Development and Promotion of Nitrogen Quick Tests for Determining Nitrogen Fertilizer Needs of Vegetables and Survey of Soil Residual Nitrate-Nitrogen Levels in Vegetables

University of California Cooperative Extension
San Benito Counties and Monterey, 1996

Project Leaders:
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Cooperator:
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Task 1: Refine correlations between the fresh sap nitrate measurements using the Cardy meter with traditional dry tissue analysis for cabbage and onions

Cabbage: A fertilizer trial for cabbage (variety = Headstart) was established in Hollister and four rates of nitrogen fertilizer were applied: 0, 10+10, 30+30 and 70+70 lbs N/A. Petiole samples for fresh sap nitrate-N analysis with the Cardy Meter were collected as well as for analysis for dry tissue nitrate-N analysis at the DANR Analytical laboratory in Davis. The data is presented in Appendix A. A good correlation between the fresh sap and dry tissue analysis was obtained ($R^2 = 0.94$). However, we did not obtain a good yield response, probably due to high residual nitrate-N in the soil. In addition, the critical values did not correlate well with the data from 1995 and an additional year of studies are needed to clarify the critical levels of nitrate-N in the fresh sap of cabbage.

Onions: A fertilizer trial for onion (variety = Fiesta) was established in Hollister and four rates of nitrogen fertilizer were applied: 50, 125, 200 and 300 lbs N/A. Root tissue was collected for fresh sap nitrate-N analysis with the Cardy Meter as well as roots for dry tissue analysis. The data is presented in Appendix B. A good correlation between the fresh sap and dry tissue analysis was obtained ($R^2 = 0.84$). The correlation equation (fresh sap nitrate-N = 0.059 dry tissue nitrate-N + 75.2) agreed well with the equation from 1995. The data indicate that the critical levels for nitrate-N in the fresh sap of the roots of long-day type onions should be from 350 - 500 ppm at early bulbing (i.e. bulbs 1.5 inches in diameter).

Task 2: Conduct a survey of fifteen lettuce/cole crop production fields and plot the course of soil nitrate-N levels in the soil over the season.

Introduction

A survey of 15 vegetable production fields in the Hollister and Salinas Valley areas was conducted in the summer of 1996. The fields surveyed were double cropped to lettuce-lettuce or cole crop-lettuce. The fields were located on a wide variety of soil types throughout the two vegetable production areas. The purpose of the survey was to examine a number of fields and determine the nitrate-N levels over the season. This information is to be used to determine residual nitrogen levels in the soil and assess the potential for growers to utilize this source of nitrogen for crop production and thereby reduce nitrogen fertilization. Based upon prior work by Tim Hartz (1), soil nitrate-N levels of 20 μg N/g soil or higher are sufficient for adequate crop growth (20 μg N/g soil corresponds to approximately 80 lbs N/ acre in the top foot of soil). The survey data will provide researchers an opportunity to determine the extent to which the soil quick test techniques can be applied to double cropped vegetable production systems to improve fertilizer use efficiency. Further tests are planned for 1997 utilizing large scale field plots to test the effect of reducing fertilizer applications based on soil nitrate tests.

Eight fields in the Hollister area and seven fields in the Salinas Valley (see appendix C for site descriptions details) that were double cropped (i.e. lettuce-lettuce; cole crop-lettuce; or lettuce-cole crop) were selected for sampling for soil nitrate-N sampling over the course of the 1996 growing season. Sampling began with the spring crop and continued at two week intervals through the fall crop. Sampling in Hollister was initiated on April 25th and was terminated on November 6th and sampling in Salinas was initiated on May 13th (after the spring crop was in production). Each field was split into four quadrants. Fifteen cores were collected from each quadrant from the top 12 inches of soil from the seed line of the bed (the top 2" of soil was not included in the sample). Soil samples were placed into plastic bags and stored on ice for transportation back to the lab and analysis that same day. In the lab each sample was thoroughly mixed and processed by the following methods: 1) At all sites 5 - 7 grams subsample of soil was shaken for one minute in a centrifuge tube with 25 mls of 2M KCl. A clear extract of this solution was sent to the DANR Analytical Laboratory at U.C., Davis for nitrate-N analysis; 2) a sample was also taken for gravimetric soil moisture; 3) for all Hollister sites, a second subsample was analyzed with a different quick test technique: soil was shaken for one minute with 30 mls 0.01M $CaCl_2$ and nitrate-N was determined using the RQflex reflectometry meter and Reflectoquant test strips that had a range of 3 - 90 μg/g NO3 strips; 4) for all Salinas sites, a second subsample analyzed by a quick test technique: soil was shaken for one minute with 30 mls 0.01M $CaCl_2$ and nitrate was determined colorimetrically with the merquant nitrate test strips with a range of 10 - 500 μg/g NO3. The values determined by methods 2 & 3 were converted to μg/g NO3-N dry soil by the conversion factors described by Hartz (1). The purpose of separating the quick test techniques between Hollister and Salinas was to give an opportunity to evaluate the

accuracy of each of the two methods. One site in Hollister and one in Salinas were discontinued due to changes in the crop mix and, as a result, a total of 13 sites are reported for the survey. The means of the nitrate-N determined from the KCl analyses were plotted with standard error bars over the season to identify the nitrate levels over the season and show the level of variability in each field. Correlation coefficients between the merquant and reflectoquant methods were determined.

Results

Hollister: Figures 1 - 7 show the nitrate-N, as determined by KCl extraction of soil, trends for seven fields in the Hollister area (the details regarding the fertilizer practices and yield are shown in appendix C). The trends vary widely, but in general, for sites 1 - 6 the levels stayed below 20 ppm except for occasional peaks. There is a great deal of variability on some sampling dates for some fields. The high levels of nitrate-N variability is typical of nitrate levels in field soils. Site 7 showed substantial periods above 20 ppm later in the season. This field was drip irrigated and fertigated, and had the lowest fertilizer application levels. Figure 8 shows the average soil nitrate-N levels in the soil. From this figure it can be seen, that, in general, the soil levels for the seven fields were at moderate levels of soil nitrate-N. Fertilizer applications were typical for the Hollister area with a range of 129 to 249 lbs N/A for the first crop and a range of 155 to 203 lbs N/A for the second crop. Yields were also typical except for some low yields due to bolting and reduced cuttings due to market conditions.

Salinas: Figures 9 - 14 show the nitrate-N trends for six fields in the Salinas area (details regarding the fertilizer practices and yield are shown in appendix C). The trends varied widely, however, most of the sites had many periods of time with soil nitrate-N levels above 20 ppm. Figure 15 shows the average soil nitrate-N levels in the soil. From this figure it can be seen that in general the soil levels for the six fields surveyed were at elevated levels of soil nitrate-N. Fertilizer application lettuce and broccoli production in the Salinas Valley with a range of 183 to 245 lbs N/A for the first crop and a range of 177 to 245 lbs N/A for the second crop. In general more fertilizer was applied than in the Hollister area and yields tended to be higher in the Salinas area.

Testing Methods: Table 1 shows the correlation coefficients between the quick test techniques and the laboratory analyses. The R-square values between the reflectoquant technique that was utilized at all Hollister sites and the laboratory analyses indicate a good overall correlation (0.85; figure 16). The correlation coefficients varied from 0.68 to 0.93. The data from Salinas was a bit more variable. Overall the correlation was 0.64 (figure 17). The correlations varied from 0.48 to 0.90. It appears that the higher values have lower correlations with laboratory data and that the lower values (i.e. <25 ppm) gave better correlations.

The data indicate that there were periods of high levels of nitrate-N (i.e. over 20 ppm nitrate-N) in the soil but that nitrate-N varied greatly through the growing season. Careful monitoring of these nitrate-N levels with soil quick test may provide

opportunities to reduce fertilizer applications. Further tests are planned for this project to test the effect of reducing fertilizer applications based on soil nitrate tests.

Literature Cited

Hartz, T.K. 1994. Drip irrigation and fertigation management of vegetable crops. Fertilizer Research and Education Program Booklet.

APPENDICES

Appendix A

Critical Nitrate-Nitrogen Levels for the Fresh Sap of Cabbage Petioles
University of California Cooperative Extension
San Benito County, 1996

Trial Specifics

Cooperator:	Ken Dobler
Experimenters:	Richard Smith, Farm Advisor and Jarrod Domingos, Research Assistant
Soil type:	Sorrento Silty Clay Loam
Prior Crop:	Lettuce
Plot size:	1 - 40" bed wide by 50' long. Four replications arranged in a randomized complete block design.
Treatments:	0, 10+10, 30+30 and 70+70 lbs N/A applied as ammonium nitrate on July 8 and July 30, 1996 (shanked into bed)
Variety:	Green Cabbage - Head Start
Sampling Dates & Growth Stage:	July 12 - 6 true leaves July 18 - 7-8 true leaves July 26 - early cupping August 2 - early heading August 16 - heads enlarging August 23 - heads near full size August 28 - harvest

Results

Figure 1 shows the trend of the levels of nitrate-N in cabbage petioles over the season. The treatments do not spread out as nicely as in 1995 and the 70+70 lbs N/A treatment is statistically greater than the control only on August 16 and 23. Figure 2 shows the correlation between the fresh sap and the dry tissue nitrate-N levels in the petioles ($R^2 = 0.94$). Based upon the correlation between fresh and dry sap nitrate levels and using the critical levels for nitrate in the dry tissue of cabbage already established, the critical level for nitrate-nitrogen in the fresh sap should be 1285-1485 at heading. In 1995 the critical levels calculated were 1000-1200 for Red cabbage. It appears that green cabbage has a higher critical level for nitrate-N in the tissue. We did not see statistical differences in the yield of cabbage this year, probably due to high background levels of nitrogen in the soil of the test plot. It appears that a third year of studies is needed to clarify the differences seen between the 1995 and 1996 data.

Table 1. Yield of Cabbage on August 28. 1996

Treatments lbs N/A	Caliper of Heads (in.)	Head Wt. lbs/head	Yield lbs/40' row
0	6.1	2.5	100.4
10+10	6.0	2.5	99.2
30+30	6.2	2.6	104.0
70+70	6.3	2.7	106.0
LSD (P=0.05)	ns	0.2	6.4

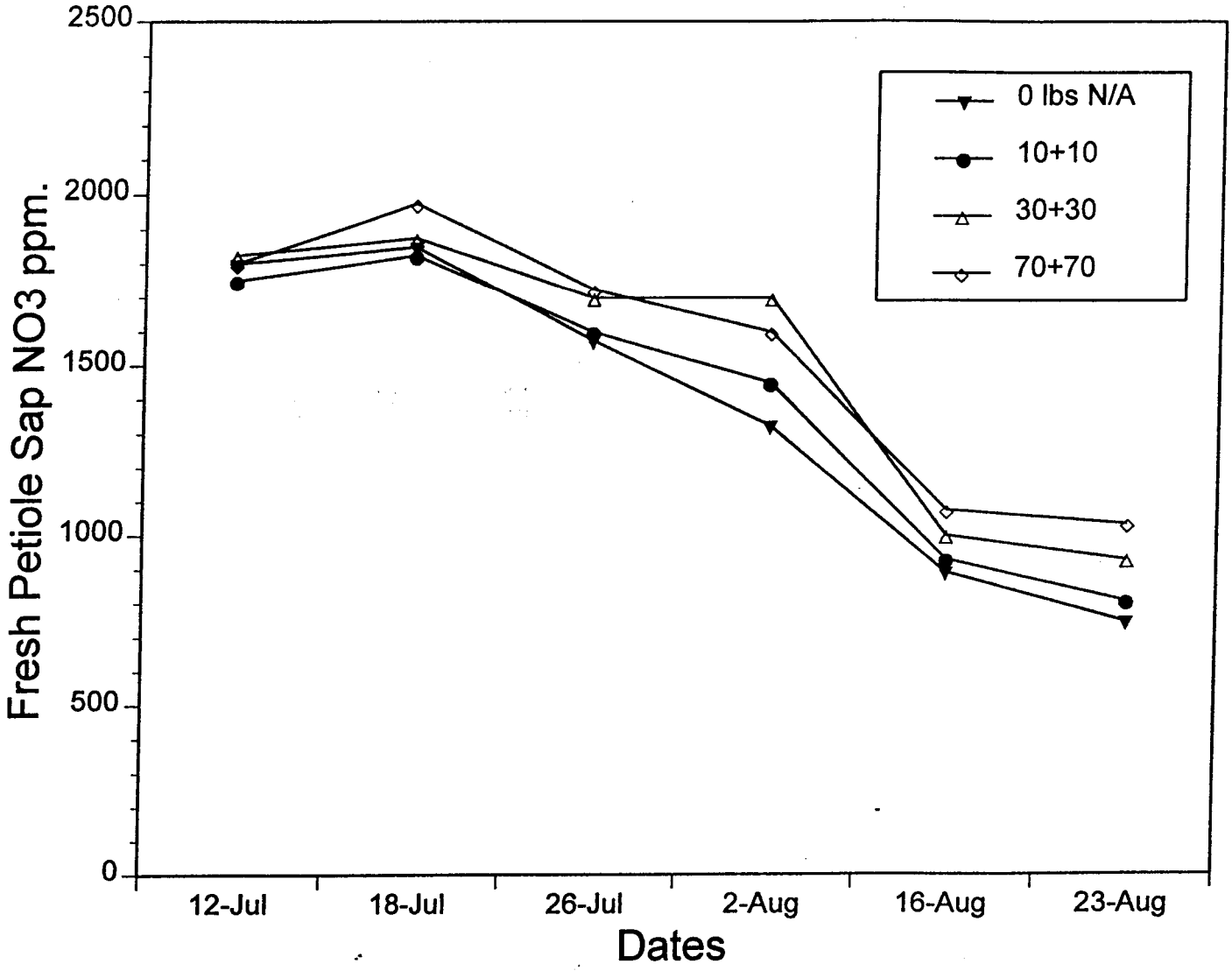
Nitrate-Nitrogen in the fresh sap of cabbage petioles under various fertilizer treatments over the season, Hollister, 1996
Fresh Petiole Sap NO3 ppm.
2500
2000
1500
1000
500
0
12-Jul
18-Jul
26-Jul
2-Aug
16-Aug
23-Aug
Dates
0 lbs N/A
10+10
30+30
70+70

