Crop Management Report
EPA 319 Project, Vegetable Farm
Spring Potato, 2002

Nutrient Management
Irrigation Management
Controlled Release Fertilizer
NFREC-SV Potato Demonstration

Through winter meetings with the landowner, it was agreed that the field would receive two differing management schemes. The North half of the field would remain under the traditional farm management, the South half would be managed by Joel Love, Environmental Specialist II, Department of Agricultural Water Policy, FDACS, and Justin Jones, Research Coordinator, North Florida Research and Education Center – Suwannee Valley, UF-IFAS. Supervision and oversight was provided by Dr. George Hochmuth with input from the other IFAS project participants. The traditional crop rotation would not grow potatoes in the same field in subsequent years, as the crop could face higher disease pressure. However, the landowner agreed to assume the higher level of risk, and made plans to accommodate the requests of the project leaders.

To achieve project goals of reducing nitrogen fertilization and irrigation on the South half, the nutrient program for South half targeted the IFAS recommended rate on potatoes of 200 lbs of nitrogen per acre. Additionally, there were plans to modify the farm's rate and timing of each application. It was also agreed that irrigation of the South half would be reduced by 20%.

Nutrient Management

Field preparation began in January for the Spring potato crop. The field was disked and leveled, and on January 10, and the first application of fertilizer was made via pull spreader. During this application, 918 lbs/A of a 4-10-27 was applied to the North half, which consisted of 38 lbs of nitrogen. The South side received 673 lbs/A of 0-11-29, containing no nitrogen. From this initial application, 2.6 inches of rain was collected before bedding began five days later.

The bedding operation applied a soil fumigant, liquid nitrogen fertilizer and then formed the initial bed on 40" centers. The North side received 26 lbs N/A, while the South received 81lbs N/A during bedding. *(One of the strategies of the Project team was to apply more fertilizer inside the bed, rather than into the bed shoulders as a sidedress. Fertilizer placed deeper within the center of the bed should be less prone to leaching due to how rainfall is shed off the bed and into the furrows during heavy rains.)* There were just over 3 inches of rain collected from bedding to planting, which began on February 12. During planting, both sides received 15 lb N/A as a starter fertilizer.

Figure 1 The potato crop growing rapidly near the end of March.

The potatoes received two applications of sidedress nitrogen during the season. The first began on March 13, with the North side receiving 91 lbs N/A, while the South received 50 lbs N/A. Between planting and the first sidedress application, nearly 6 inches of rainfall was collected, with just over 5 inches collected in just two days. An additional irrigation of 0.23 inches was applied just 2 days before the 5-inch leaching rain.

The final sidedress nitrogen application began on March 25. During this application, both sides received approx. 90 lbs N/A. *(IFAS recommendation allows an additional 30 lbs nitrogen application following a leaching rain.)* This final application brought the nitrogen fertilizer totals to 263 lbs N/A on the North side, and 233 lbs N/A on the South.

Irrigation Management

Irrigation management considerations began with the needed replacement of the existing pivot, which had failed several times in the previous two crops. Since replacement was inevitable, suggestions were made to select a Senninger iWob nozzle package. The iWobs claimed to have a high efficiency, uniformity, large droplet size, and a large ‘footprint.’ The Senninger LDN’s (Low Drift Nozzle) had performed during the previous crops with exceptional efficiency and uniformity, at the sacrifice of enhanced erosion of the potato beds. The larger ‘footprint’ of the iWob, and its rain-like droplet size and pattern was hoped to maintain that same level of efficiency while reducing bed erosion.

Figure 2 The irrigation system as it fell in the previous corn crop.

After the new center pivot was installed with Senninger iWob nozzles, the Suwannee River Mobile Irrigation Lab performed an efficiency evaluation of the pivot’s irrigation pattern. Their thorough evaluation reported excellent application efficiency as well as excellent application uniformity. Figures 4-6 are efficiency graphs provided by the Mobile Irrigation Lab that reveal the increasing efficiencies over several modifications to the irrigation system.

Figure 3 Senninger iWob nozzle during the Mobile Irrigation Lab's efficiency evaluation.

Tensiometers were installed throughout the field as the crop began to emerge. These tensiometers were installed in clusters of three, with one placed at 6” depth, one at 8” depth and the last at 12.” There were 5 clusters of tensiometers installed per half. These were read and recorded three times per week throughout the crop season. This provided information of actual soil moisture tension in the field to aid in irrigation management decisions.

