YES	180	nodes 11-15/linear

*pattern of application refers to how the rate applied varied over time - applications were either matched to approximate changes in nutrient uptake over time (labeled as "uptake") or were applied at a constant rate (linear).

Seed cotton yields:

-Seed cotton yields were significantly lower in the no applied-N treatment (TI) than in all other treatments (table 1, figure 1).

-Highest seed cotton yields were at the intermediate N application level (120 kg N/ha), although differences from low or high application treatments were not significant in all cases.

-Even though petiole nutrient levels generally were not lower in the treatments which did not receive preplant N, yields tended to be slightly lower (5 to 9%) in treatment without preplant N applications.

Soil nutrient status:

-Early-season and end-of-season samples were collected to identify initial and final soil nitrogen (and other nutrients) levels as a function of N treatment and depth in the profile.

-We expected and did find residual, early--season N levels to be somewhat high this first year of the study - this was not a surprise because 215 kg N/ha were uniformly applied to these plots in the year before the study and in years prior to that a seed alfalfa crop was grown in the field for the prior three years.

Petiole nutrient status:

-As with the results from the leaf and petiole samples analyzed in Davis, petiole N03-N levels separated out quite well across N treatments (figures 2-6), with significantly lower petiole N03-N levels in low- and no-N treatments than in moderate and high N application treatments. In general, there were few significant differences between petiole nutrient levels in moderate- and high-N treatments. In addition, there were few interactions of N treatments with petiole P04-P or K levels.

Protein values for cotton leaf samples:

There are no readily apparent treatment differences, but we do see leaf position differences. At position 3, proteins are highest at the earliest harvest, then decline. This is expected with age. At position 5, proteins remain relatively constant until harvest 5, at which time they increase somewhat. Also, at position 8, protein decreases with age. It appears that protein from the upper leaves (position 8) is being remobilized for use in fruiting. The same thing is happening at position 3, but the older leaves are further along. The high level of protein at position 5, at harvest, is more difficult to interpret. It may be that this also reflects remobilization. The remobilization of storage proteins for transport to fruiting bodies, under conditions where transport is not yet occurring, would account for these results (tables 2 through 12).

Soil water status/plant water status:

-Applied water amounts are shown in table 13.

-Soil water content was monitored every two to three weeks during the entire season using neutron probe - data not yet summarized.

-Total evapotranspiration (ET) on all treatments will be in the 700 to 800 mm range, for the entire season - no statistical analysis completed yet to determine treatment differences in total season ET, but total season ET averaged 3 to 6% lower in the no-N and low-N treatments than in the other treatments.

-Plant water status monitored weekly on select treatments using infrared thermometry/CWSI techniques - data not yet summarized.

Plant growth/mapping/other analyses:

-Plant samples separated into component parts (leaf, petioles, stems, bolls, lint) at four separate sampling dates during- season, dried and ground for chemical analysis and determination of nutrient concentrations and uptake rates.

-Leaf samples analyzed for N03-N and total N as a function of age, position on plant, and growth stage (samples are being analyzed at the USDA lab).

-Leaf samples analyzed for soluble protein and enzyme function at UC Davis lab (see their report for description of activities).

-Plant mapping (during season and final) done by Mark Keeley and Cooperative Extension crew from Shafter.

2. Rate and Timing of Nitrogen Applications

Two field tests were conducted each year for the past 4 years. One test was at the USDA Cotton Research Station in Shafter and the other test was at the Field Research Laboratory in Dos Palos. The findings indicate that there is little or no yield response to high rates of N fertilization. It is thought that cotton plants are utilizing pools of N from 2-4 feet depths. A new proposal for 1998 has been written to study the effects of residual N.

Nitrogen deficiency symptoms were detected in the water run nitrogen treatments (no preplant N) at the UC West side Research and Extension Center. Tissue analyses are not yet available. Final plant mapping has been completed. Plots where 200 lbs/acre nitrogen were applied with the three in-season irrigations were 4.4 inches shorter than plots where all the nitrogen was applied prior to the first in-season irrigation. Delayed nitrogen also decreased the number of fruiting branches, decreased fruit retention approximately 6 percent at the first position of the first 10 fruiting branches, and caused a 12 percent reduction in total number of harvestable bolls per plant at the end of the season.

Soil samples were collected from fields at the UC West Side Field Station and the Field Research Laboratory and subjected to a complete soil analysis. Twenty cores were taken from 0-12" and from 12-36".

A subsurface drip irrigation system was installed at the West Side Field Station site. Nitrogen was applied by the, system prior to early square stage of growth or metered into daily irrigation water throughout the growth period. Method of application was the main plot treatment and four nitrogen rates (0, 75, 180, and 300 lbs/A) were sub-plot treatments. An optimum rate (200 lbs/A) was applied prior to early square and compared to the same amount applied in irrigation throughout the growing season. This paired comparison was repeated 8 times at the West Side Field Station and 10 times at the Field Research Laboratory. Both sites were planted to Acala Maxxa cotton and thinned to 45,000 plants per acre.

In season plant map data (height, nodes, growth rates, node to lst fruiting branch, fruit retention, date to first bloom, and nodes above white flower) were collected on four dates in all tests.

A final plant mapping- of plant height, nodes, fruit retention, earliness, and date of cut out was conducted at all locations.

All plots were machine harvested, plot weights recorded, and a six pound sample taken for gin turnout and fiber quality analysis.

There was a significant difference among the means of petiole N between sidedressed N and water run N at both test sites (table 14).

When petiole nitrate values were regressed vs. time, it was noted that sidedressed N resulted in higher petiole N03-N levels in both tests. Nitrate levels in petioles from both methods of N application fell more rapidly than expected with time. Although values began at sufficient levels in early in the season, by 200 days after planting, they were below deficient levels. (figures 7 and 8). Critical levels are about 10,000 ppm and plot levels were approximately 5,000 ppm at both test sites. This trend held for the rest of the growing season with the water run N treatment always being lower than the sidedress treatment.

It was felt by the principal investigators that applying N in the irrigation water does not provide the nutrient soon enough for the crops needs. A change for future experiments will include a third treatment in which 40% of the N is applied preplant in order to provide enough N for early season needs.

Table 15 shows seed cotton yields for the two test sites. There was a significant difference among yield means between the two treatments. Sidedressed N outyielded water run N (p=O.008). There was a significant location difference ($p=0.00$) and a significant treatment by location difference ($p=0.007$).

3. Soil Test Methods for Determining Potassium Response

Approximately 50 field locations in all six San Joaquin Valley cotton growing counties were screened for soil potassium at two or three depths. Three locations in each of six counties were selected for study. These 18 field locations represented a difference in soil test level, ranged geographically in the San Joaquin Valley and represented soil that have fixation. Prior to the first irrigation, 0 or 400 lbs/acre of potassium was applied to large scale plots. Petiole and plant growth data were collected four times during the season. The first three year's data has been summarized.

Preliminary soil samples (0-8") were taken from as many as 10 sites in each of the six San Joaquin Valley cotton growing counties. These samples were analyzed by UC Diagnostic Laboratory for SP, pH, soluble K, and exchangeable K. Three sites in each county were selected from the preliminary ones that best provided a balance in East-West, North-South, soil type, K level, etc,

The three selected fields in each county were sampled from 0-5", 5"-15", and 15'' - 30'' and evaluated for K sufficiency by four laboratory methods including the neutral ammonium acetate extraction method, a K-resin method, and water extraction method, and eight other methods. The soils were also fully characterized as to other nutrients, cation balance, salinity, clay mineralogy, and nitrogen mineralization rates.

Each county advisor established three tests in which 0 or 400 lbs/A K as Kcl was applied in paired comparisons. Plots were the length of the field, replicated four times. Materials were applied by agricultural chemical companies using their commercial application equipment. Growth and development data (plant height, nodes, nodes above white flower) were taken at two week intervals. All plots were plant mapped prior to harvest.

Petiole and blade samples were collected at early bloom, two weeks later, and at cut out.

Complete soil tests were conducted on end of season soil samples taken at 0-5", 6-15", and 16-30" depths.

Yield response to K was regressed vs. soil test K by various laboratory methods to determine, relative predictability of each soil test method.

Table 16 shows the statistical analysis for 16 paired comparisons conducted in the six San Joaquin Valley cotton growing counties. There was a significant difference among yield means between the two treatments (O and 400 lbs K/A) with a probability of 0.007. There was a highly significant difference among location means ($p=0.00$), and a significant treatment by location difference ($p=0.015$).

Some visibility received by project "Establishing Updated Guidelines for Cotton Nutrition".