Figure 1

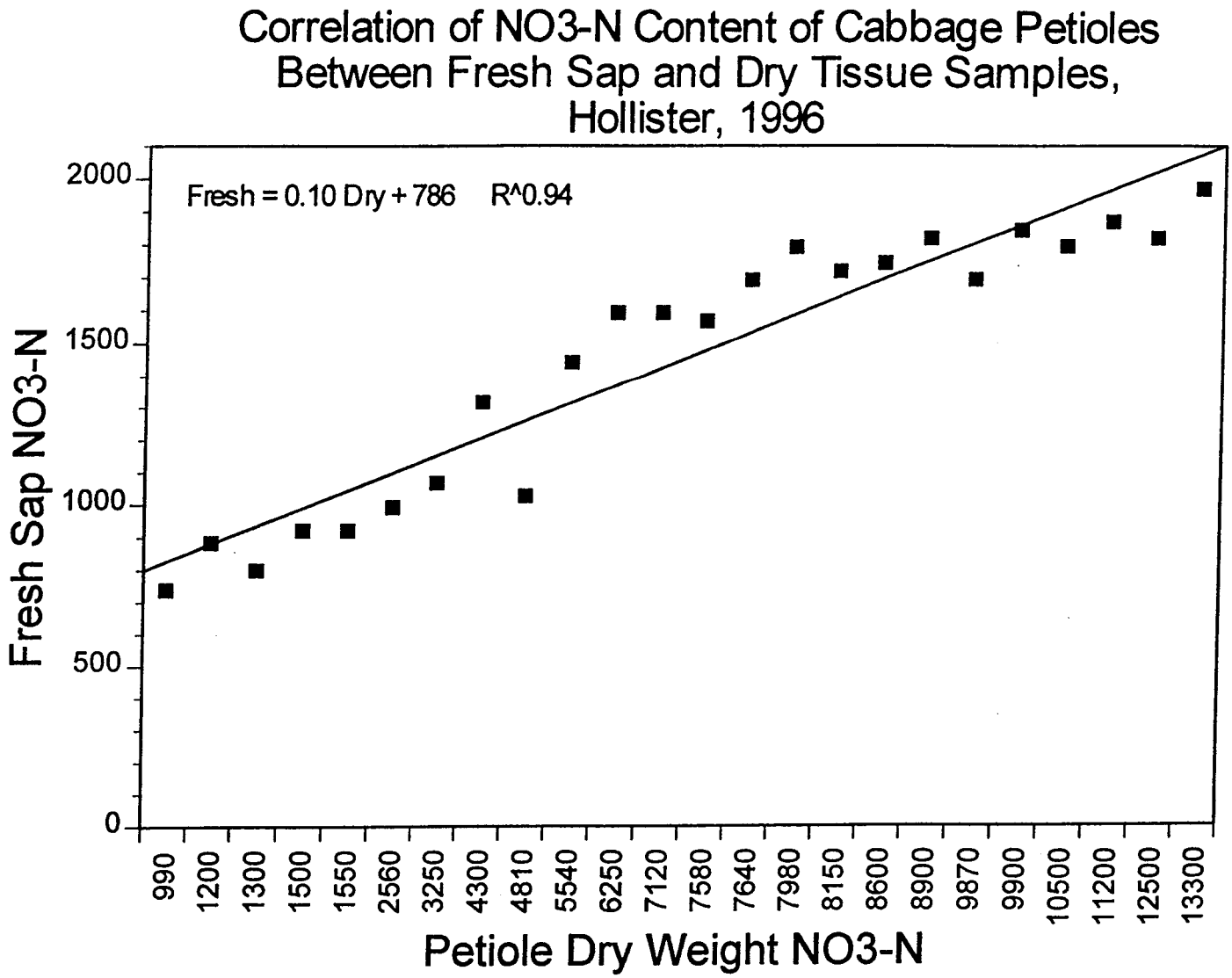
Correlation of NO3-N Content of Cabbage Petioles Between Fresh Sap and Dry Tissue Samples, Hollister, 1996
Fresh = 0.10 Dry + 786 R^0.94
Fresh Sap NO3-N
2000
1500
1000
500
0
990
1200
1300
1500
1550
2560
3250
4300
4810
5540
6250
7120
7580
7640
7980
8150
8600
8900
9870
9900
10500
11200
12500
13300
Petiole Dry Weight NO3-N

Figure 2

Appendix B

Onion Fertility Trial
University of California Cooperative Extension
San Benito County, 1996

Trial Specifics

Grower:	Paul Bertuccio
Experimenters:	Richard Smith, Farm Advisor and Jarrod Domigos, Research Assistant
Location:	Hwy 25, Hollister
Soil Type:	Sorrento Clay Loam
Previous Crop:	Lettuce
Variety:	Fiesta
Planting Date:	April 16, 1996
Plot size:	1 - 40" bed wide by 50' long. Four replications arranged in a randomized complete block design
Treatments:	50, 125, 200 and 300 lbs N/A.

	1	2	3	4
Starter	50	50	50	50
Top Dress	0	50	100	200
Sidedress	0	25	50	50
Total	50	125	200	300 lbs N/A

	Starter applied on April 10; Top dress applied on June 20 and Sidedress applied on July 13.
Sampling:	Root tissue samples were collected weekly and analyzed for nitrate-N in the fresh sap and the dry tissue levels from June 12 to August 7.
Sampling Procedure:	Root samples from 10 plants were collected from each plot. The samples were washed, blot dried and mixed together. Nitrate-N analysis was taken on a portion of the sample using a Cardy selective electrode meter. The remainder of the sample was oven dried and sent to the DANR Analytical Laboratory at UC, Davis for nitrate-N analysis.
Harvest Date:	September 9, 1996 (20 foot sections were harvested from each plot, graded and weighed)

Results

In 1996 we were located in a field that had high initial levels of nitrate-N in the soil (21.0 ppm). There was not a good yield response to added nitrogen in the trial (see table 1) even though the level of nitrate-N in the 300 lbs N/A treatment separated out in the weekly sampling (see figure 1). The correlation between nitrate-N in the fresh and

the dry sap was fresh = 0.059 dry + 75.2 (R2=0.84) which agrees well with the correlation seen in 1995 (fresh = 0.046 dry + 93, R2 = 0.95). This correlation indicates that the levels of nitrate nitrogen in the fresh sap of the root tissue should be between 350 to 500 ppm nitrate-N at early bulbing (i.e. roots 1.5 inches in diameter).

Table 2. Yield of onions under various fertilizer treatments

	Category					Total	**Mkt**
Treatment	Prepack	Medium	Jumbo	Colossal	Culls	Yield	**Yield**
50 lbs N/A	5.7	13.2	8.9	0.3	1.7	29.8	**28.9**
125	4.6	11.7	11.7	1.4	2.5	32.0	**29.5**
200	6.1	13.3	11.2	2.4	2.2	35.3	**33.0**
300	5.5	11.7	9.6	0.7	1.7	29.2	**27.5**
0.05	ns	ns	ns	1.2	ns	ns	**ns**

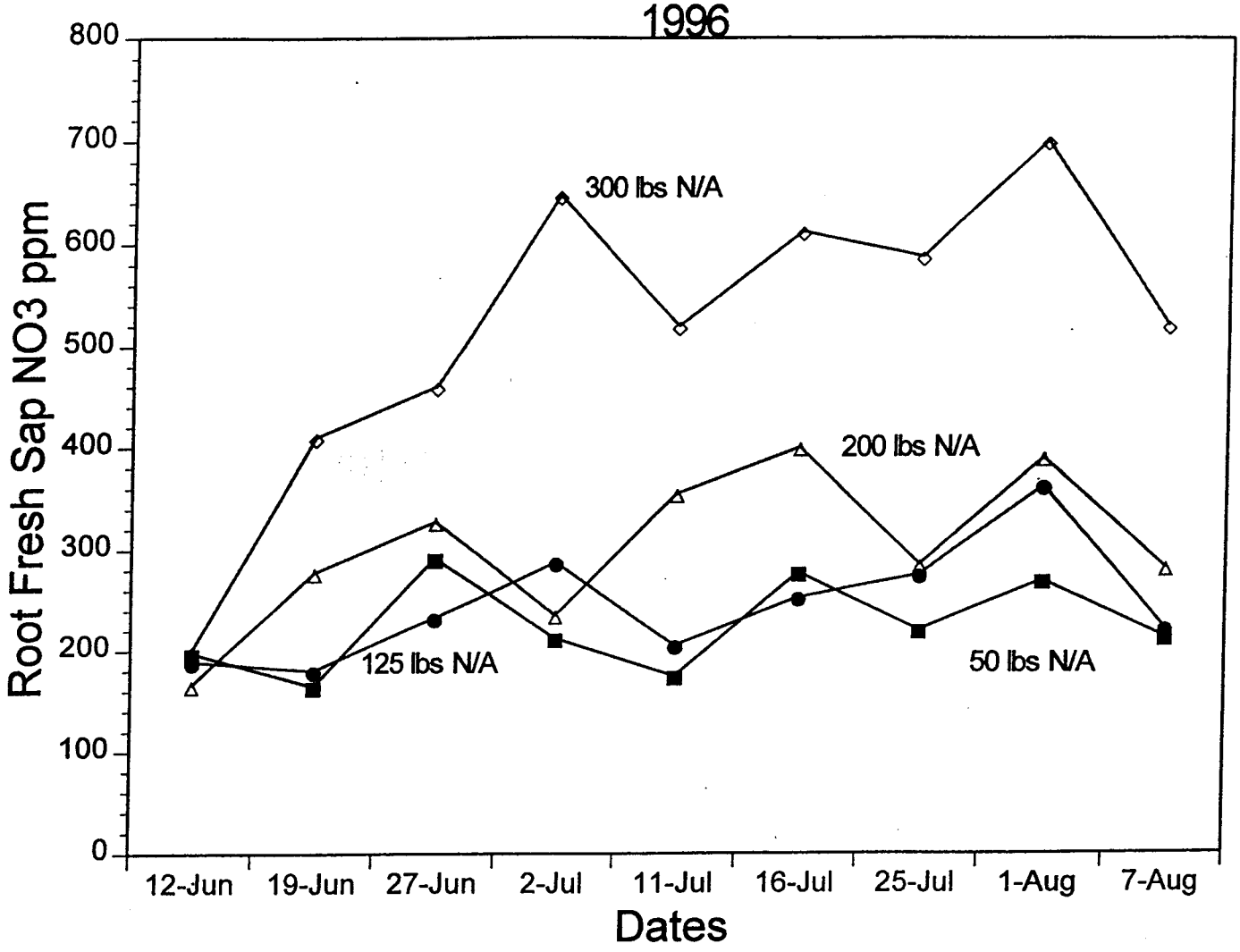
Nitrate-nitrogen in the fresh sap of onion roots under various fertilizer treatments over the season, Hollister, 1996
Root Fresh Sap NO3 ppm
800
700
600
500
400
300
200
100
0
300 lbs N/A
200 lbs N/A
125 lbs N/A
50 lbs N/A
12-Jun
19-Jun
27-Jun
2-Jul
11-Jul
16-Jul
25-Jul
1-Aug
7-Aug
Dates

Figure 1

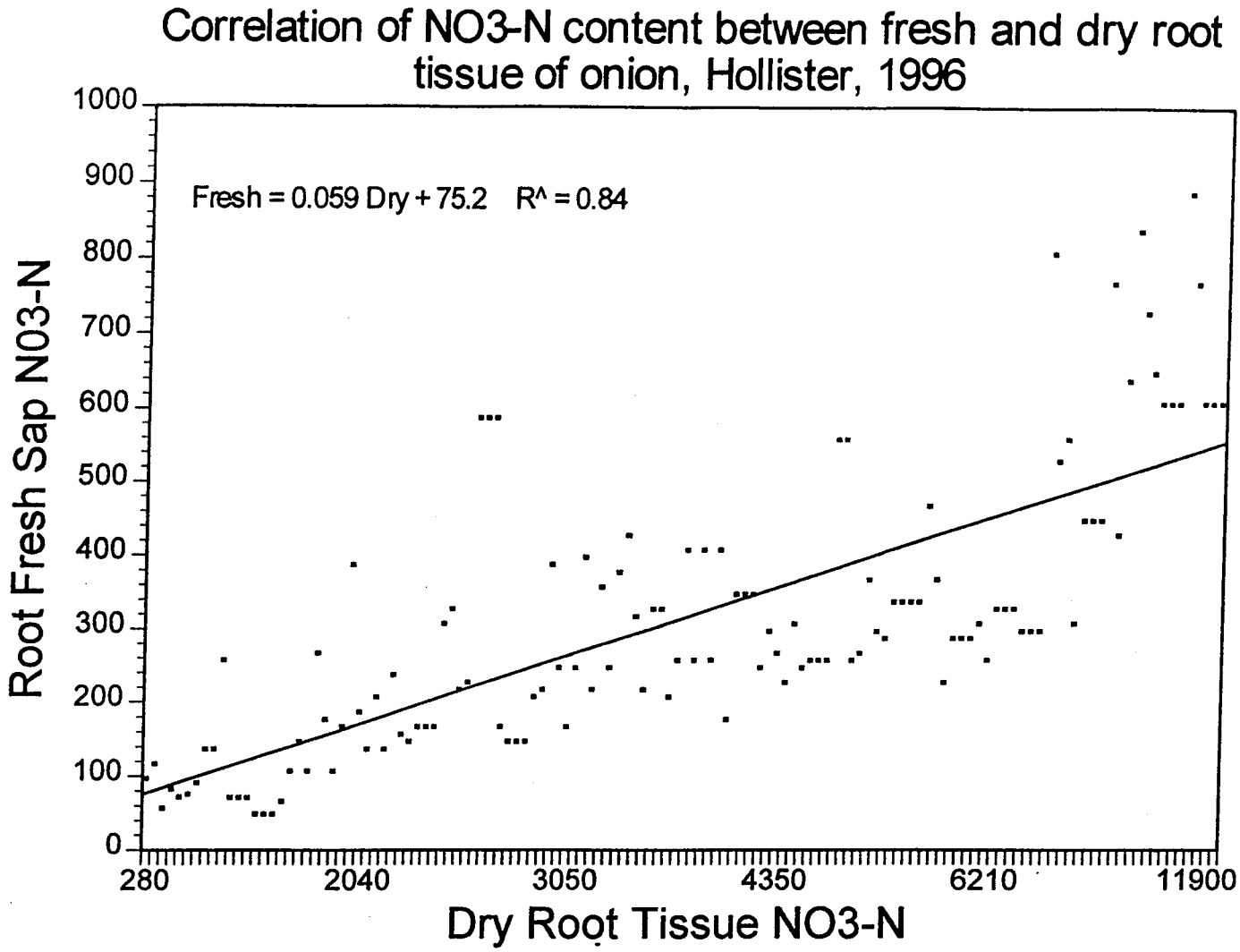
Correlation of NO3-N content between fresh and dry root tissue of onion, Hollister, 1996
Fresh = 0.059 Dry + 75.2 R^ = 0.84
Root Fresh Sap N03-N
1000
900
800
700
600
500
400
300
200
100
0
280
2040
3050
4350
6210
11900
Dry Root Tissue NO3-N