Active irrigation management of the South half did not begin until the crop was fully emerged in mid-March. Decisions of when to irrigate was yielded to the landowner (during much of the season, irrigation is required daily). However, decisions of how much to irrigate were made as a factor of tensiometer readings, current weather conditions, calculated potential evapotranspiration rates, weather forecasts and physical examination of the bed. As a result of this close monitoring, irrigation rates for the South half were near half of that being applied to the North during late March. Overall, total irrigation was reduced by 36% on the South half as compared to the North half in March.

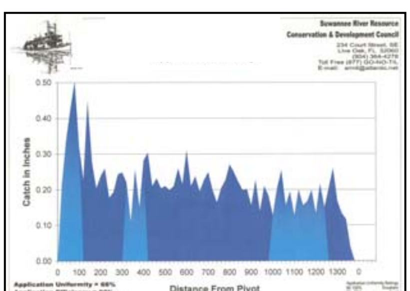


Figure 4 Irrigation performance before installation of Senninger LDN. Efficiency 90%. Uniformity 66%.

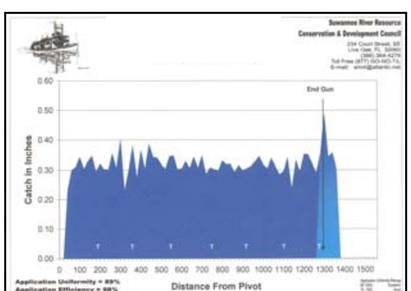


Figure 5 Irrigation performance after installation of the Senninger LDN. Efficiency 98%. Uniformity 89%.

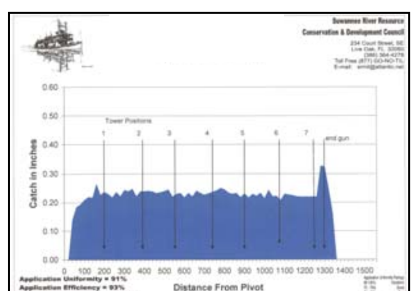


Figure 6 Irrigation performance with Senninger iWob nozzles. Efficiency 93%. Uniformity 91%.

In early April, as the crop was growing rapidly, irrigation rates on the South half were gradually increased keeping up with the increasing water requirements of the crop. Irrigation rates were chosen that would apply slightly more than the anticipated daily need of the crop. This 'extra' water was applied to cover any unforeseen inefficiencies or losses. Typically, this extra was approximately 0.05."

Disaster struck through rainfall on April 10. Rainfall amounts of approx. 0.75" were collected April 10 & 11, with light rains of approx. 0.08" collected on the 12th and 13th. Due to the fact that when to irrigate was yielded to the landowner, irrigation amounts were chosen for each of these days to apply either a minimum or necessary irrigation amount. However, the irrigation system wasn't restarted until the 15th, when the North side was already in visible wilt. At our request, the pivot was started that afternoon on the North side. During the night, electrical wiring to the pump shorted out disabling the pivot, which had not yet completed irrigating the North half. It took much of April 16 to repair the electrical problems, and the South side went into heavy wilt. The pivot was repaired, irrigation resumed, and a 1" rain fell from heaven that night. Irrigation management was resumed the following day, applying slightly over the anticipated daily evapotranspiration rate.

By April 18, total irrigation on the South half had been reduced by 34% as compared to the North. To achieve the agreed 20% overall reduction on the South, irrigation rates were increased on the South similar to that of the North for the remainder of the crop season.

As the crop matured and evapotranspiration rates reduced, irrigation was also reduced on both halves to provide conditions that would not encourage development of enlarged lenticels. The last irrigation was on May 12, and the crop was killed May 17-18.

The potato season ended receiving a total of 17.9 inches of rain, 13.6 inches of irrigation on the North side, and 10.9 inches of Irrigation on the South. Irrigation on the South side had been reduced 20%.

Figure 7 April 15, 2002. North side under drought stress.

Figure 8 April 15, 2002. South side revealing no signs of drought stress.

Figure 9 April 16, 2002. Repair crew on sight restoring the electrical wiring of the irrigation system.

Figure 10 April 16, 2002. Drought stress on South side as the irrigation system resumes operation on the North.

Figure 11 Leaf burn on the South side as a result of drought stess.

Figure 12 Leaf burn on the North side as a result of drought stress.