1. 1994 - Agenda at Cotton Workgroup Meeting.
2. 1994 - Article in Cotton Review Newsletter - Munk
3. Agenda item at Merced/Madera cotton Meeting - Weir and Vargas
4. 1994 - Agenda Item at Merced Cotton Field Day - Weir
5. 1994 - Agenda item Westside Field Station Field day - Munk
6. 1994 - Agenda item Kings and Tulare Field day - Wright and Roberts
7. 1994 - Poster at Kings open house - Roberts
8. 1994 - Poster at Fertilizer Research and Education Meeting- Weir
9. 1995 - Poster at Beltwide Cotton Conference - Weir
10. 1995 - Oral paper at Beltwide Cotton Conference - Hutmaker
11. 1995 - Oral paper at Beltwide Cotton Conference - Miller
12. 1996 - Article in Cotton Review - Weir
13. 1996 - Publication (in Press) - all researchers
14. 1996 - Oral Presentation at cotton meeting in Visalia - Weir
15. 1996 - Poster at Fertilizer Research and Education Mtg - Modesto - Weir
16. 1996 - Oral presentation at cotton production met in Yuba City - Weir
17. 1997 - Oral and poster presentations at Plant and fertilizer conference in Visalia - Weir
18. 1997 - Oral presentation at Beltwide Cotton Conference in New Orleans - Miller
19. 1997 - Oral presentation at Cotton production meeting in Visalia - Roberts
20. 1997 - Oral presentation and Handout at Cotton production mtg in Ddos Palos - Weir

When K lint yields were regressed against SP, pH, soluble K, and exchangeable K, at three soil depths, only exchangeable K means were significant at the 95% confidence level (table 17).

There is an indication that a correlation exists between the ammonium acetate extraction method and lint yield.

Figures 9, 10, and I I show yield responses versus exchangeable K at all 16 locations for three soil depths. Quadratic equations give the best fit with R=0.52 for the 0-5" soil samples, R--O.72 for the 6-15" soil samples, and R=0.71 for the 16-30" soil samples. It can be seen that the, more exchangeable K in the lower soil levels, the less the effect of added K to the top 5 inches.

N03-N and K petiole and blade analyses are shown in table 7 for tissues samples at first bloom. There was no significant difference among N03-N means between the K treated plots and the control for either leaf petioles or blades. Although N03-N content was higher in petioles and blades collected from the 400 lbs/A K20 treated plots.

Petiole and blade K levels were significantly higher in treated plots than in the untreated control plots.

Table 19 shows leaf petiole and blade N03-N and K levels of tissues collected 10 days after cut out. There was no significant difference in petiole N due to treatment. However, differences among the means of blade N03-N petiole K, and blade K were significantly different at the 95% confidence level. As the season progresses, there is more effect on leaf N and K content as a result of adding K to the soil.

When exchangeable K vs. relative cotton yield is subjected to Cate-Nelson analysis, it is determined that 90 percent of the cotton yield can be correlated with 90 ppm extractable K in the 5-15 inch soil depth (figure 12).

Also, 90 percent of the cotton yields can be correlated with 70 ppm exchangeable K in the 15-30 inch soil depth as shown in figure 13.

Cate-Nelson critical points for petiole K vs. relative cotton yield are shown in figure 14. 92 percent of the relative cotton yield occurred when petiole K values were 1.3 percent at the 3rd sampling date, or mid to late July (figure 15).

These comparisons indicate that the ammonium acetate extraction method, and Mehlich 3 extraction methods, for exchangeable soil
K correlates fairly well to lint cotton yields. We are looking forward to seeing how other soil extraction methods for K correlate with yields, as well.

Item 1 is a copy of the Updated K Guidelines for Cotton, which was produced as a result of three years research. Also, the following presentations were made.

Table 1. Effect of various rates and timing of applied N on cotton yields.

Trt.	Harvest plot	Variety	N Trt.	Block #	KG seed cotton per harvest area	% of row harvested	Cotton (kg/ha)	Avg.	Est. lint yield (assuming 36% turnout) (bales/A)
No N:	4	Maxxa	T1	1	2.8	21.5	5607.3		
	11			2	3.1	23.5	5679.7		
	23			3	2.8	21.0	5740.8		
	36			4	5.1	36.5	6016.0	5760.966	3.86
No-preplant:									
Low 60 lbs	7	Maxxa	T2	1	3.1	32.0	6067.0		
	17			2	3.5	22.5	6697.6		
	19			3	6.2	40.0	6673.7		
	31			4	3.2	22.0	6262.7	6425.238	4.30
Med 120 lbs	5	Maxxa	T3	1	3.5	22.0	6849.8		
	16			2	3.5	21.0	7176.0		
	27			3	8.1	52.5	6642.9		
	34			4	3.7	22.0	7241.2	6977.495	4.67
High 180 lbs	6	Maxxa	T4	1	3.1	22.0	6067.0		
	18			2	6.7	41.0	7036.0		
	20			3	3.0	22.0	5871.3		
	30			4	3.2	21.5	6408.3	6345.642	4.25
Preplant 50 lbs N/A:									
Low 60 lbs	1	Maxxa	T5	1	6.2	40.0	6673.7		
	12			2	3.1	20.5	6510.9		
	26			3	4.0	24.0	7176.0		
	35			4	3.5	21.0	7176.0	6884.147	4.61
Med 120 lbs	9	Maxxa	T6	1	8.4	50.0	7233.4		
	14			2	3.8	21.0	7791.1		
	25			3	3.9	22.0	7632.7		
	32			4	3.5	20.5	7351.0	7502.043	5.02
High 180 lbs	3	Maxxa	T7	1	3.2	21.5	6408.3		
	15			2	3.6	22.0	7045.5		
	24			3	3.8	23.0	7113.6		
	29			4	4.3	23.0	80949.6	7154.266	4.79
Preplant 50 lbs N/A Linear:									
180 lbs nodes 50-10	2	Maxda	T8	1	3.2	22.0	6262.7		
	13			2	3.4	22.0	6654.1		
	22			3	4.5	22.5	8611.2		
	28			4	9.0	50.0	7750.1	7319.52	4.90
180 lbs nodes 11-15	8	Maxxa	T9	1	3.5	23.0	6552.0		
	10			2	9.0	49.0	7908.2		
	21			3	2.9	21.5	5807.6		
	33			4	3.7	23.5	6779.0	6761.707	4.52

Table 2. Harvest #1, mg/g FW

Trtmt.	1	2	3	4	5	6	7	8	9
	10.72	18.58	5.90	7.74	10.19	7.34	11.31	8.54	9.92
	6.15	6.45	5.06	8.77	11.73	10.03	7.43	9.76	8.43
	8.96	5.38	13.23	5.88	8.72	6.93	12.17	9.64	6.44
	5.91		4.60	8.66	7.86	17.52	6.95	5.52	10.09
Avg.	7.94	10.14	7.20	7.61	9.63	10.47	9.47	8.35	8.72

Table 3. Harvest #2 - positon 3, mg/g/FW

Trtmt.	1	2	3	4	5	6	7	8	9
	12.74	10.78	4.78	5.38	3.37	4.64	13.32	5.05	9.73
	8.62	5.41	12.87	9.95	8.20	11.97	3.89	6.80	12.52
	11.22	3.93	11.34	4.53	5.09	6.33	11.74	7.68	4.26
	5.09		8.24	9.43	4.05	3.93	9.56	4.37	5.11
Avg.	9.43	6.11	9.32	7.32	5.18	6.72	9.64	5.98	7.91

Table 4. Harvest #2 - position 5

Trtmt.	1	2	3	4	5	6	7	8	9
	9.62	9.17	6.18	5.23	9.94	8.56	11.30	13.62	6.25
	11.66	12.11	12.52	6.82	10.80	10.81	9.16	13.53	9.81
	8.74	8.71	8.72	4.55	9.86	7.87	6.42	12.82	9.14
	8.85		3.08	8.49	5.65	5.71	10.50	8.92	9.96
Avg.	9.72	10.00	7.63	6.27	9.06	8.24	9.35	12.17	8.79

Table 5. Harvest #3 - position 3, mg/g FW

Trtmt.	1	2	3	4	5	6	7	8	9
	2.94	5.24	5.47	4.28	3.11	4.40	8.08	9.54	4.78
	9.44	2.96	5.63	4.78	4.68	3.84	7.06	6.52	6.02
	6.04	6.16	6.05	6.51	7.02	5.33	6.74	4.63	9.75
	5.32		3.24	4.72	5.35	3.66	4.55	4.47	6.04
Avg.	5.94	4.79	5.24	5.07	5.04	4.31	6.61	6.29	6.65