Figure 2

Appendix C

Soil Nitrate Sampling, 1996 - Hollister

Hollister, Site No. 1; Filice, Dassell Ranch 1A- Hwy 156

Date	Day of Year	Stage of Growth
April 25	116	Irrigating Up first head lettuce crop
May 11	132	2nd true leaf
May 21	142	just prior to thinning
June 4	156	rosette stage
June 17	169	mid-heading
July 1	183	harvesting
July 15	197	disced, being listed
July 30	212	planted head lettuce, being sprinkled up irrigated
August 10	223	2-3 true leaf
August 24	237	rosette stage
September 7	251	cupping stage
September 21	265	mid-heading
October 4	278	harvesting
October 18	292	disced flat
November 4	309	disced flat

Soil Type: Sorrento Silty Clay Loam
Irrigation Type: sprinkler
First Crop: head lettuce (Raider)
Fertilizer Program: Fall preplant - 400 lbs 6-20-20; Sidedress #1 - 30 gallons 18.5-5-0-4; Sidedress #2 - 18.5-5-0-4; Sprinkler application #1 10 gallons CAN 17; Sprinkler application #2 10 gallons CAN 17. Total N = 233.8 lbs/A.
Yield: 650 boxes/A
Second Crop: head lettuce
Fertilizer Program: Preplant - 400 lbs 6-20-20; Sidedress#1 - 35 gals/A 17-0-0-2.8; Sidedress#2 - 35 gals/A 17-0-0-2.8: Total N = 154.9 lbs/A.
Yield: 370 boxes/A - bolted

Hollister, Site No. 2; Filice, Dassell Ranch 1B - Hwy 156

Date	Day of Year	Stage of Growth
April 25	116	bed shaped, not planted yet
May 11	132	seedlings just emerging
May 21	142	2-3 true leaves
June 4	156	rosette stage
June 17	169	early heading stage
July 1	183	just prior to harvest
July 15	197	disced, being listed
July 30	212	being planted
August 10	223	cotyledons emerging
August 24	237	3-4 true leaves
September 7	251	rosette stage
September 21	265	early heading
October 4	278	just prior to harvest
October 18	292	harvested but not disced yet
November 4	309	disced flat

Soil Type: Sorrento Silty Clay Loam
Irrigation Type: Sprinkler
First Crop: head lettuce (Raider)
Fertilizer Program: Fall preplant - 400 lbs 6-20-20; Starter - 30 gallons 5-17-0 (with Kerb); Sidedress #1 - 30 gallons 18.5-5-0-4; Sidedress #2 - 18.5-5-0-4; Sprinkler application #1 10 gallons CAN 17; Sprinkler application #2 10 gallons CAN 17. Total N = 248.8 lbs/A.
Yield: 820 boxes/A
Second Crop: head lettuce
Fertilizer Program: Preplant - 400 lbs 6-20-20; Sidedress#1 - 35 gals/A 17-0-0-2.8; Sidedress#2 - 35 gals/A 17-0-0-2.8: Total N = 154.9 lbs/A.
Yield: 690 boxes/A

Hollister, Site No. 3; Yamaoka - Resetar Ranch, San Juan Bautista

Date	Day of Year	Stage of Growth
April 25	116	Cotyledons emerging - head lettuce
May 11	132	thinned
May 21	142	rosette stage
June 4	156	mid-heading
June 17	169	near harvest
July 1	183	harvested, disced and landplaned
July 15	197	still disced flat
July 30	212	bed shaped and planted
August 10	223	cotyledons emerging of head lettuce
August 24	237	3-4 true leaves
September 7	251	rosette stage
September 21	265	early heading
October 4	278	just prior to harvest
October 18	292	harvested and disced
November 4	209	disced flat, beginning to list up and apply preplant

Soil Type: Sorrento Silty Clay Loam
Irrigation Type: Sprinkler
First Crop: head lettuce
Fertilizer Program: Preplant - 409 lbs/A 6-20-20; Sidedress #1 - 50 gals/A 15-8-4; Sidedress #2 - 41 gals/A UN 32: Total N = 248.9 lbs.
Yield: 868 boxes/A equivalent (harvested as bulk lettuce)
Second Crop: head lettuce
Fertilizer Program: Preplant - 372 lbs/A 6-20-20; Sidedress #1 - 41 gals/A 15-8-4; Sidedress #2 - 36 gals/A 20%: Total N = 162.5 lbs.
Yield: 447 boxes/A equivalent (harvested as bulk lettuce)

Hollister, Site No. 4; Dobler -Field 6C, San Juan Bautista

Date	Day of Year	Stage of Growth
April 25	116	Cotyledons present- leaf lettuce
May 11	132	thinned
May 21	142	rosette stage
June 4	156	mid-heading
June 17	169	harvesting
July 1	183	harvested, disced
July 15	197	listed
July 30	212	listed
August 10	223	listed
August 24	237	listed
September 7	251	planted, not yet irrigated
September 21	265	cotyledons
October 4	278	just prior to harvest
October 18	292	rosette stage
November 4	309	near harvest

Soil Type: Salinas Clay Loam
Irrigation Type: Sprinkler
First Crop: leaf lettuce (romaine and green leaf)
Fertilizer Program: Preplant in fall - 600 lbs/A 10-7-7; Sidedress - 35 gals/A 19-0-0-2.8; water run - 10 gals/A CAN 17; Total N = 158.6 lbs/A.
Yield: 775 boxes/A
Second Crop: leaf lettuce (romaine and green leaf)
Fertilizer Program: Preplant - 400 lbs/A 8-24-6; Sidedress #1 - 35 gals/A 19-0-0-2.8; Sidedress #2 - 25 gals/A 19-0-0-2.8: Total N = 164.2 lbs/A.
Yield: 750 boxes/A

Hollister, Site No. 5; Tonascia - Stevens Ranch 31, Hollister

Date	Day of Year	Stage of Growth
April 25	116	2 true leaves - leaf lettuce
May 11	132	thinned
May 21	142	rosette stage
June 4	156	mid-heading
June 17	169	harvested
July 1	183	disced and being listed
July 15	197	listed
July 30	212	listed
August 10	223	planted, not yet sprinkled - broccoli
August 24	137	cotyledons
September 7	251	3-4 true leaves
September 21	265	5-8 true leaves
October 4	278	plants half grown
October 18	292	broccoli button stage
November 4	309	broccoli heads 1-2" size

Soil Type: Clear Lake Clay, Saline
Irrigation Type: Sprinkler
First Crop: (red leaf and green leaf)
Fertilizer Program: Preplant - 300 lbs 5-17-17; Sidedress #1 - 350 lbs 20-0-0-5; Sidedress #2 - 350 lbs 20-0-0-5; Total N = 155 lbs/A.
Yield: 684 boxes/A
Second Crop: broccoli
Fertilizer Program: Preplant - 0 lbs; Sidedress #1 - 400 lbs 20-0-0-5; Sidedress #2 - 400 lbs 20-0-0-5; Total N = 160 lbs/A.
Yield: 200 boxes/A (one cut only)

Hollister, Site No. 6; Tonascia - Borelli Ranch 5, Hollister

Date	Day of Year	Stage of Growth
April 25	116	cotyledons - mixed lettuce
May 11	132	thinned
May 21	142	rosette stage
June 4	156	mid-heading
June 17	169	harvesting
July 1	183	disced
July 15	197	listed
July 30	212	planted
August 10	223	cotyledons emerging - head lettuce
August 24	237	3-4 true leaves
September 7	251	rosette stage
September 21	265	mid-heading
October 4	278	ready for harvest
October 18	292	harvested, not disced
November 4	309	sundanced

Soil Type: Pacheco Silty Clay
Irrigation Type: Sprinkler
First Crop: head lettuce
Fertilizer Program: Preplant - 300 lbs 5-17-17; Sidedress #1 - 350 lbs 20-0-0-5; Sidedress #2 - 350 lbs 20-0-0-5; Two Sprinkler applications of - 10 gallons CAN 17: Total N = 197.8 lbs/A.
Yield: 662 boxes/A
Second Crop: head lettuce
Fertilizer Program: Preplant - 0 lbs; Sidedress #1 - 400 lbs 20-0-0-5; Sidedress #2 - 400 lbs 20-0-0-5; Two Sprinkler applications of - 10 gallons CAN 17: Total N = 202.8 lbs/A.
Yield: 660 boxes/A

Hollister, Site No. 7; Christopher - Ferry Morse 16B, San Juan Bautista

Date	Day of Year	Stage of Growth
April 25	116	2 true leaves - head lettuce
May 11	132	rosette stage
May 21	142	early heading
June 4	156	near harvest
June 17	169	harvested and sundance disced
July 1	183	listed
July 15	197	listed
July 30	212	planted and irrigated - head lettuce
August 10	223	cotyledons emerging
August 24	237	thinned
September 7	251	rosette stage
September 21	265	mid-heading
October 4	278	ready for harvest
October 18	292	harvested, not disced
November 4	309	sundanced

Soil Type: Sorrento Silty Clay Loam
Irrigation Type: Drip
First Crop: head lettuce
Fertilizer Program: 35 gals/A - 6-16; 18 gals NpHuric; 35 gals/A - CAN 17: Total N = 128.4 lbs/A.
Yield: 750 boxes/A
Second Crop: head lettuce
Fertilizer Program: 45 gals/A - 6-16; 5 gals NpHuric; 53 gals/A - CAN 17: Total N = 149.9 lbs/A.
Yield: 863 boxes/A

Soil Nitrate Sampling, 1996 - Salinas

Salinas, Site No. 1; Pisoni, Breschini Ranch 7, US 101 Access Road

Date	Day of Year	Stage of Growth
May 13	134	broccoli heads 1-2"
May 30	151	broccoli heads 2-4"
June 11	163	harvesting broccoli
June 25	177	disced
July 9	191	listed
July 22	204	listed
August 11	224	cotyledons - lettuce
August 25	238	2-3 true leaves
September 6	250	rosette stage
September 20	264	mid-heading
October 5	279	harvesting
October 21	295	disced flat
November 6	311	disced flat

Soil Type: Cropley silty clay
Irrigation Type: sprinkler
First Crop: broccoli
Fertilizer Program: Fall preplant - 500 lbs 10-10-15; Sidedress #1 - 500 lbs 20%; Sidedress #2 - 300 lbs 20%; Total N = 233.8 lbs/A.
Yield: 860 boxes/A
Second Crop: head lettuce
Fertilizer Program: preplant - 500 lbs 10-10-15; Sidedress #1 - 500 lbs 20%; Sidedress #2 - 300 lbs 20%; Total N = 233.8 lbs/A.
Yield: 702 boxes/A

Salinas, Site No. 2; Pisoni, Breschini Ranch 12, US 101 Access Road

Date	Day of Year	Stage of Growth
May 13	134	crop thinned
May 30	151	rosette stage
June 11	163	mid-heading
June 25	177	harvested and disced
July 9	191	listed
July 22	204	cauliflower just transplanted
August 11	224	transplants 5-6 true leaves
August 25	238	plants 9-12" tall
September 6	250	near full size
September 20	264	full size, no buttons showing
October 5	279	heads 2-3"
October 21	295	heads 4-6"
November 6	311	disced flat

Soil Type: Cropley silty clay
Irrigation Type: sprinkler
First Crop: head lettuce
Fertilizer Program: Fall preplant - 500 lbs 10-10-15; Sidedress #1 - 500 lbs 20%; Sidedress #2 - 300 lbs 20%; Total N = 233.8 lbs/A.
Yield: 860 boxes/A
Second Crop: cauliflower
Fertilizer Program: preplant - 500 lbs 13-13-13; Sidedress #1 (after planting) - 500 lbs 20%; Sidedress #2 - 400 lbs 20% (2 weeks prior to harvest); Total N = 245.0 lbs/A.
Yield: 837 boxes/A

Salinas, Site No. 3; Tamagni Home Ranch, Lot #4, Foster Road

Date	Day of Year	Stage of Growth
May 13	134	winter crop harvested and disced flat
May 30	151	winter crop harvested and disced flat
June 11	163	listed
June 25	177	bed shaped
July 9	191	lettuce planted and cotyledons emerging
July 22	204	lettuce 2-3 true leaves
August 11	224	rosette stage
August 25	238	mid-heading
September 6	250	near harvest
September 20	264	disced
October 5	279	working ground (disced, chiseled)
October 21	295	disced flat
November 6	311	disced flat

Soil Type: Salinas Clay Loam
Irrigation Type: sprinkler
First Crop: head lettuce
Fertilizer Program: Manure - 4 T/A; Preplant - 298 lbs/A 6-20-20; Starter (with Kerb) 25 gals/A - 7-7-0-7; Sidedress - 433 lbs/A 15-8-4; Sidedress #2 - 403 lbs/A 20%: Total N = 182.7 lbs/A.
Yield: 832 boxes/A
Second Crop: head lettuce
Fertilizer Program: Preplant - 300 lbs/A 6-20-20; Starter (with Kerb) 25 gals/A - 7-7-0-7; Sidedress - 433 lbs/A 15-8-4; Sidedress #2 - 403 lbs/A 20%: Total N = 182.7 lbs/A.
Yield: 605 boxes/A

Salinas, Site No. 4; Tamagni Home Ranch, Lot #9, middle of ranch

Date	Day of Year	Stage of Growth
May 13	134	winter crop harvested and disced flat
May 30	151	winter crop harvested and disced flat
June 11	163	listed
June 25	177	planted
July 9	191	cotyledons
July 22	204	lettuce 3-4 true leaves
August 11	224	rosette stage
August 25	238	mid-heading
September 6	250	near harvest
September 20	264	disced
October 5	279	landplaned
October 21	295	disced flat
November 6	311	planted to winter crop

Soil Type: Salinas Clay Loam
Irrigation Type: drip
First Crop: head lettuce
Fertilizer Program: Manure - 4 T/A; Preplant - 311 lbs/A 6-20-20; Starter (with Kerb) 25 gals/A - 7-7-0-7; Sidedress - 433 lbs/A 15-8-4; Sidedress #2 - 403 lbs/A 20%: Total N = 183.5 lbs/A.
Yield:789 boxes/A
Second Crop: head lettuce
Fertilizer Program: Preplant - 300 lbs/A 6-20-20; Sidedress - 350 lbs/A 15-8-4; Sidedress #2 - 250 lbs/A 28%: Sidedress #3 - 100 gals/A 10-17: Total N = 240.5 lbs/A.
Yield: 909 boxes/A

Salinas, Site No. 5; Jensen Esperanza Ranch, Lot #5E, Esperanza Rd.