Figure 13 Digging potatoes on the South side, June 12, 2002.

Figure 14 Potatoes from the field ready for processing.

Controlled Release Nitrogen

During the initial conversations with the landowner about the project objectives, discussion was made about using a controlled release nitrogen source as a demonstration/comparison to traditional fertilization practices. Efforts were then made to locate and apply the product at the project site. Dr. Chad Hutchinson, from the Hastings Research Education Center, provided the controlled release product for this demonstration. It was a 40-0-0, and had a temperature dependent release; as soil temperature increased, increasing rates of nitrogen were released correspondingly. Unfortunately, the controlled release nitrogen product was not available early enough to apply during bedding, which would be the optimum time and placement. However, it was available just before the first application of sidedress nitrogen.

Four rows were marked on the South side for the controlled release nitrogen, and the product was applied to the field on March 15. The two inside rows received 156 lb N/A as a sidedress granular application, the two outside rows received 72 lbs N/A. These rows received no additional nitrogen during the remainder of the season.

Despite the fact that the controlled release nitrogen was applied late, the potato plants responded well throughout the season. Only slight color differences were visible as compared to the traditional rows. Final pack out information; 156 lb N/A rows yielded an average of 243 cwt/acre, 72 lb N/acre rows yielded 159 cwt/acre.

Figure 15 Joel Love adjusts drop tubes for improved fertilizer placement on the rig used to apply the controlled release nitrogen fertilizer.

Figure 16 Placement of the controlled release nitrogen on the bed. Centered are the two rows receiving 156 lbs N/A. The two outside rows received 72 lbs.N/A.

Figure 17 The controlled release nitrogen was covered following application. Here, personnel from the farm covers the nitrogen with a 4 row bedder.

Figure 18 Controlled release nitrogen rows on April 15, 2002. Note the slight color variation as compared to the adjacent rows.

Yield . . . . . . Where the Rubber Meets the Road!

In any on-farm project, the big answer always boils down to how much produce is marketable. This potato project is no different. The bottom line is revealed in how many bags of potatoes are harvested out of the field.

About a week after the field was desiccated, project leaders conducted a plot harvest of the field. Plots to be dug were measured at 25 ft long, and replicated 6 times per half of the field. In addition, to maintain consistency, each plot was located between the 5th and 6th towers of the irrigation system. Finally, because the landowner had applied a trial soil inoculant to part of the field, all data plots were located outside this treatment area. As a result, all data plots were located in the short rows of the field (in the corners).

Figure 23 Potatoes in the processing line being presorted before entering the hydra cooler.

Data from these plots indicate that in total yield, there was no significant difference between the two halves under the two different management schemes. However, when looking at potato quality, the South side had fewer enlarged lenticels. *(In general, enlarged lenticels are usually the result of excessive moisture in the bed. For most of the potato season, the South half had been managed to provide adequate moisture needed by the plants without saturating the beds.)* Fortunately, many of those considered as 'culls' by the project harvest crew were deemed acceptable by the USDA inspector assessing the quality of the potatoes being processed.

Careful packing data was also collected by the packing shed foreman in this side by side comparison. Total pack out information received from the landowner reports that 37,200 50 lb. bags came out of the North half, and 36,928 50 lb. bags came out of the South. This correlates to average yields of 268 cwt/acre on the North and 266 cwt/acre on the South.

Figure 24 The final product. Bagged potatoes ready for market.

During the winter planning stages of the EPA 319 vegetable project, a similar demonstration was planned at the North Florida Research and Education Center – SV. Specifically, there were two treatments that were to be compared. The "A" treatments were to receive fertilization in the traditional manner: Initially there would be 60 lbs N applied preplant into the bed about 14 days before planting, 15 lbs N at planting, followed by two sidedress applications of 60 lbs N each; the first at 2' – 4" plant height and the second at about 6" plant height.

The "B" treatment that would receive a modified fertilization program would follow the following: 0 lbs. N preplant, 15 lbs N at planting, 60 lbs N at cracking, 60 lbs N at 2"-4" plant height and 60 lbs N at 6" plant height. All fertilizer was applied as sidedress except that at planting, which was placed just below the seed piece.

Harvest plots measured 25' long, like those at the project site, and yielded the following results. The traditional rows yielded an average of 346 cwt/acre, with 285 cwt/A being marketable. The modified rows yielded an average of 380 cwt/acre, with 337 cwt/acre being marketable.