Table 6. Harvest #3 - position 5

Trtmt.	1	2	3	4	5	6	7	8	9
	6.68	12.34	13.64	11.48	14.50	9.30	10.54	11.12	9.91
	8.46	7.19	6.32	8.23	7.30	8.39	11.66	11.17	9.08
	10.34	8.33	10.58	15.23	12.77	8.05	10.01	13.72	12.54
	12.68		14.41	10.71	9.24	9.23	14.71	11.34	9.81
Avg.	9.54	9.29	11.24	11.41	10.95	8.74	11.73	11.84	10.35

Table 7. Harvest #3 - position 8

Trtmt.	1	2	3	4	5	6	7	8	9
	14.82	12.04	10.24	4.37	11.70	8.47	9.75	13.66	10.01
	14.90	9.53	8.31	8.52	10.67	10.69	14.11	7.30	11.02
	13.46	16.38	14.34	12.10	18.85	11.95	13.55	16.27	12.69
	12.78		9.92	7.11	11.69	14.065	14.17	8.07	14.98
Avg.	14.12	12.65	10.73	8.03`	13.23	11.42	12.40	11.33	12.18

Table 8. Harvest #4 - position 3

Tr	1	2	3	4	5	6	7	8	9
	3.08	3.58	4.01	5.83	4.91	3.21	3.38	3.85	3.42
	5.02	3.42	3.52	2.38	3.77	3.43	3.44	3.71	4.11
	3.96	3.89	2.89	8.28	2.69	1.19	2.23	2.21	4.99
	3.57		3.52	4.06	1.70	4.51	4.87	3.96	4.67
Avg.	3.91	3.63	3.50	5.14	3.27	3.09	3.48	3.43	4.30

Table 9. Harvest #4 - position 5

Trtmt.	1	2	3	4	5	6	7	8	9
	7.61	15.06	9.03	13.06	13.43	15.47	10.98	8.29	12.81
	13.03	10.19	8.95	11.85	6.80	8.12	10.89	19.45	7.79
	12.04	7.16	10.21	9.09	9.52	12.55	16.05	17.47	13.20
	4.50		11.04	6.72	9.17	10.35	8.83	7.34	10.53
Avg.	9.31	10.80	9.82	10.18	9.73	11.62	11.69	13.14	11.08

Table 10. Harvest #4 - position 8

Trtmt.	1	2	3	4	5	6	7	8	9
	4.74	8.45	6.99	7.70	8.02	11.79	6.06	7.02	8.62
	6.46	6.57	6.94	8.41	6.06	5.63	9.56	11.63	7.13
	7.69	7.08	11.68	8.82	6.50	4.17	10.12	7.75	8.48
	10.89		8.64	6.06	5.14	9.73	7.18	12.66	6.83
Avg.	7.45	7.37	8.56	7.75	67.43	7.83	8.23	9.77	7.77

Table 11. Harvest #5 - position 5

Trtmt.	1	2	3	4	5	6	7	8	9
	8.53	14.85	9.90	17.58	12.98	21.77	18.41	15.15	14.16
	12.77	6.64	11.68	13.63	7.58	10.34	14.55	18.27	11.46
	18.82	22.75	8.80	16.06	21.12	15.29	14.48	18.94	17.72
	12.60		20.15	17.65	13.21	22.01	9.64	9.98	11.29
Avg.	13.18	14.75	12.63	16.23	13.72	17.31	14.28	15.59	13.65

Table 12. Harvest #5 - position 8

Trtmt.	1	2	3	4	5	6	7	8	9
	3.95	4.62	8.26	7.67	7.44	3.60	6.71	8.62	13.04
	8.16	5.76	5.41	4.24	3.80	3.38	5.19	11.17	4.07
	9.27	4.73	4.03	9.81	16.71	5.89	12.06	4.77	6.67
	12.74		3.37	3.41	4.44	8.41	5.89	4.65	4.51
Avg.	8.53	6.70	5.27	7.66	8.10	5.32	7.46	7.32	7.07

Table 13. Total amounts of N and water applied. Year end totals: WSFS/1993/N Study

1. Nitrogen applied as CAN-17

Treatment	2	66.52	Kg/ha	(59.35 lbs/acre)
	3	134.35	"	(119.87 ")
	4	201.57	"	(179.84 ")
also	)5	66.52	"	(59.35 ")
56.04 Kg	)6	134.45	"	(119.95 ")
preplant	)7	201.57	"	(179.84 ")
	)8	117.82	"	(105.12 ")
	)9	201.90	"	(180.13 ")

2. Water applied

Treatment	1	520.1 mm
	2	519.3 mm
	3	519.3 mm
	4	522.8 mm
	5	524.8 mm
	6	511.8 mm
	7	530.9 mm
	8	526.4 mm
	9	510.4 mm

3. Phosphoric acid = 70.83 Kg/ha

4. Potassium thiosulphate = 204.56 Kg/ha

5. Et = 439.82 mm

Table 14. Effect of sidedress or water run N on petiole nitrate levels.

	---petiole N (ppm)----		
Location	Sidedress	Water	Probability
West Side Field Sta.	7986	6054	0.007
Field Research Lab.	8307	5387	0.000

Table 15.

1993 WATER RUN N VS. SIDEDRESS N TRIALS - OVERLOC.

LOCATION: WSFS & MERCED CO.

TREATMENT		SEED COTTON LBS/A	LINT %	GIN T.O. %	LINT YIELD LBS/A
200 N SIDEDRESS		4447.6			
200 N WATER RUN		4334.3			
MEAN		4391.0	ERR	ERR	ERR
LSD 0.05		76.4			
%CV		2.4			
P		0.008			
LOCATION					
WSFS		4818.8			
MERCED		3963.2			
LSD 0.05		64.6			
%CV		2.2			
P		0.000			
TRT. X LOC.					
SIDEDRESS	WSFS	4922.3			
SIDEDRESS	MERCED	3973.0			
WATER RUN	WSFS	4715.4			
WATER RUN	MERCED	3953.3			
LSD 0.05		91.4			
%CV		2.2			
P		0.007			

Table15. Effect of soil applied K on cotton yields..

K FERTILITY 1993

LOCATION: 6 COUNTIES

LBS. K2O/A	LINT %	GIN T.O. %	LINT YIELD LBS/A
0	40.8	35.4	1327
400	40.9	35.7	1431
MEAN	40.9	35.6	1379
LSD 0.05	NS	NS	38
%CV	1.1	2.8	3.1
P	0.317	0.295	0.007
LOCATION			
KERN-1	41.4	35.2	1446
KERN-2	37.7	33.7	751
KERN-3	42.5	38.0	1190
KINGS-1	40.0	35.1	1702
KINGS-2	40.9	36.1	1377
KINGS-3	40.2	34.6	1291
TULARE-1	41.2	36.5	1417
TULARE-3	41.8	37.8	1414
FRESNO-1	41.9	34.6	1755
FRESNO-3	40.4	35.5	1691
MADERA-1	40.4	35.6	1440
MADERA-2	39.9	35.3	946
MADERA-3	40.4	33.5	1185
MERCED-1	42.7	36.2	1559
MERCED-2	41.1	35.7	1333
MERCED-3	41.0	35.5	1565
LSD 0.05	0.4	0.8	108
%CV	0.9	1.9	6.8
P	0.000	0.000	0.000

	LINT %	GIN T.O. %	LINT YIELD LBS/A
TRT. * LOC.			
CONTROL KERN-1	41.5	35.5	1441
K KERN-1	41.3	35.0	1451
CONTROL KERN-2	37.6	33.4	747
K KERN-2	37.9	33.9	755
CONTROL KERN-3	42.4	37.8	1163
K KERN-3	42.6	38.1	1217
CONTROL KINGS-1	40.1	35.0	1643
K KINGS-1	39.9	35.2	1761
CONTROL KINGS-2	40.6	36.0	1343
K KINGS-2	41.1	36.1	1411
CONTROL KINGS-3	40.1	34.2	1143
K KINGS-3	40.2	34.9	1438
CONTROL TULARE-1	41.2	36.4	1374
K TULARE-1	41.2	36.7	1460
CONTROL TULARE-3	41.9	37.9	1394
K TULARE-3	41.8	37.6	1435
CONTROL FRESNO-1	41.8	34.4	1728
K FRESNO-1	41.9	34.8	1782
CONTROL FRESNO-3	40.5	35.2	1567
K FRESNO-3	40.2	35.8	1815
CONTROL MADERA-1	40.1	35.4	1370
K MADERA-1	40.7	35.8	1509
CONTROL MADERA-2	39.8	35.4	761
K MADERA-2	40.1	35.2	1131
CONTROL MADERA-3	40.5	33.0	1107
K MADERA-3	40.4	33.9	1263
CONTROL MERCED-1	42.6	35.9	1540
K MERCED-1	42.9	36.6	1577
CONTROL MERCED-2	41.2	35.6	1355
K MERCED-2	41.0	35.8	1310
CONTROL MERCED-3	40.6	35.5	1556
K MERCED-3	41.3	35.5	1574
LSD 0.05	NS	NS	153
%CV	0.9	1.9	6.8
P	0.612	0.936	0.015

Table 17. Linear regression of yield response against various soil paramaters at three soil depths when 400 lbs/A K was added.