Date	Day of Year	Stage of Growth
May 13	134	broccoli 8-9 true leaves
May 30	151	broccoli plants near full size, no heads showing
June 11	163	heads button stage
June 25	177	heads 2-4"
July 9	191	harvesting
July 22	204	harvested and disced
August 11	224	cotyldons just emerging
August 25	238	3-4 true leaves
September 6	250	rosette stage
September 20	264	mid-heading
October 5	279	harvesting
October 21	295	beds worked with a sundance impliment
November 6	311	left in peaked beds

Soil Type: Chular Loam
Irrigation Type: sprinkler
First Crop: broccoli
Fertilizer Program: Preplant - 300 lbs/A 13-13-13; Top dress 600 lbs/A - 16%; Sidedress - 400 lbs/A 20%; Water run 150 lbs 20%. Total N = 245 lbs/A.
Yield:799 boxes/A
Second Crop:head lettuce
Fertilizer Program: Preplant - 300 lbs/A 9-9-9; 1st sidedress 300 lbs/A - 20-0-0-5; 2nd Sidedress - 300 lbs/A 20%; Water run 150 lbs 20%. Total N = 177 lbs/A.
Yield: 650 boxes/A

Salinas, Site No. 6; Jensen Wallace Ranch, Lot #7E, Old Stage Road

Date	Day of Year	Stage of Growth
May 13	134	broccoli 7-8 true leaves
May 30	151	broccoli half grown
June 11	163	plants near full size
June 25	177	broccoli plants full size, buttons showing
July 9	191	broccoli near harvest
July 22	204	harvesting
August 11	224	lettuce planted and sprinkling
August 25	238	cotyledons showing
September 6	250	3-4 true leaves
September 20	264	rosette stage
October 5	279	mid-heading
October 21	295	near harvest
November 6	311	harvested, no worked yet

Soil Type: Elder sandy loam
Irrigation Type: lateral move sprinkler
Second Crop: head lettuce
Fertilizer Program: Preplant - 310 lbs/A 13-13-13; Top dress 600 lbs/A - 16%; Sidedress - 300 lbs/A 20%; Water run 200 lbs 20%. Total N = 236 lbs/A.
Yield: 701 boxes/A
Third Crop: head lettuce
Fertilizer Program: Preplant - 300 lbs/A 9-9-9; 1st sidedress 300 lbs/A - 20-0-0-5; 2nd Sidedress - 300 lbs/A 20%; 3rd sidedress - 300 lbs/A 20%. Total N = 207 lbs/A.
Yield: 387 boxes/A

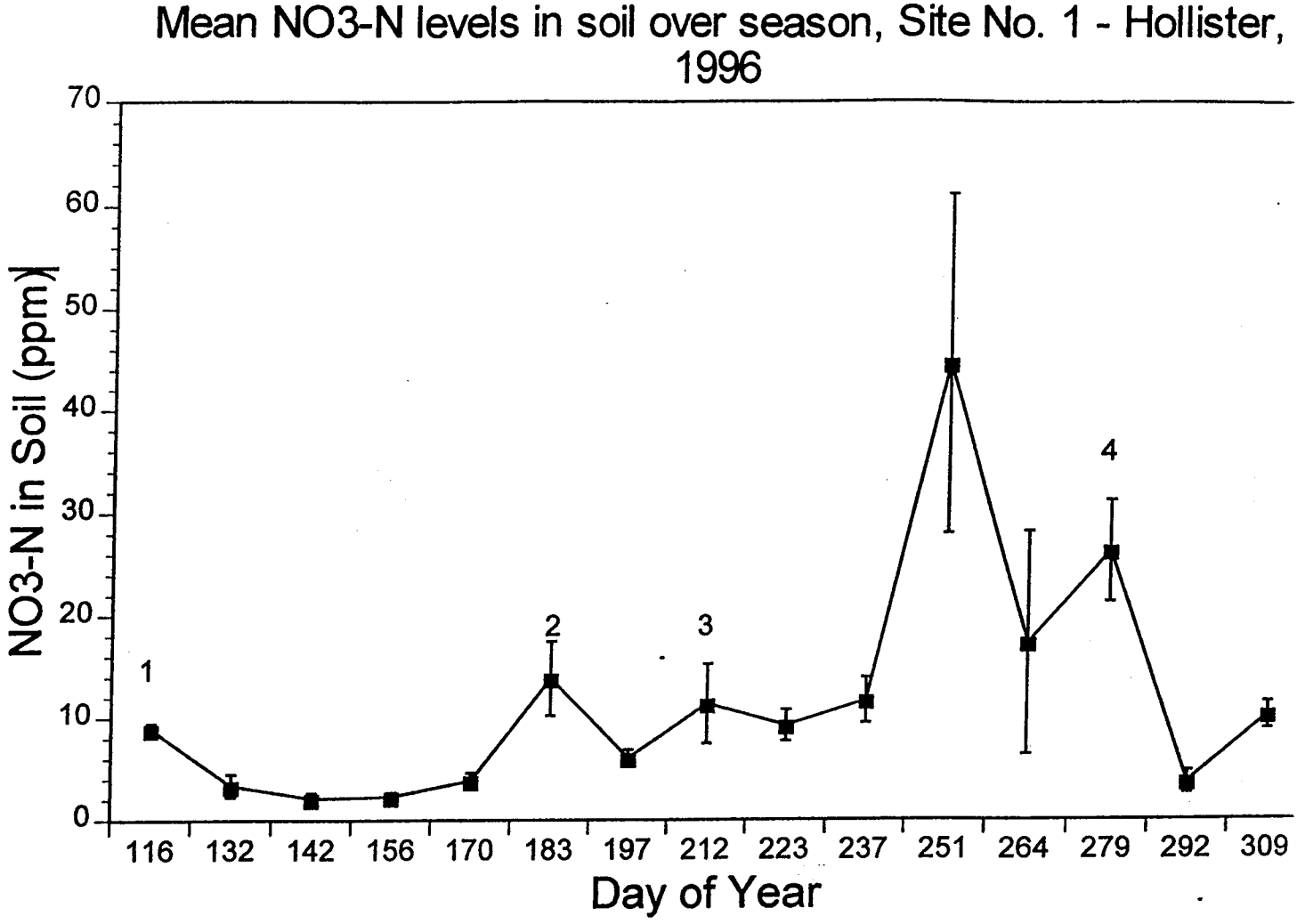

Figure 1

1-2: Spring - Head Lettuce; 234 lbs N; 650 b/A
3-4: Fall - Head Lettuce; 155 lbs N; 370 b/A

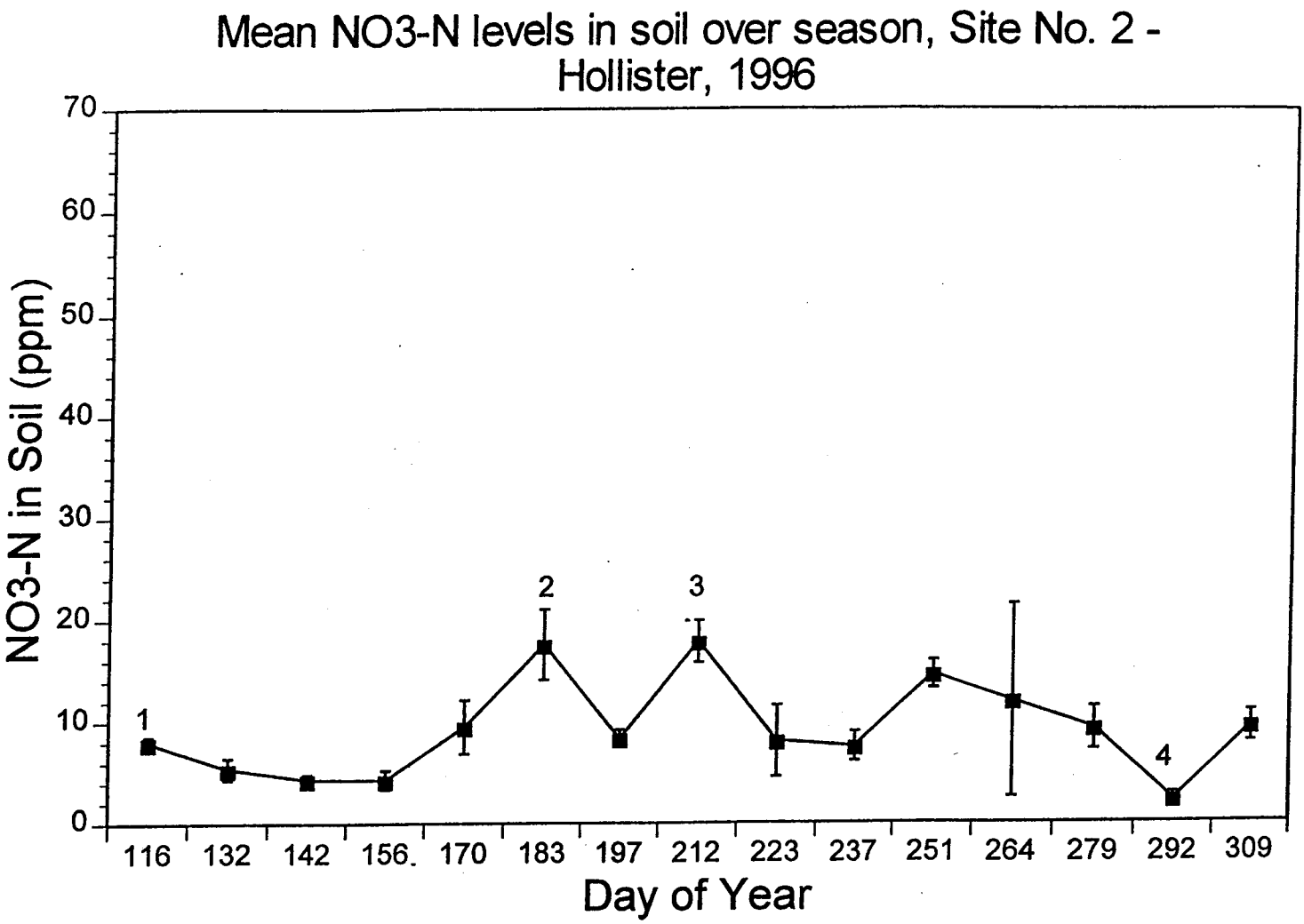

Figure 2

1-2: Spring - Head Lettuce; 249 lbs N; 820 bA

3-4: Fall - Head Lettuce; 155 lbs N; 690 b/A

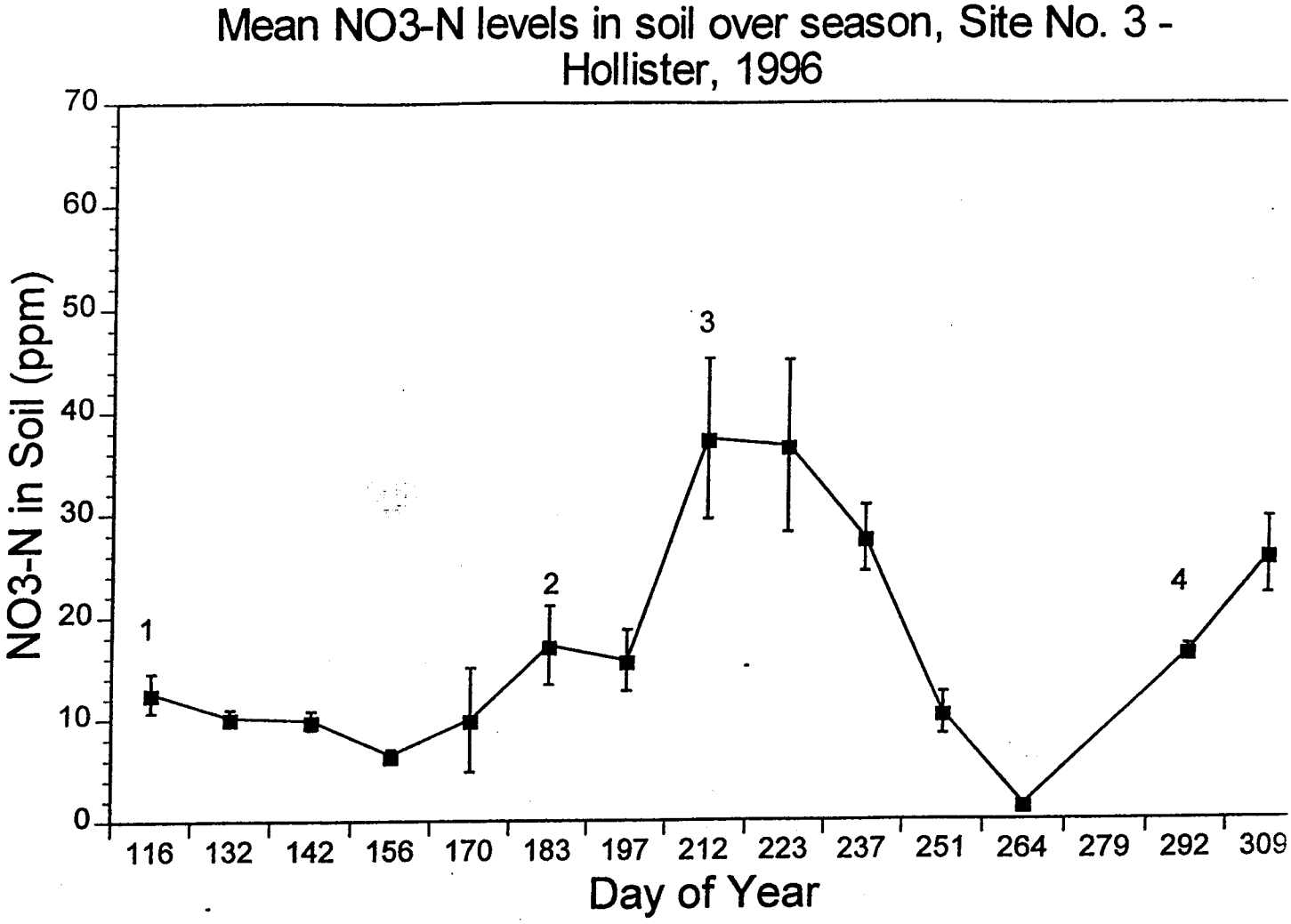

Figure 3

1-2: Spring - Head Lettuce; 249 lbs N; 868 b/A
3-4: Fall - Head Lettuce; 163 lbs N;447 b/A