Figure 19 The traditional and modified rows alternate. Here, there is no visible difference between treatments.

Figure 20 NFREC-SV staff harvest the 25 ft. plots by hand in the potato demonstration.

Figure 21 Marketable potatoes out of both treatments. Note the size of potato as compared to wooden stake. Potatoes averaged 6.2 oz in the modified treatment, 5.6 oz in the traditional treatment.

Figure 22 The cull box from both treatments. As graded, 88% of the modified treatment potatoes were marketable as compared to 82% of the traditional treatment potatoes. Also, a larger than expected portion of rots were found due to the delayed harvest date.

Summary

At the conclusion of the Spring 2002 potato crop, the overall management program on the South half had reduced nitrogen fertilizers by 30 lbs and total irrigation by 20%, without affecting yield. In fact, under more stringent grading standards, the reduced nitrogen and irrigation may have yielded more marketable potatoes due to a higher number of potatoes with enlarged water lenticels found on the North side.

This information combined with that gathered in the potato demonstration at NFREC-SV suggests that both nutrient and irrigation management practices can be modified further. Withholding significant fertilizer applications until plant emergence may allow for further reductions in nitrogen fertilizer rates. Likewise, irrigation rates could receive a greater reduction both early and late in the season than was realized during the spring potato crop. Further opportunity to demonstrate this theory is necessary to determine actual results of such modifications to current nutrient and irrigation management practices.

Figure 25 These photos are root profiles from project demonstrations at the vegetable farm (top) and at the North Florida Research and Education Center – Suwannee Valley (bottom). The root board is marked with a six-inch grid marked in red. Comparing the two, it is obvious that both sets of potatoes developed a root system that was approximately forty inches wide. However, there are marked differences in root depth and distribution within the bed. Potato roots at the Center were found as deep as the board captured the roots (18 inches) and also had larger volume of fibrous roots within the bed. These advantages were influenced by disturbing the compaction layer that was found at approximately 9 inches from the soil surface, and by modified irrigation management. No irrigation events took place before full emergence of the plants requiring them to utilize more energy in root development than top growth in the early stages of the crop.