Soil parameter	Soil depth 0-5"	6-15"	16-30"
	--------------------	*probability*	--------------------
SP	0.17	0.94	0.98
pH	0.43	0.52	0.58
Sol K	0.83	0.69	0.52
Exch K	0.03*	0.03*	0.03*

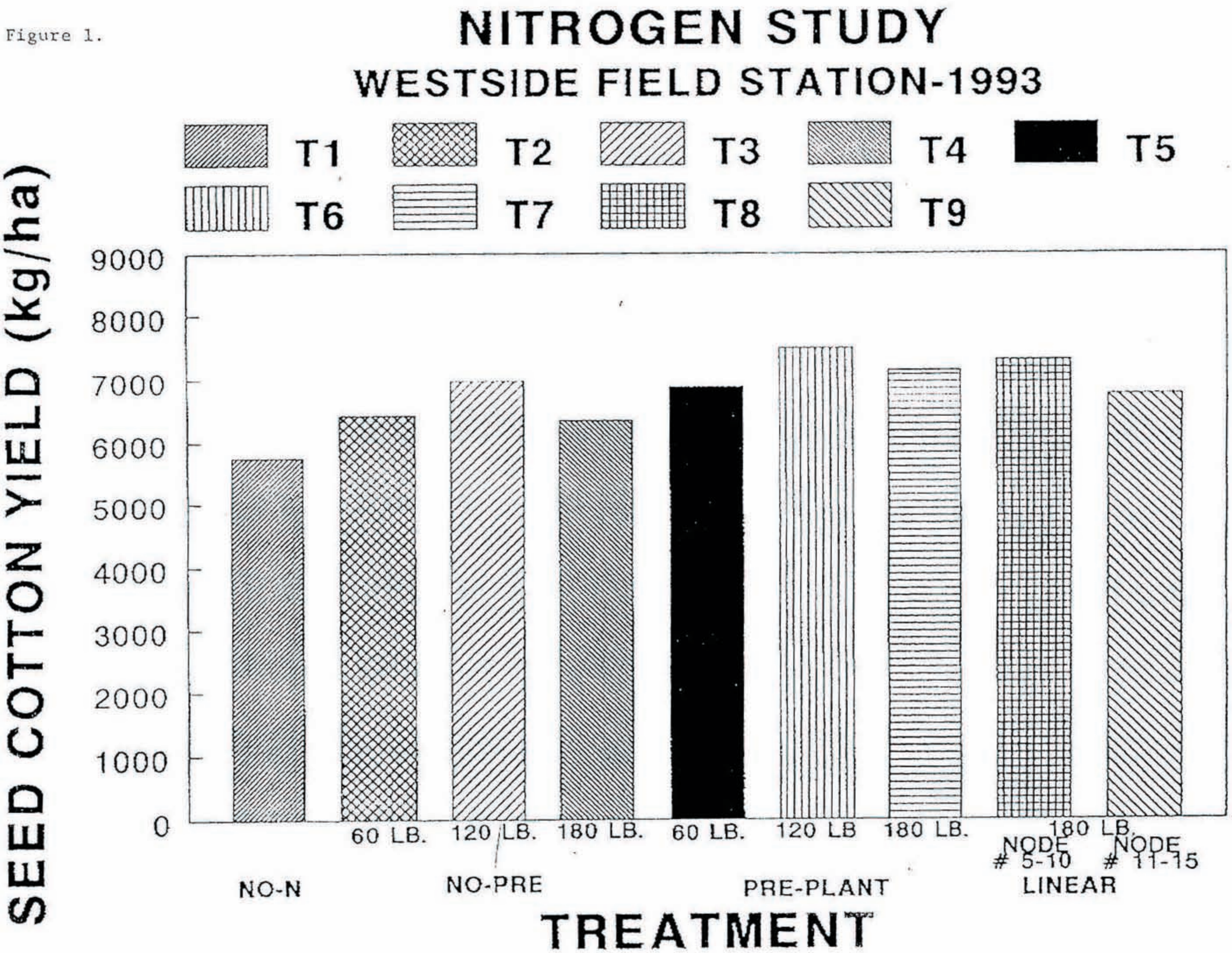
Table 18. Leaf petiole and blade NO_3-N and K levels at first bloom resulting from 0 or 400 lbs/A K_2O fertilizer.

Treatment	Petiole N (ppm)	Blade N (ppm)	Petiole K (%)	Blade K (%)
Untreated control	8720	209	3.69	1.03
400 lbs/A K_2O	9550	241	4.29*	1.14*

Table 19. Leaf petiole and blade NO_3-N and K levels 10 days after cut out as a result of 0 or 400 lbs/A K_2O fertilizer.

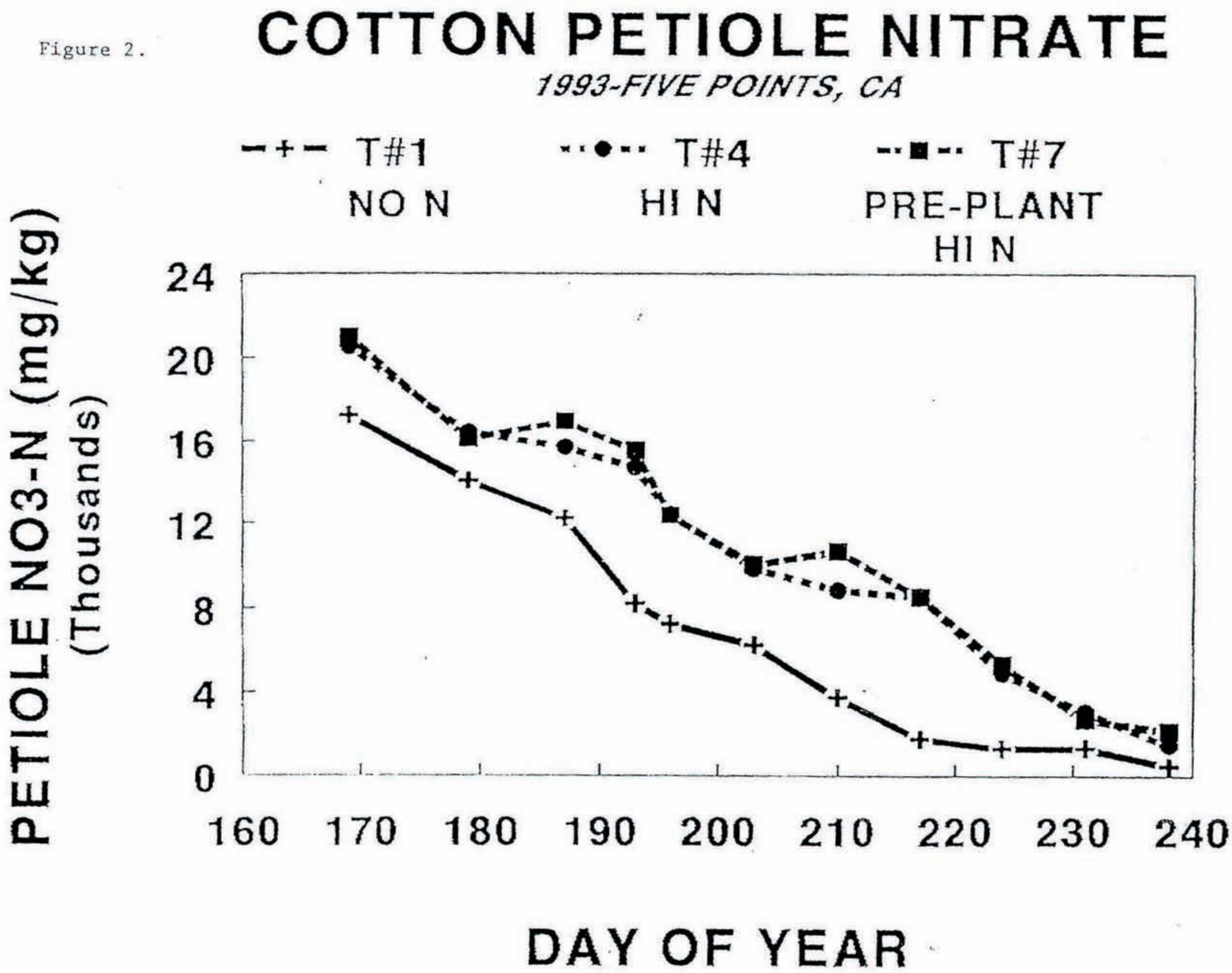
Treatment	Petiole N (ppm)	Blade N (ppm)	Petiole K (%)	Blade K (%)
Untreated control	1371	104	2.31	1.04
400 lbs/A K_2O	1441	129*	2.54*	0.95*

Figure 1.