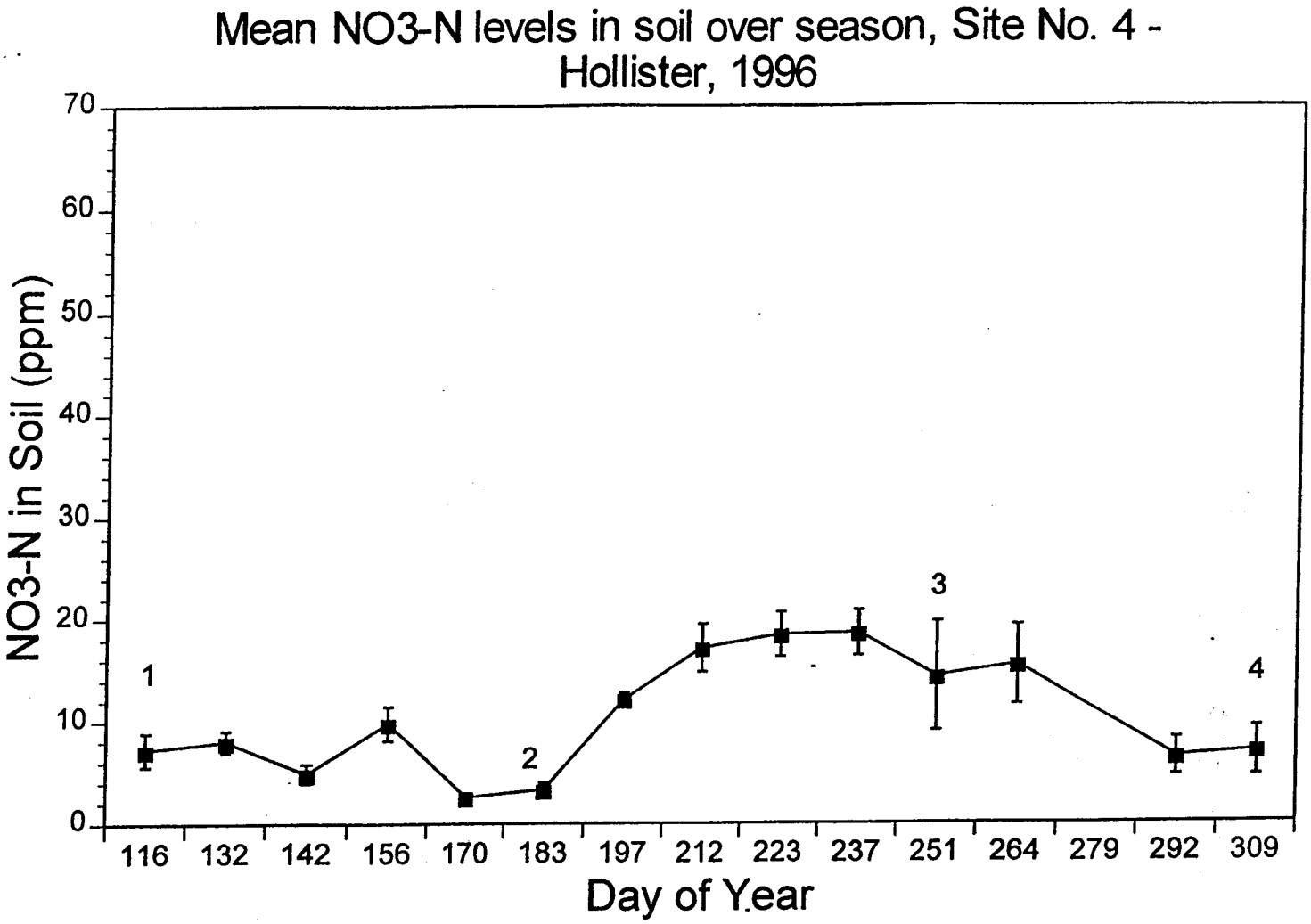

Figure 4

1-2: Spring - Leaf Lettuce; 159 lbs N; 775 b/A
3-4: Fall -Leaf Lettuce; 164 lbs N; 750 b/A

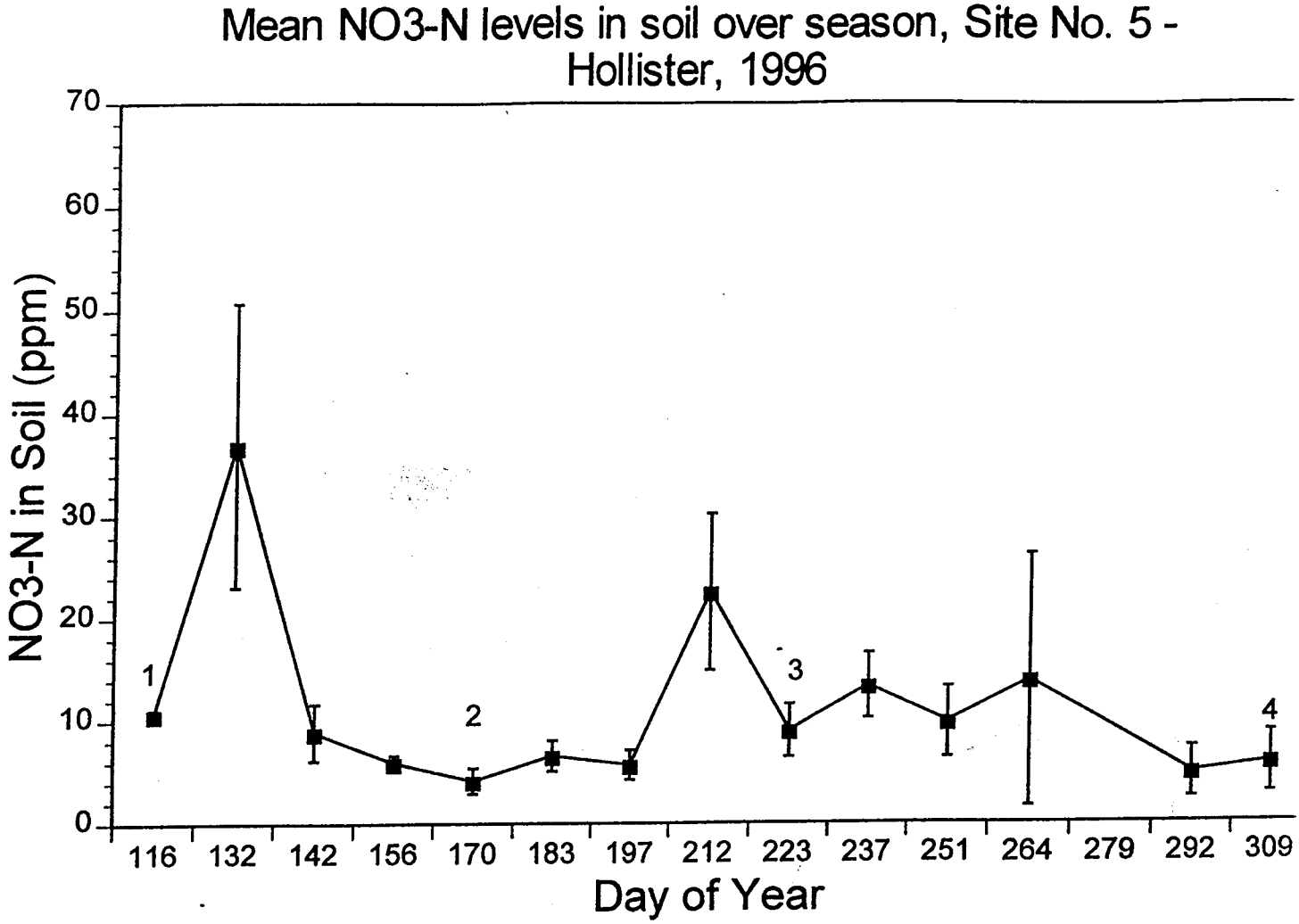

Figure 5

1-2: Spring -Leaf Lettuce; 155 lbs N; 684 b/A
3-4: Fall - Broccoli; 160 lbs N; 200 b/A (1 pick)

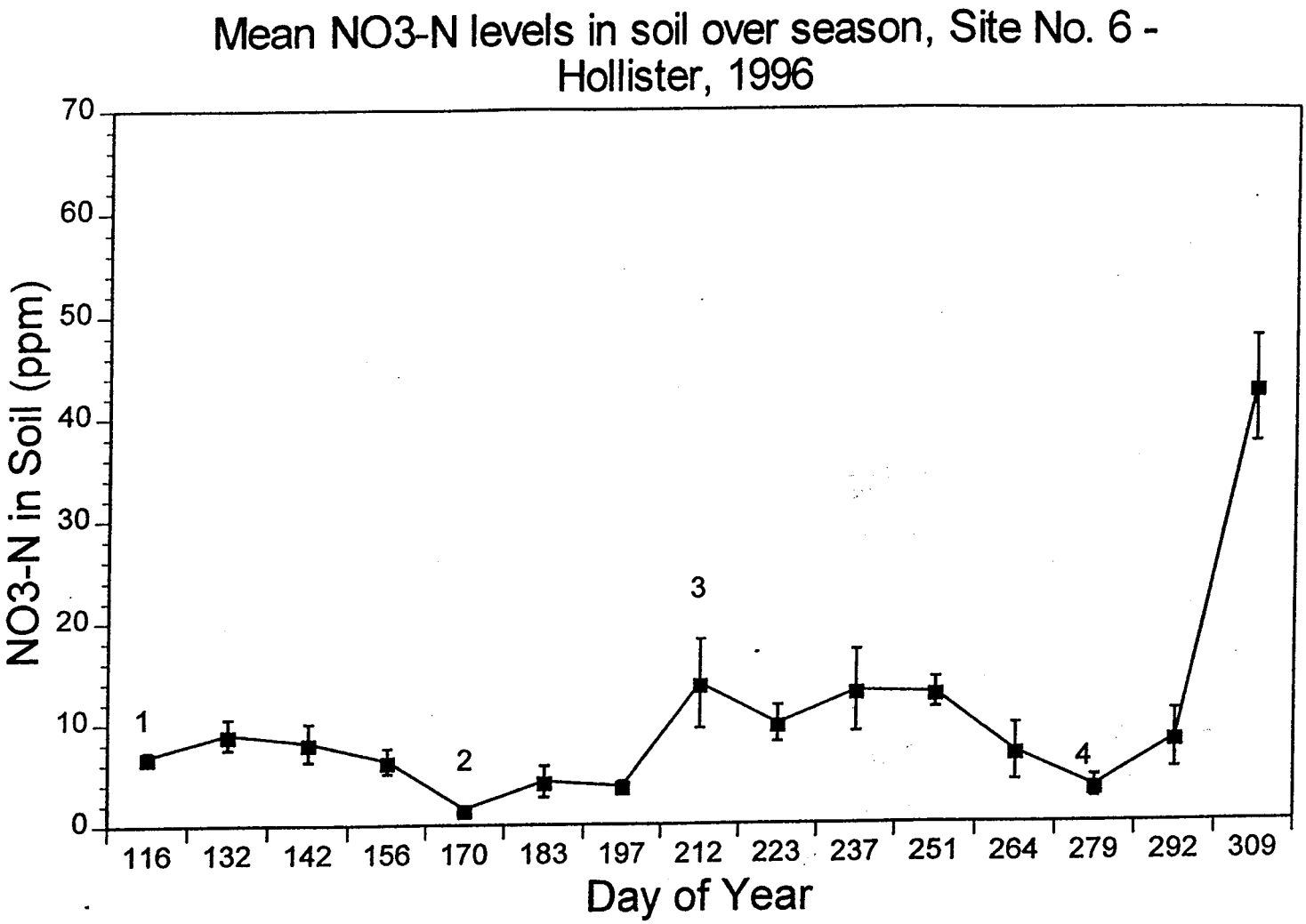

Figure 6

1-2: Spring - Head Lettuce; 198 lbs N; 662 b/A
3-4: Fall - Head Lettuce; 203 lbs N; 660 b/A

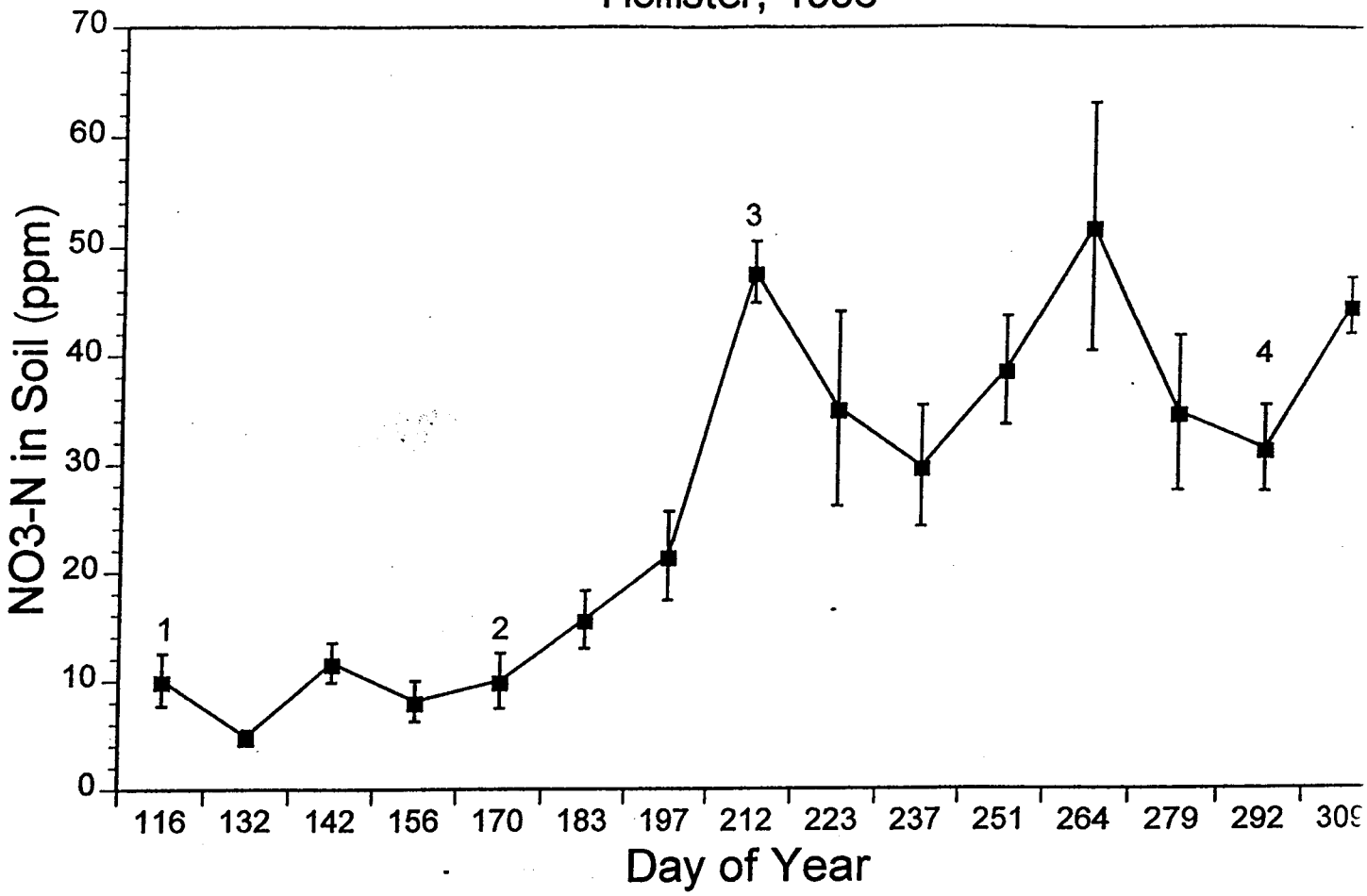

Figure 7

1-2: Spring - Head Lettuce;128 lbs N; 750 b/A
3-4: Fall - Head Lettuce; 150 lbs N; 863 b/A