NITROGEN STUDY
WESTSIDE FIELD STATION-1993
T1
T2
T3
T4
T5
T6
T7
T8
T9
SEED COTTON YIELD (Kg/ha)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
60 LB.
120 LB.
180 LB.
60 LB.
120 LB
180 LB.
180 LB.
NODE # 5-10
NODE # 11-15
NO-N
NO-PRE
PRE-PLANT
LINEAR
TREATMENT

Figure 2.



COTTON PETIOLE NITRATE
1993-FIVE POINTS, CA
T#1
NO N
T#4
HI N
T#7
PRE-PLANT
HI N
PETIOLE NO3-N (mg/kg)
(Thousands)
0
4
8
12
16
20
24
160
170
180
190
200
210
220
230
240
DAY OF YEAR

Figure 3.

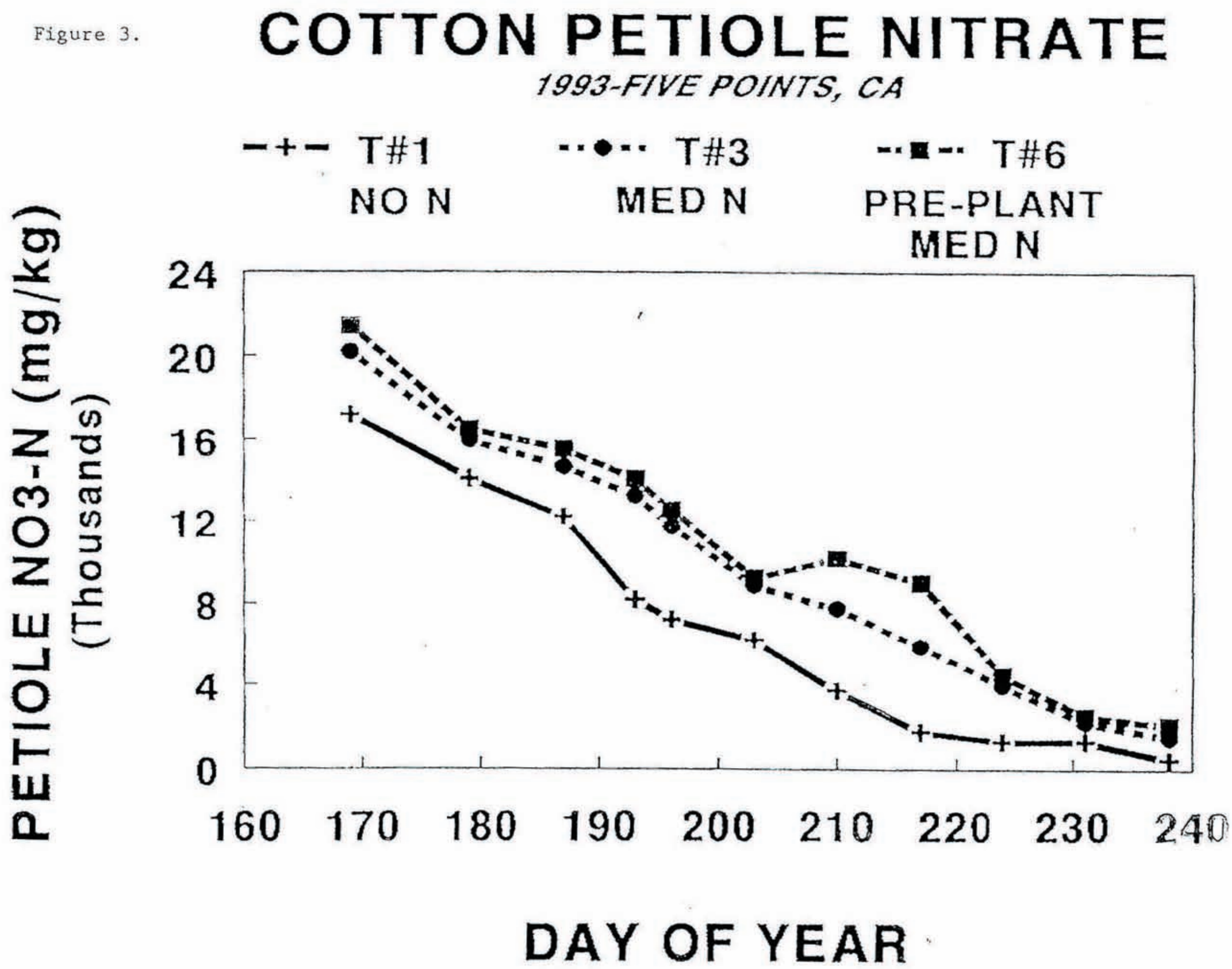

COTTON PETIOLE NITRATE
1993-FIVE POINTS, CA
T#1 NO N
T#3 MED N
T#6 PRE-PLANT MED N
PETIOLE NO3-N (mg/kg) (Thousands)
24
20
16
12
8
4
0
160
170
180
190
200
210
220
230
240
DAY OF YEAR

Figure 4.

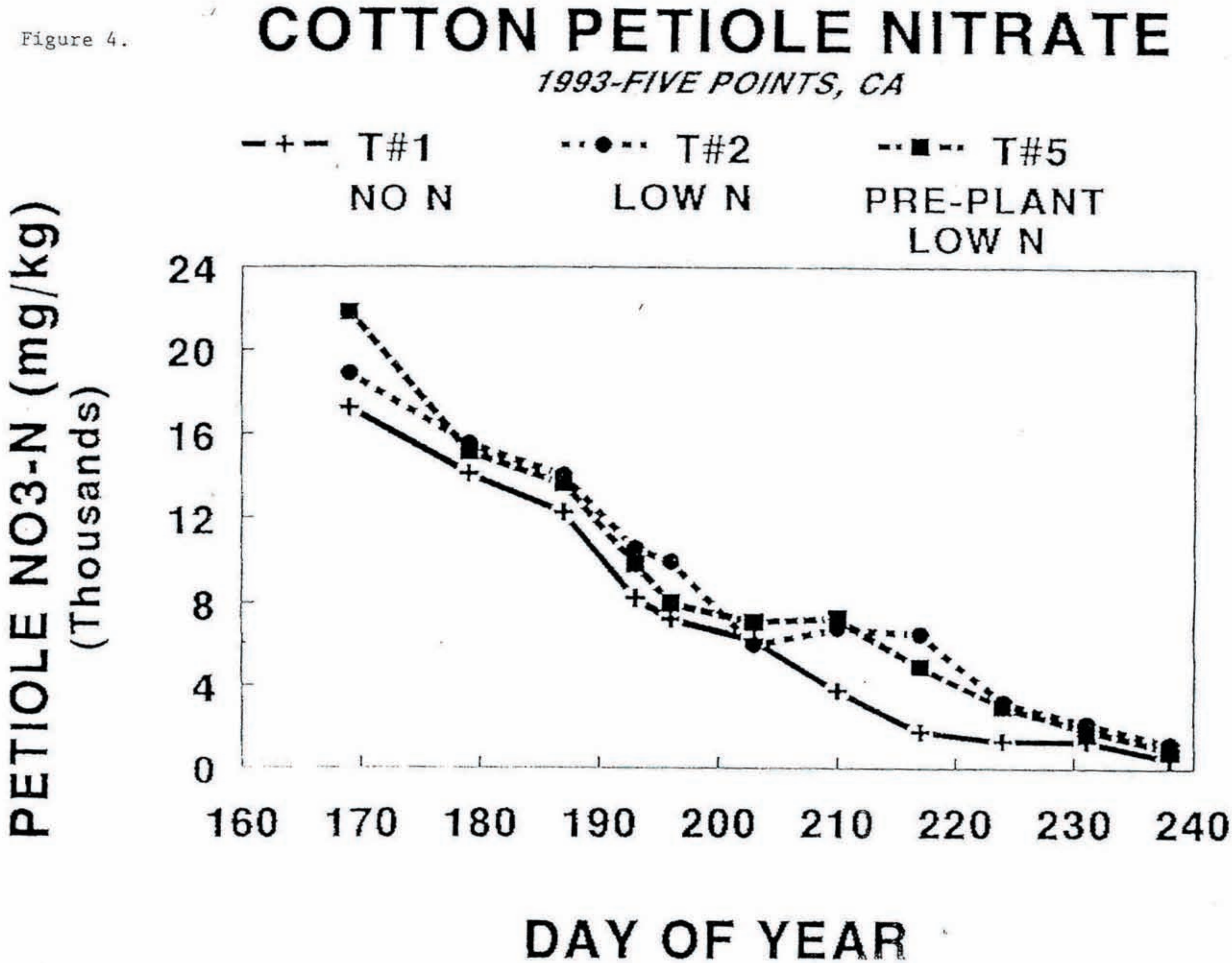
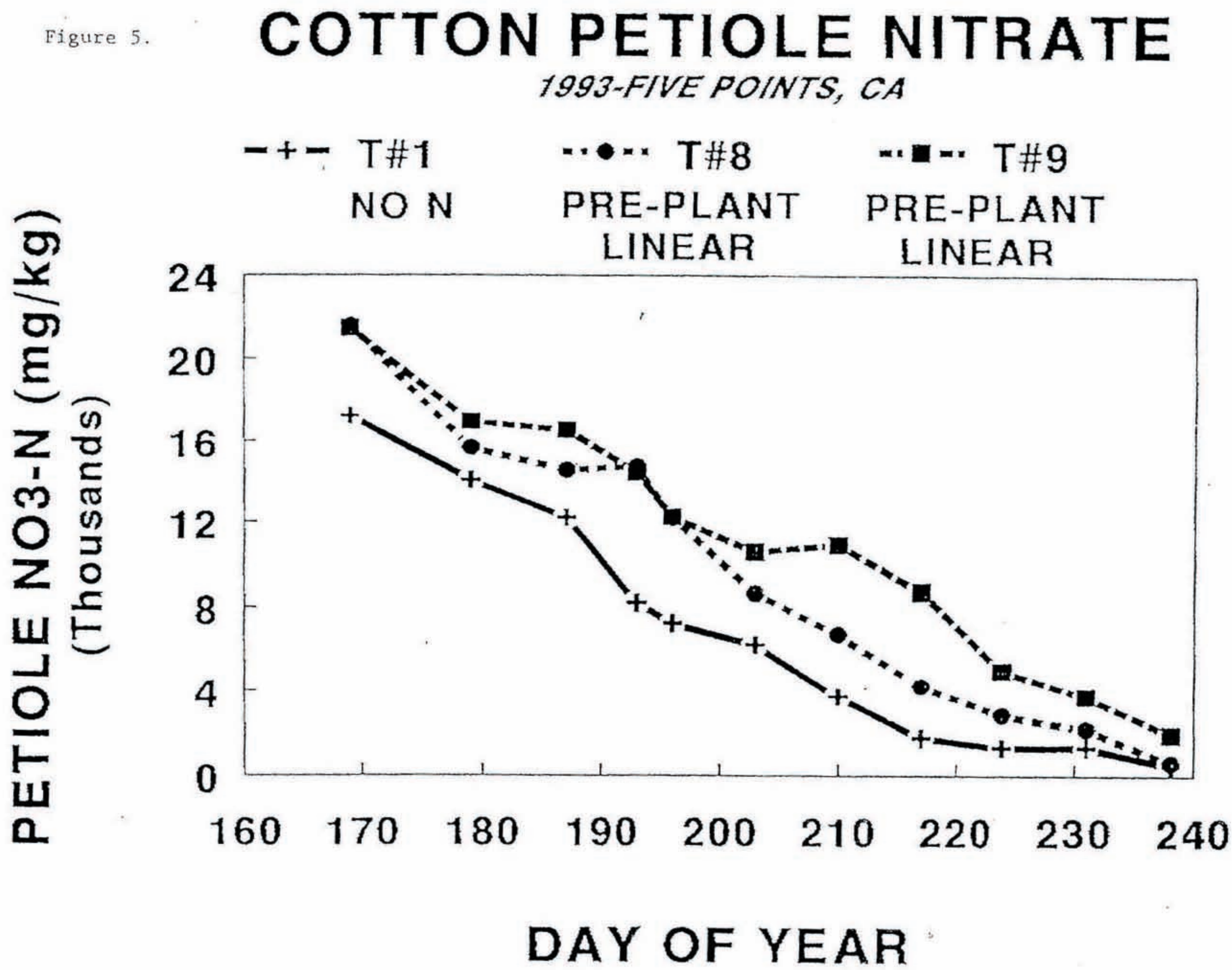

COTTON PETIOLE NITRATE
1993-FIVE POINTS, CA
T#1
NO N
T#2
LOW N
T#5
PRE-PLANT
LOW N
PETIOLE NO3-N (mg/kg)
(Thousands)
24
20
16
12
8
4
0
160
170
180
190
200
210
220
230
240
DAY OF YEAR

Figure 5.



COTTON PETIOLE NITRATE
1993-FIVE POINTS, CA
T#1
NO N
T#8
PRE-PLANT
LINEAR
T#9
PRE-PLANT
LINEAR
PETIOLE NO3-N (mg/kg)
(Thousands)
24
20
16
12
8
4
0
160
170
180
190
200
210
220
230
240
DAY OF YEAR

Figure 6.

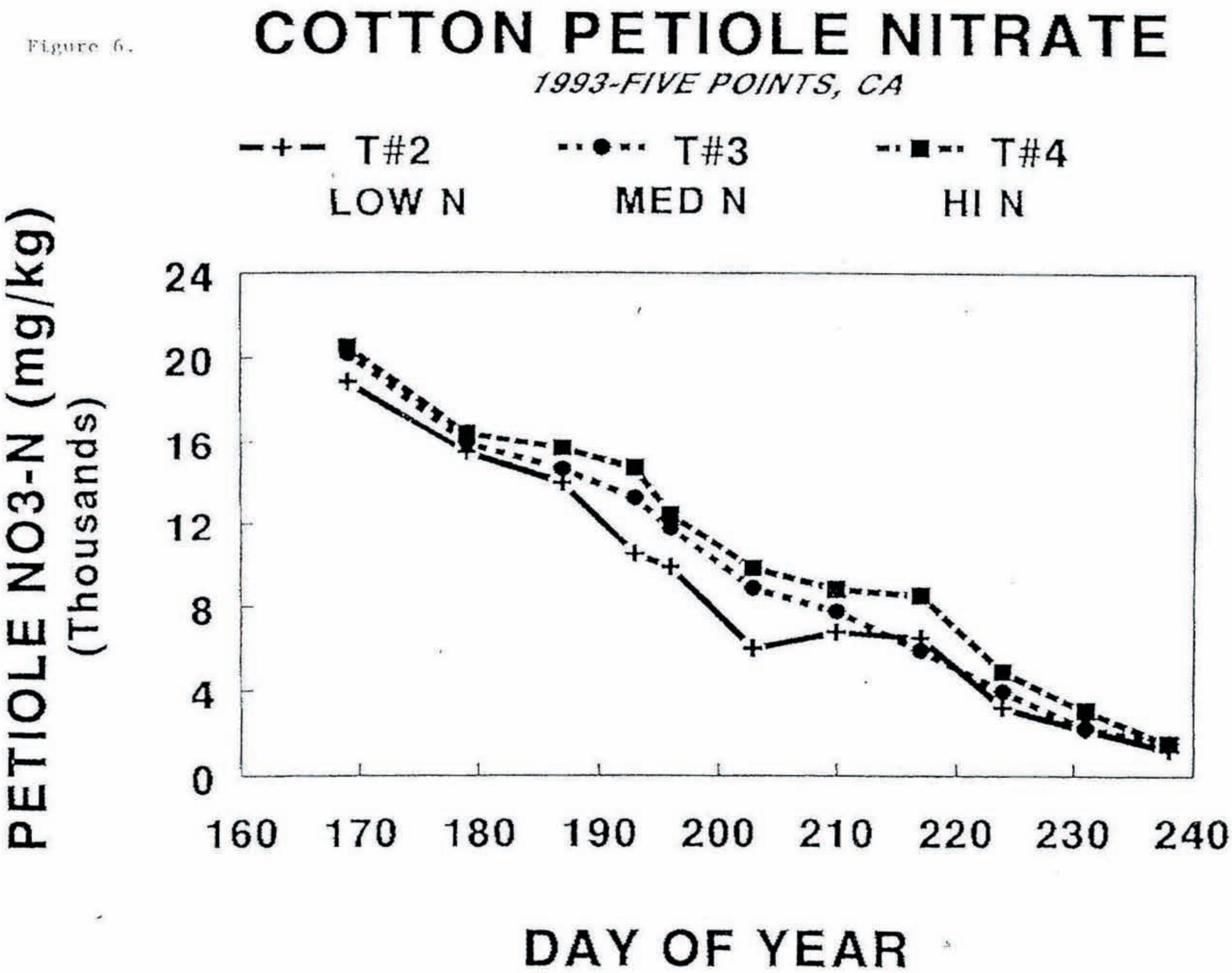

COTTON PETIOLE NITRATE
1993-FIVE POINTS, CA
T#2 LOW N
T#3 MED N
T#4 HI N
PETIOLE NO3-N (mg/kg) (Thousands)
24
20
16
12
8
4
0
160
170
180
190
200
210
220
230
240
DAY OF YEAR

Figure 7.