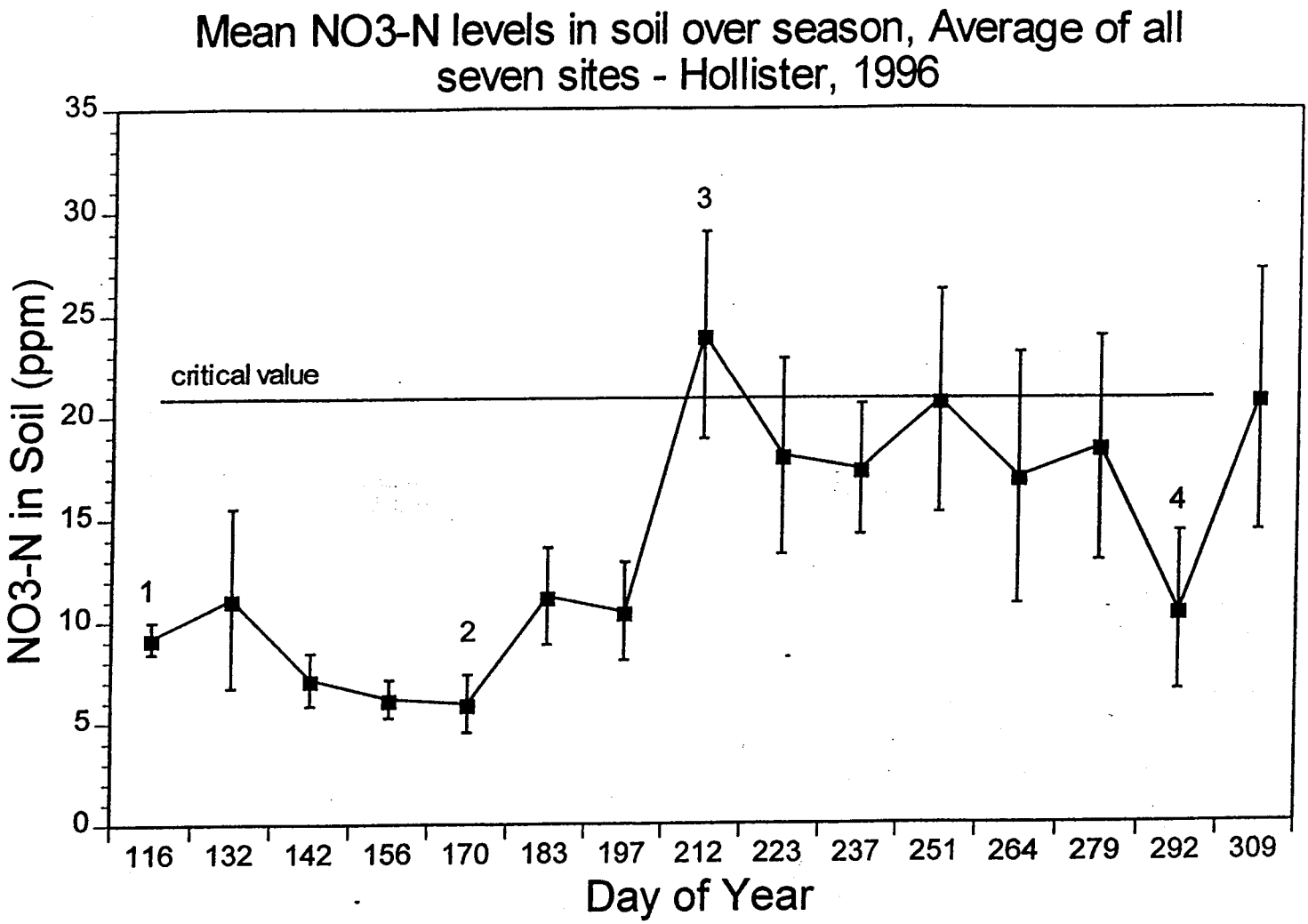
Mean NO3-N levels in soil over season, Average of all seven sites - Hollister, 1996
NO3-N in Soil (ppm)
35
30
25
20
15
10
5
0
critical value
1
2
3
4
116
132
142
156
170
183
197
212
223
237
251
264
279
292
309
Day of Year

Figure 8

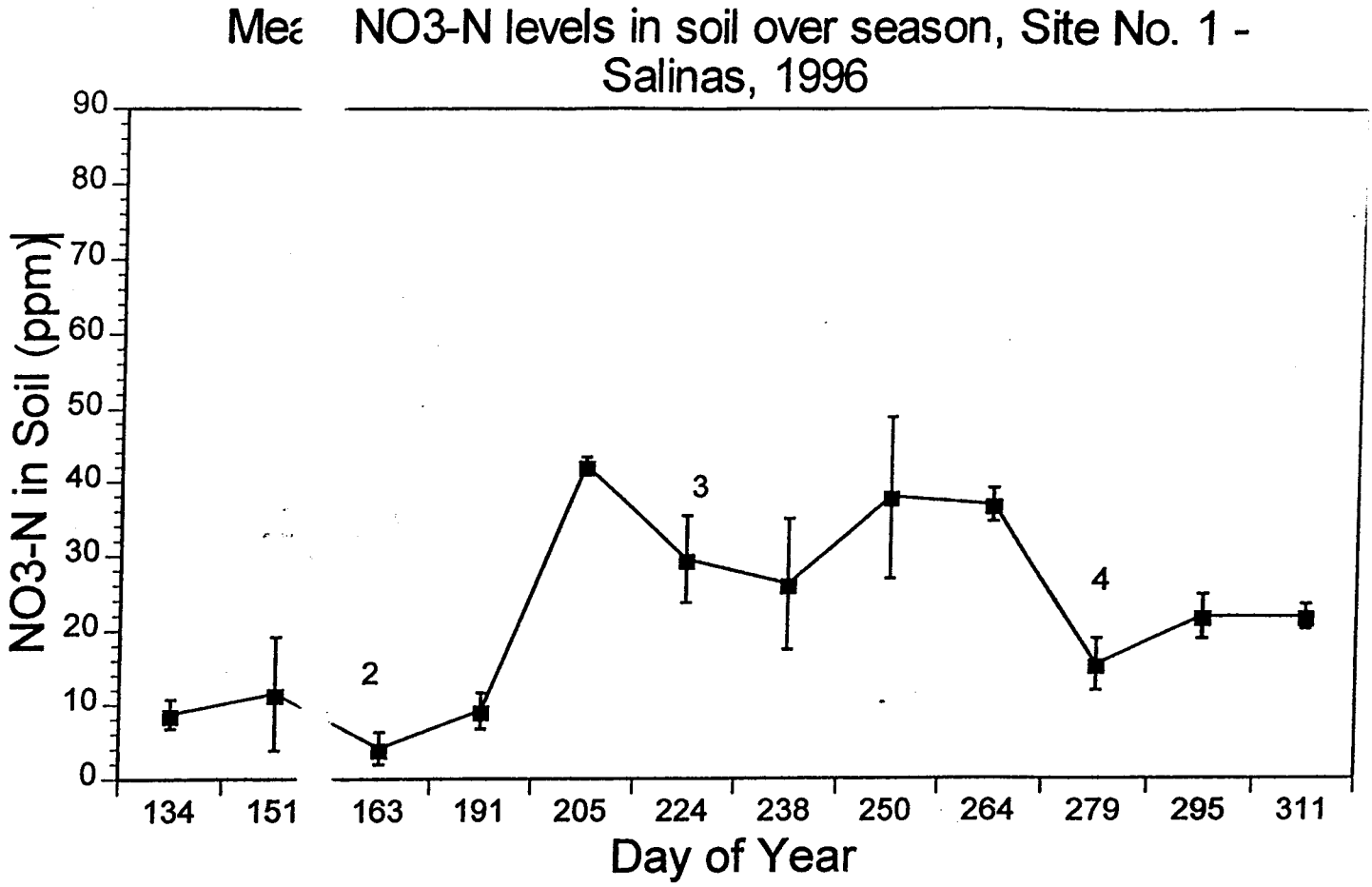

Figure 9

1-2: Sprin · Broccoli; 234 lbs N; 860 b/A
3-4: Fall - ead Lettuce; 234 lbs N; 702 b/A

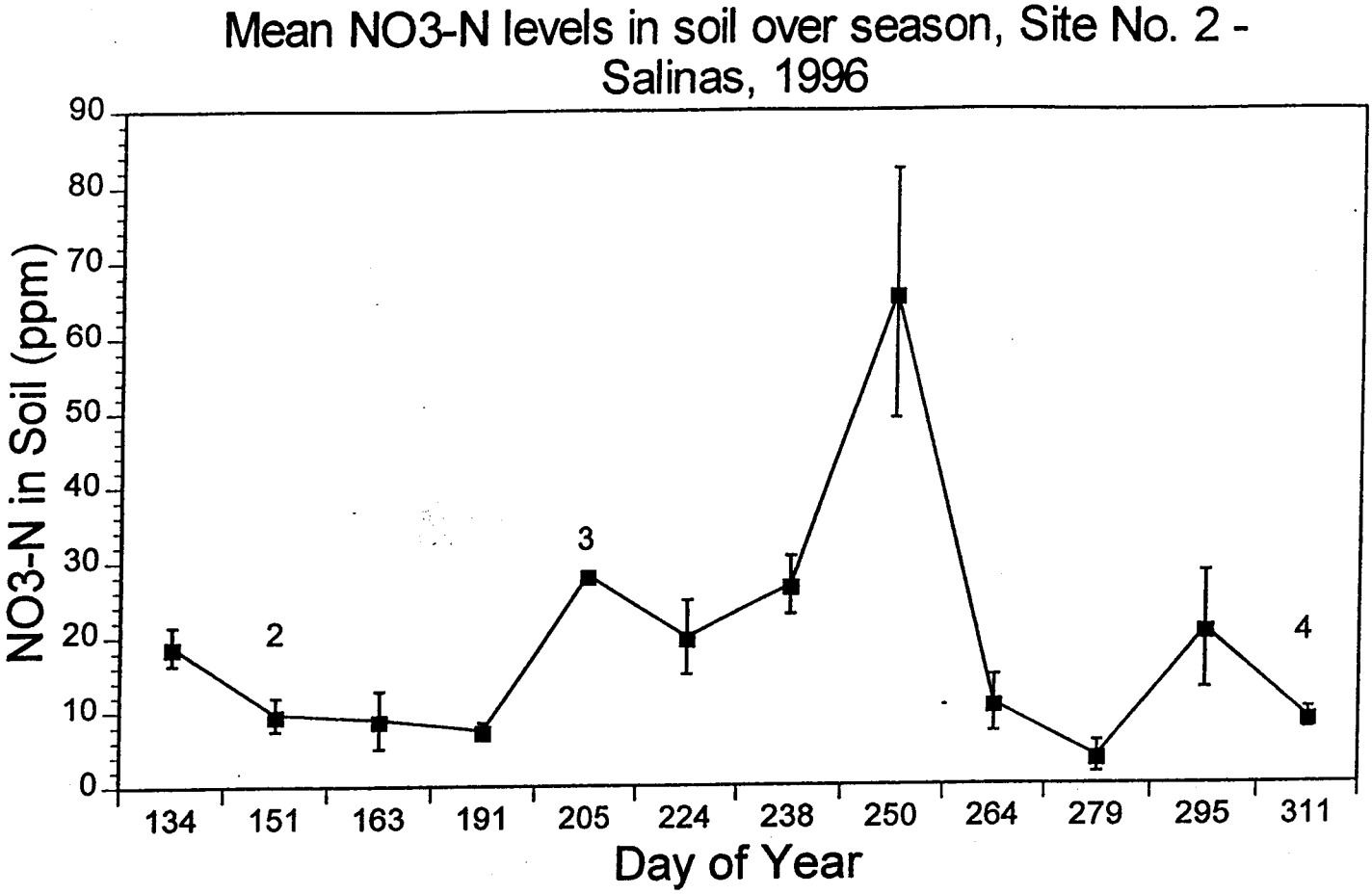

Figure 10

1-2: Spring - Head Lettuce; 234 lbs N; 860 b/A
3-4: Fall - Cauliflower; 245 lbs N; 837 b/A