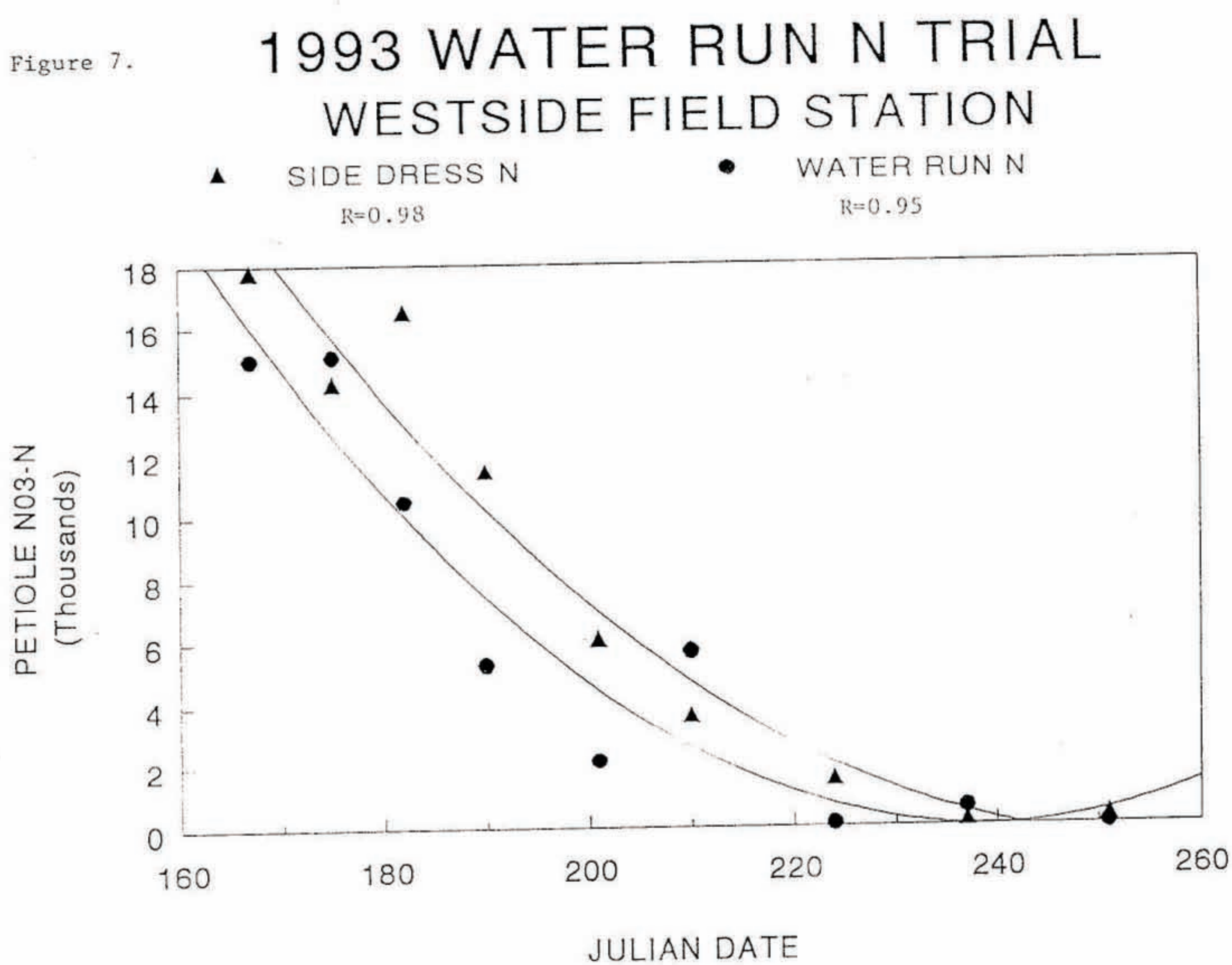

1993 WATER RUN N TRIAL
WESTSIDE FIELD STATION
SIDE DRESS N
R=0.98
WATER RUN N
R=0.95
PETIOLE N03-N
(Thousands)
18
16
14
12
10
8
6
4
2
0
160
180
200
220
240
260
JULIAN DATE

Figure 8.

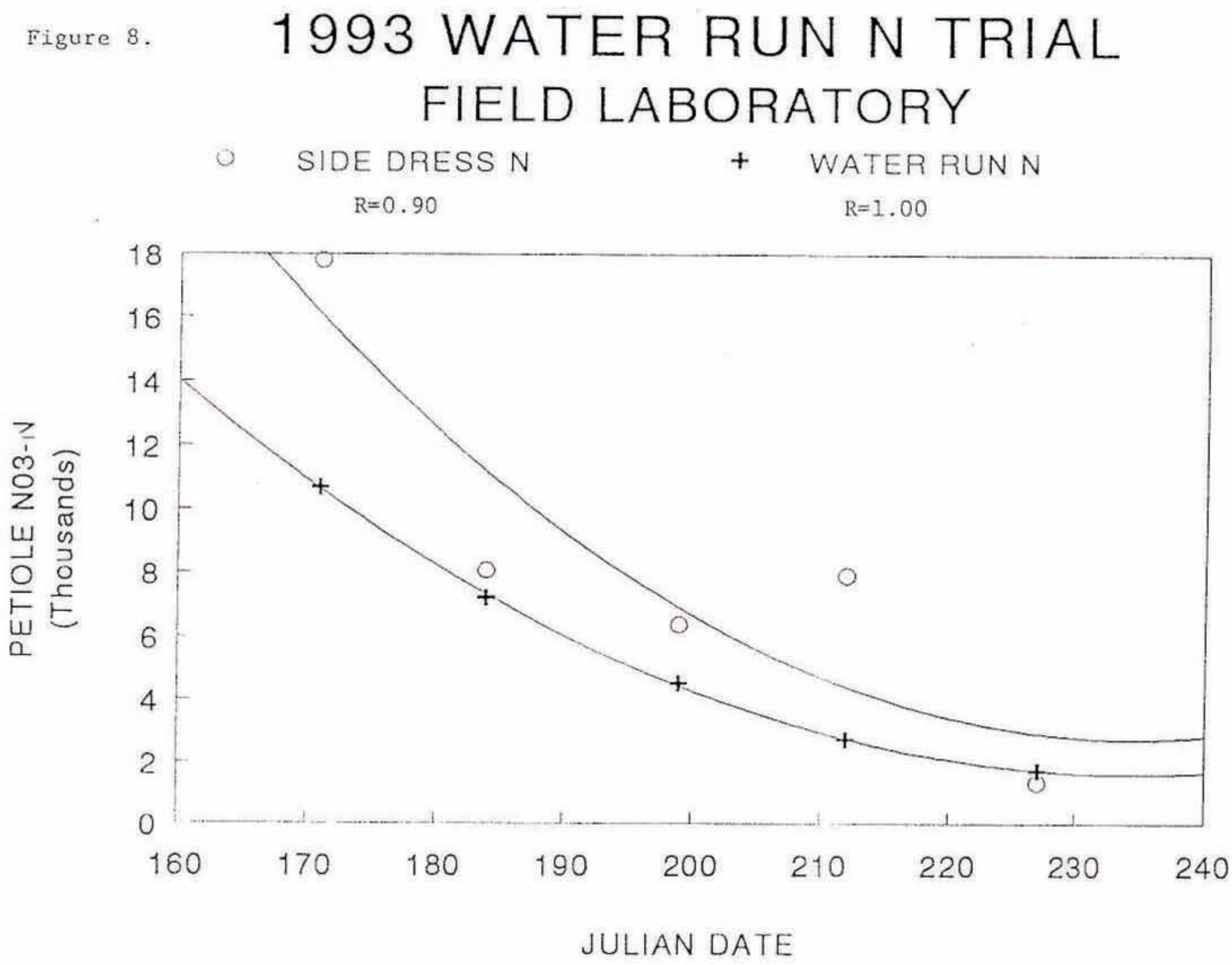

1993 WATER RUN N TRIAL
FIELD LABORATORY
○ SIDE DRESS N
R=0.90
+ WATER RUN N
R=1.00
PETIOLE N03-N
(Thousands)
18
16
14
12
10
8
6
4
2
0
160
170
180
190
200
210
220
230
240
JULIAN DATE

Figure 9. Lint cotton yield response to exchangeable K in the top 5 inches of soil.

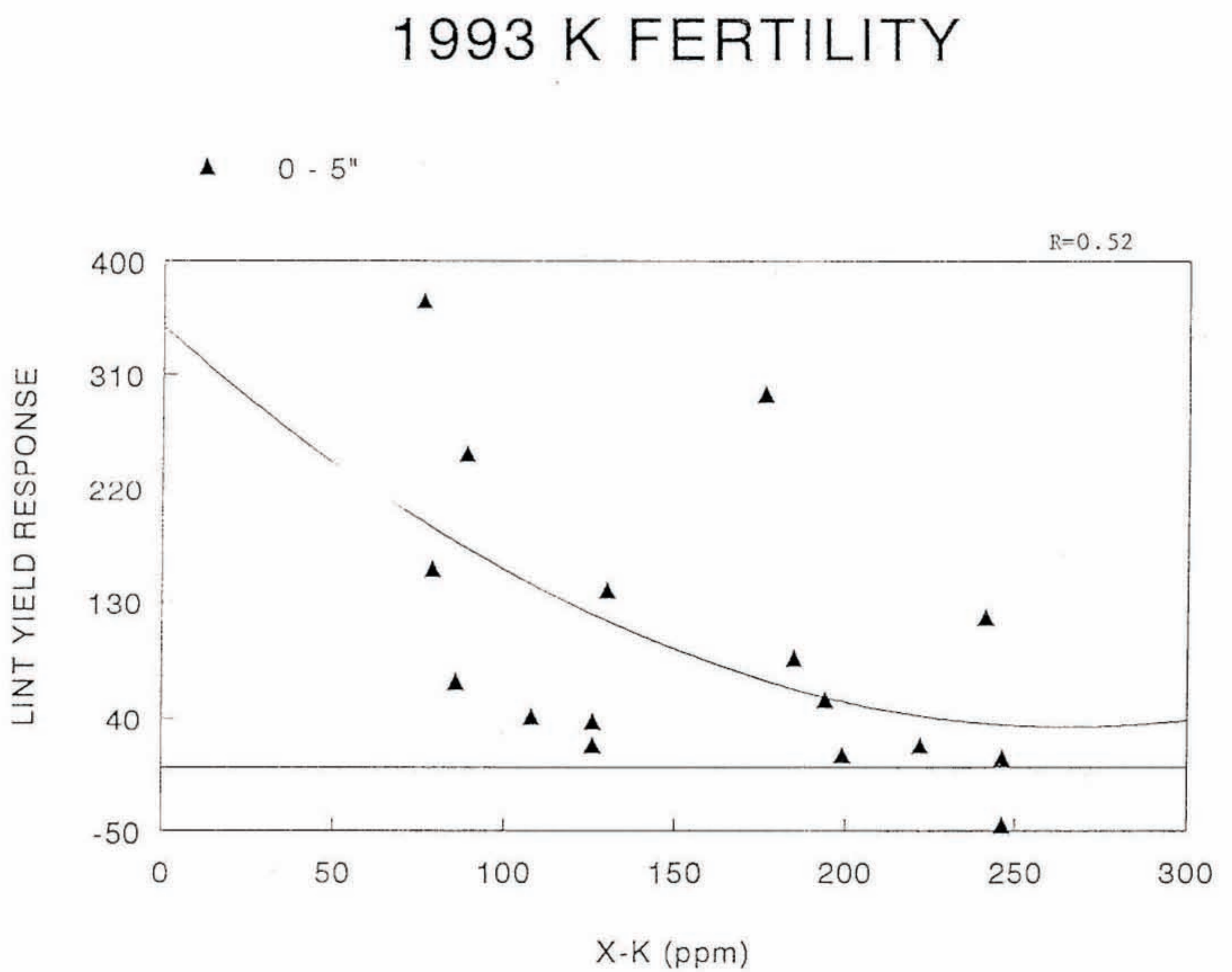


Figure 10. Lint cotton yield response to exchangeable K in the 5-15" soil depth.

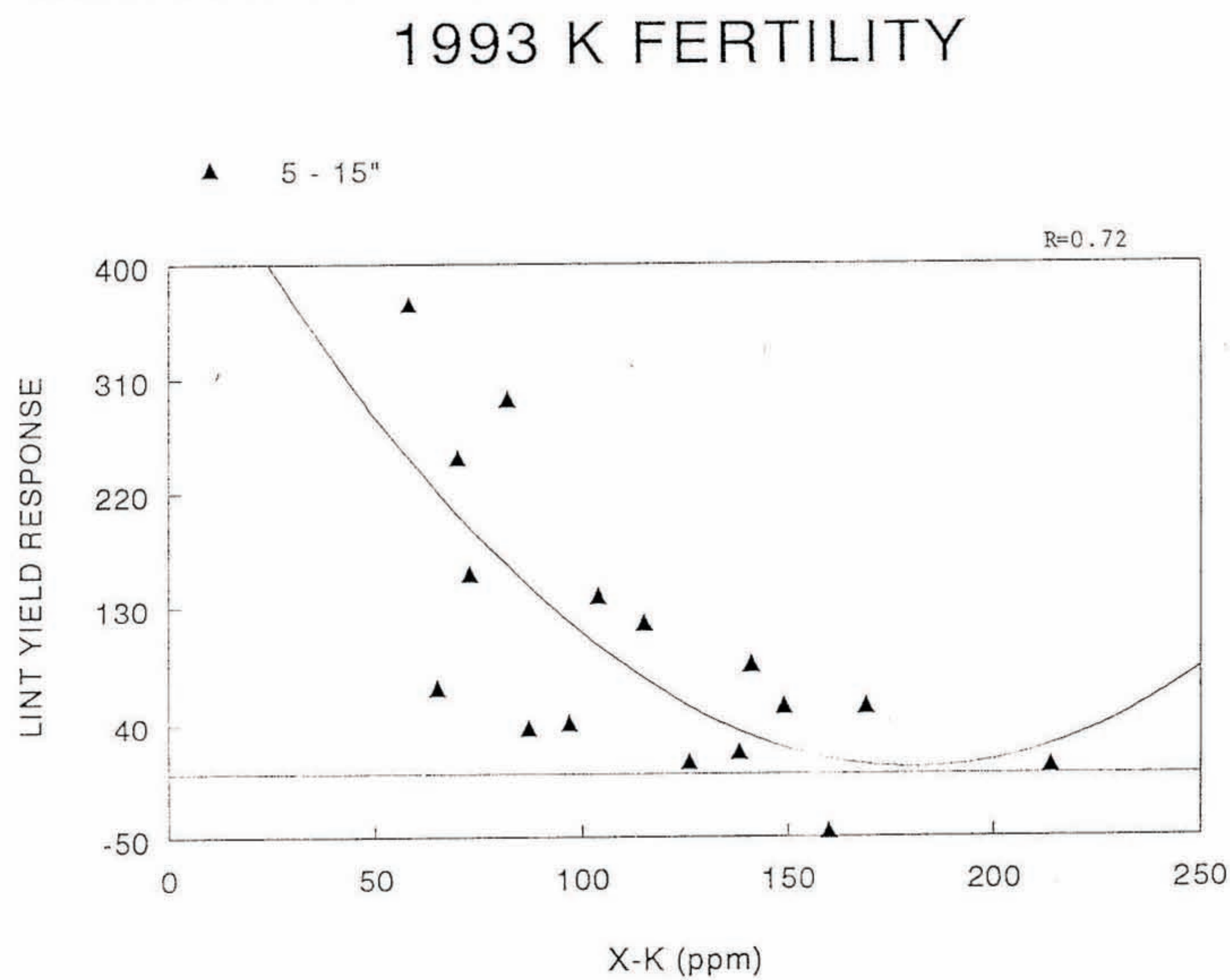


Figure 11. Lint cotton yield response to exchangeable K in the 15-30" soil depth.