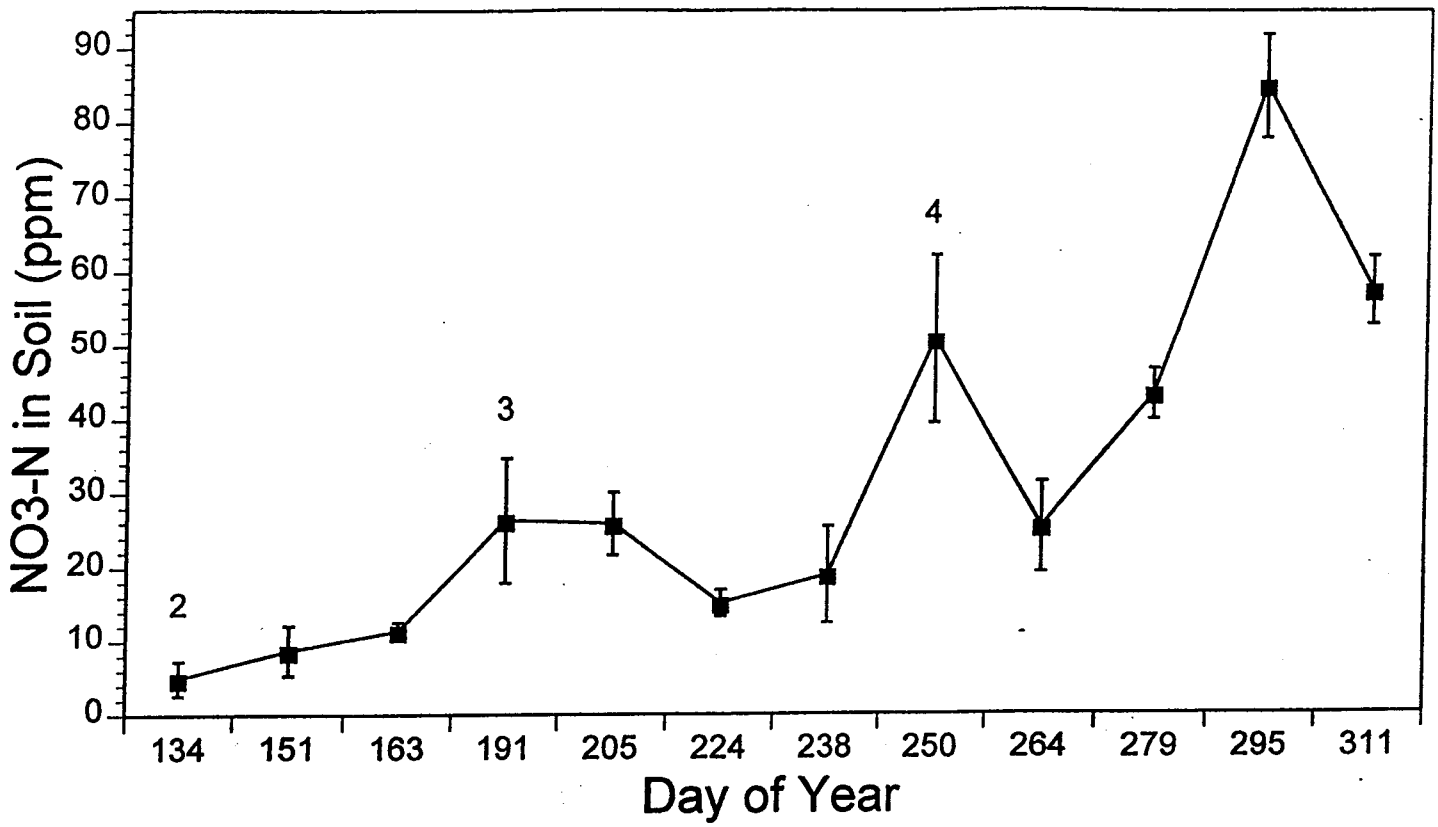

Figure 11

1-2: Spring - Head Lettuce; 183 lbs N; 832 b/A
3-4: Fall - Head Lettuce; 183 lbs N; 605 b/A

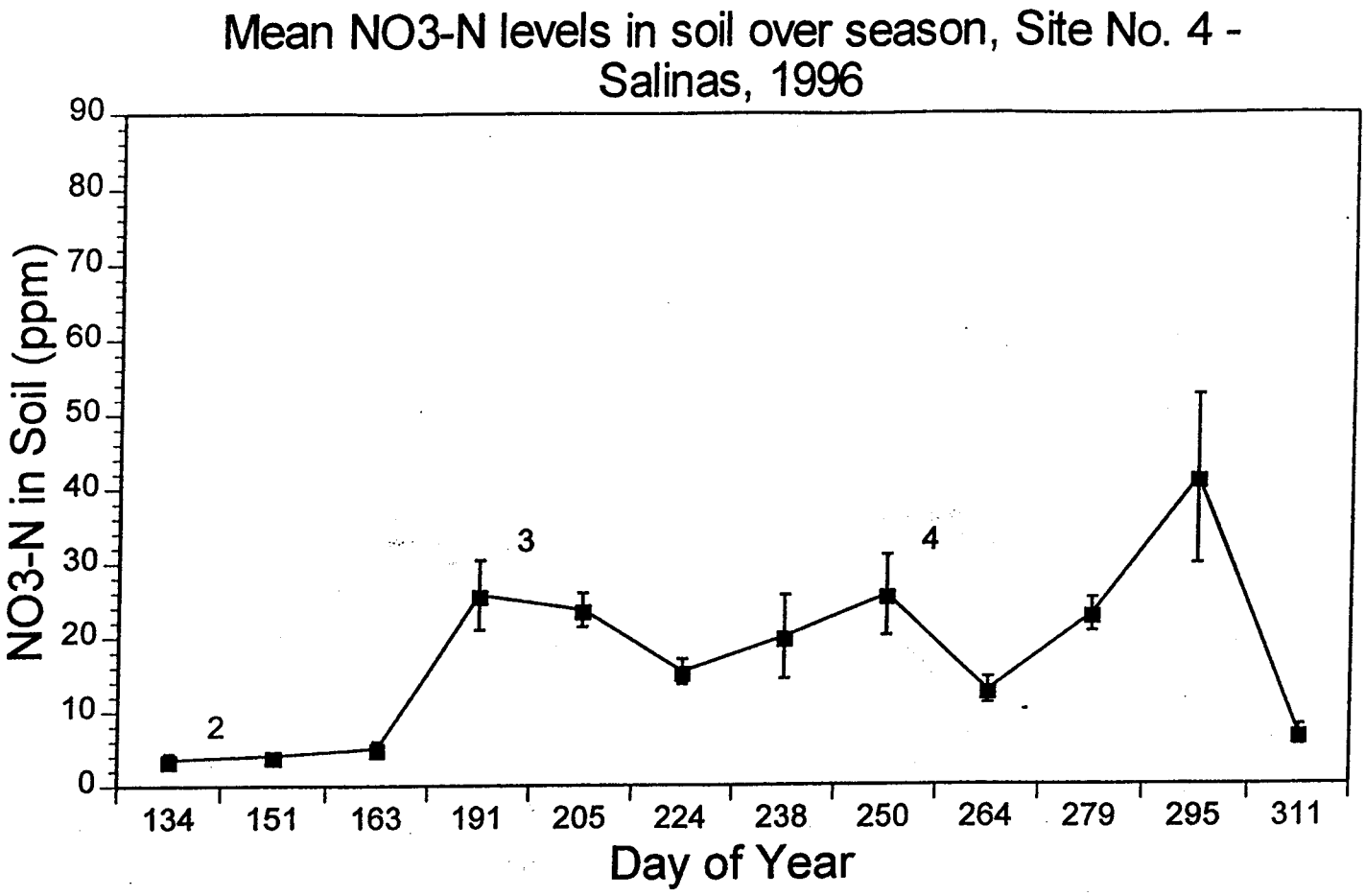

Figure 12

1-2: Spring -Head Lettuce; 184 lbs N; 789 b/A
3-4: Fall - Head Lettuce; 241 lbs N; 909 b/A

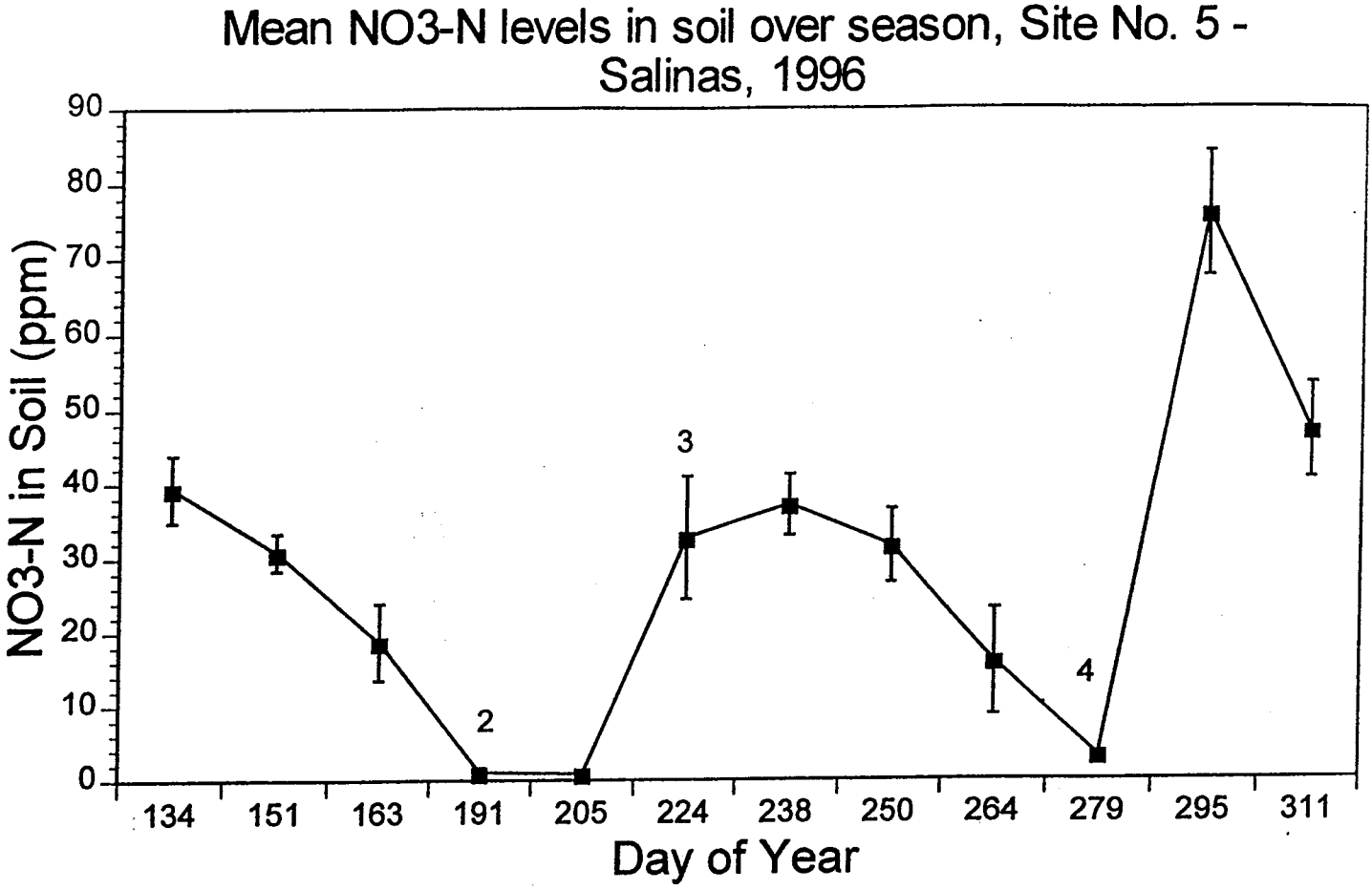

Figure 13

1-2: Spring - Broccoli; 245 lbs N; 799 b/A
3-4: Fall - Head Lettuce; 177 lbs N; 650 b/A

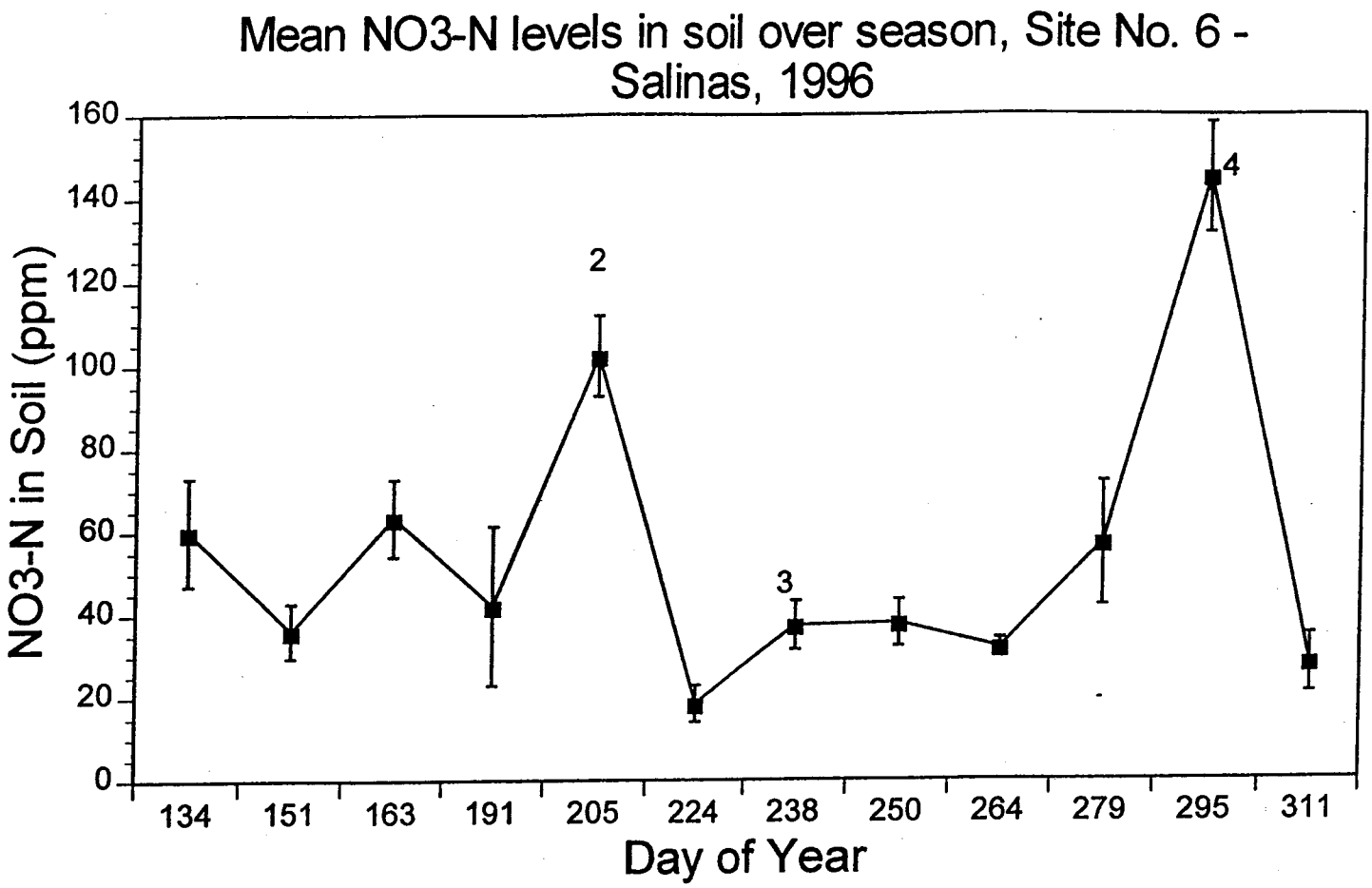

Figure 14

1-2: Spring - Head Lettucei; 236 lbs N; 701 b/A
3-4: Fall - Head Lettuce; 207 lbs N; 387 b/A

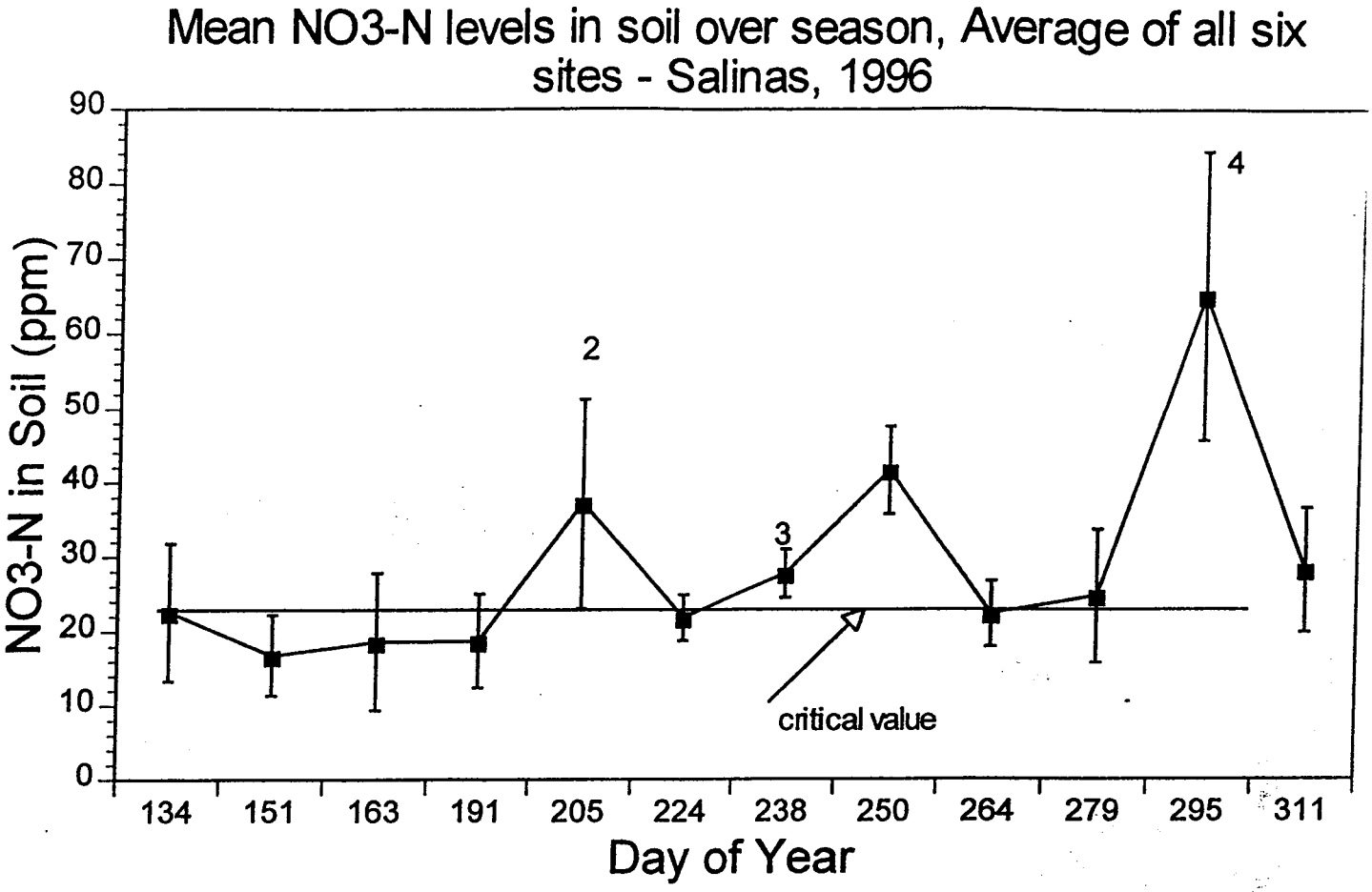
Mean NO3-N levels in soil over season, Average of all six sites - Salinas, 1996
NO3-N in Soil (ppm)
90
80
70
60
50
40
30
20
10
0
2
3
4
critical value
134
151
163
191
205
224
238
250
264
279
295
311
Day of Year

Figure 15

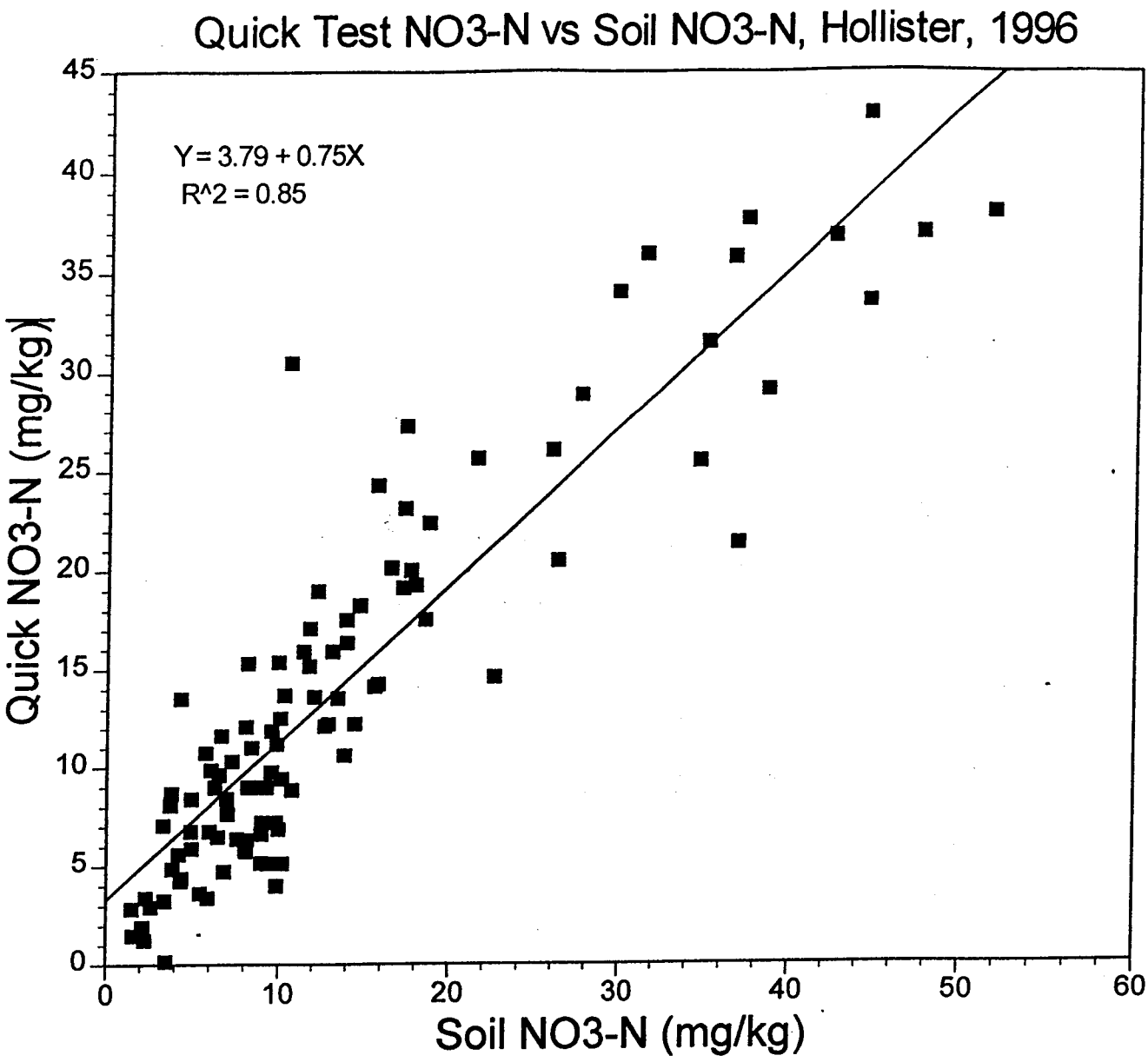
Quick Test NO3-N vs Soil NO3-N, Hollister, 1996
Y = 3.79 + 0.75X
R^2 = 0.85
Quick NO3-N (mg/kg)
Soil NO3-N (mg/kg)
0
5
10
15
20
25
30
35
40
45
0
10
20
30
40
50
60

Figure 16

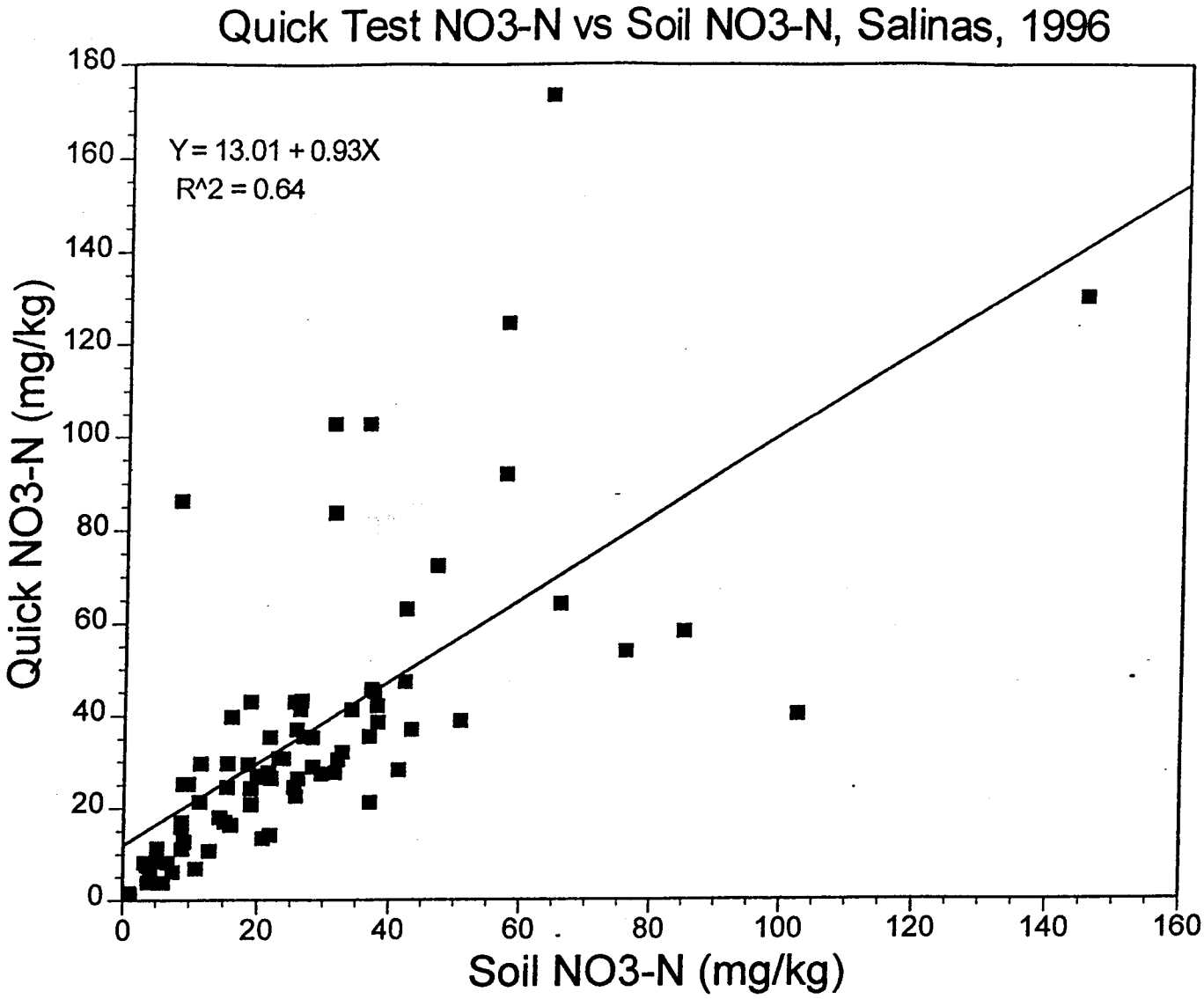
Quick Test NO3-N vs Soil NO3-N, Salinas, 1996
Y = 13.01 + 0.93X
R^2 = 0.64
Quick NO3-N (mg/kg)
Soil NO3-N (mg/kg)
0
20
40
60
80
100
120
140
160

Figure 17

Table 1. Correlations between the soil nitrate-N values as determined by the analytical lab and soil quick tests

Site Number	Correlation Equation	R-square
Hollister - 1	Y = 0.74X + 3.33	0.87
Hollister - 2	Y = 1.26X - 1.90	0.93
Hollister - 3	Y = 0.87X + 4.63	0.68
Hollister - 4	Y = 0.90X + 3.51	0.82
Hollister - 5	Y = 0.43X + 5.54	0.80
Hollister - 6	Y = 0.52X + 4.36	0.24
Hollister - 7	Y = 0.67X + 7.83	0.83
Hollister - Overall	Y = 0.75X + 3.79	0.85
Salinas - 1	Y = 0.86X + 8.85	0.81
Salinas - 2	Y = 0.90X + 5.69	0.90
Salinas - 3	Y = 0.88X + 9.98	0.66
Salinas - 4	Y = 0.75X + 8.19	0.79
Salinas - 5	Y = 0.89X + 13.49	0.64
Salinas - 6	Y = 0.61X + 37.93	0.48
Salinas - Overall	Y = 0.93X + 13.01	0.64