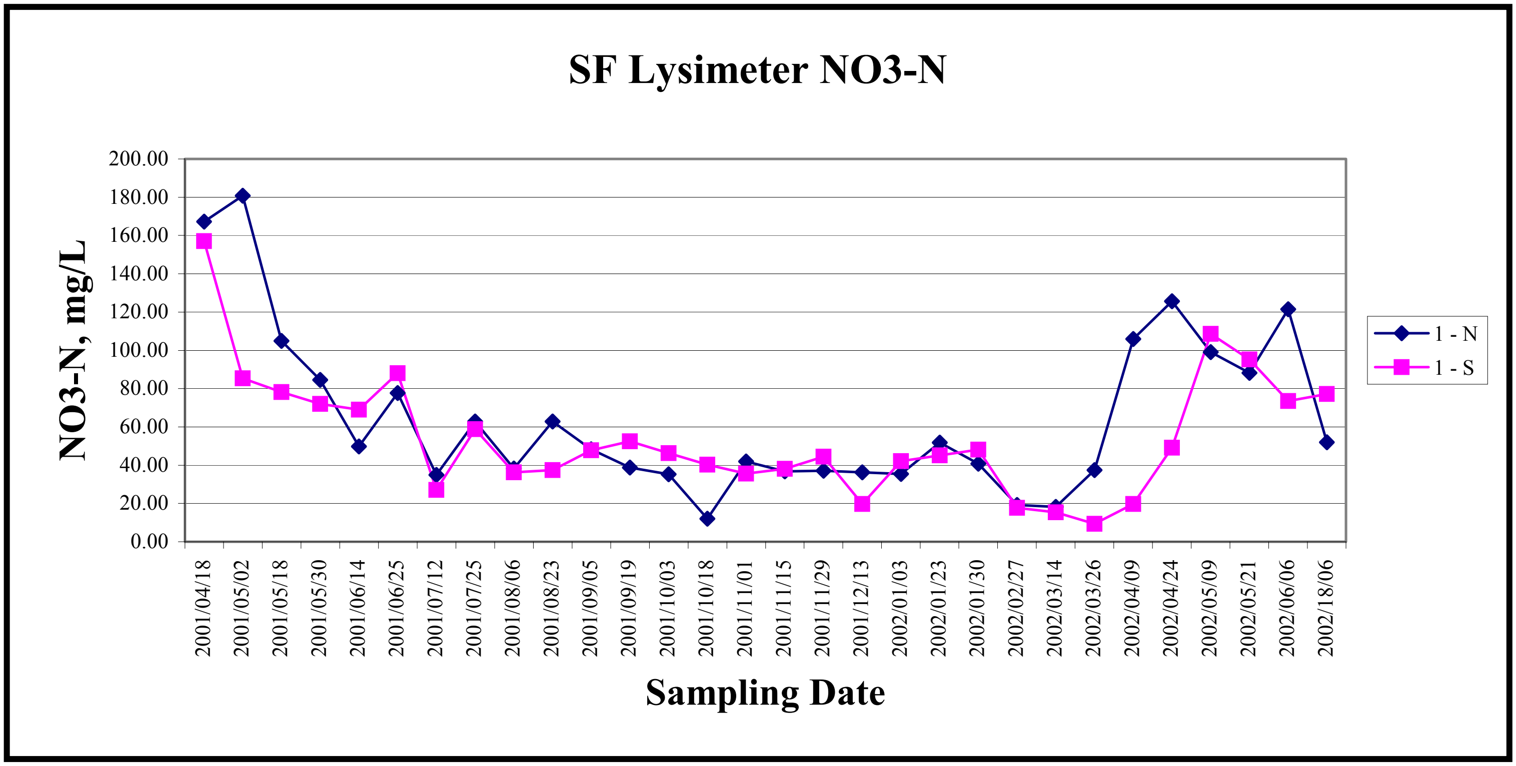
Lysimeter Sampling

Lysimeters were installed at two depths (1 and 2 meters) and 12 locations during the period of February 27 to April 2, 2001. Sampling was initiated on April 14, 2001 at 2-week intervals. Summaries of the lysimeter nitrate-N concentrations at 1 and 2 meter depths, averaged for the North and South sides of the vegetable farm are show in Figures 1 and 2, respectively. The effects of the potato fertilization are evident starting on 3/26/2002 for both sampling depths. Although the crop received fertilizer applications starting in January, it appears that the nitrate remained above the one-meter depth for both sides of the pivot for several weeks. Movement of nitrate to the 1-meter depth on the South side was delayed by at least two weeks most likely due to the reduced irrigation on the South side. Concentrations eventually reached similar levels on both sides of the pivot. At the 2-meter depth, nitrate concentrations peaked earlier on the South side than on the North side. The reason for these results being opposite of those obtained at the one-meter depth are not evident at this time. Interpretation of these data will require additional evaluation of irrigation, rainfall, and fertilization records.

Soil Profile Sampling

Initial sample locations were selected to provide a representative coverage of the pivot quadrants. On subsequent sampling dates, sample locations were selected on a 5-meter radius around the initial sample location. The soil profile was sampled at 50 cm intervals to a depth of 2 meters and thereafter, 100 cm increments until the clay layer was reached. Even with a 5-meter radius considerable variation was observed in depth of the clay layer. This makes it difficult to summarize the data strictly on soil profile depth. Therefore, data have been summarized for each site by calculating the average nitrate-N concentration in the soil profile for each sampling date. The summary data are presented as mg N/m^2-cm which can be likened to the concept of acre-inches. The average profile depth for each farm component is also presented to provide an indication of clay layer depth at each farm.

Figures 3 and 4 show the average soil nitrate concentration and the clay layer depth, respectively, for the four quadrants of the center pivot starting just previous to the 2002 potato crop and through the crop growing season. Soil nitrate concentrations, starting on the 2/20 sampling date, reflect the fertilizer applications to the crop during the previous month. The south quadrants had higher nitrate concentrations than the north half on this sampling date. This may reflect the fact that less irrigation was applied to the south half of the field although we are still evaluating the interpretation of this summary data. Concentrations for both halves peaked at the 4/3 sampling date and showed a major decrease by the 5/15 sampling date. The overall conclusion that can be drawn from the summary soils data at this time is that we have substantial amounts of nitrate in the soil profile from the potato crop and management of the fertilization program is critical to protection of the ground water.


SF Lysimeter NO3-N
NO3-N, mg/L
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180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
2001/04/18
2001/05/02
2001/05/18
2001/05/30
2001/06/14
2001/06/25
2001/07/12
2001/07/25
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2002/03/14
2002/03/26
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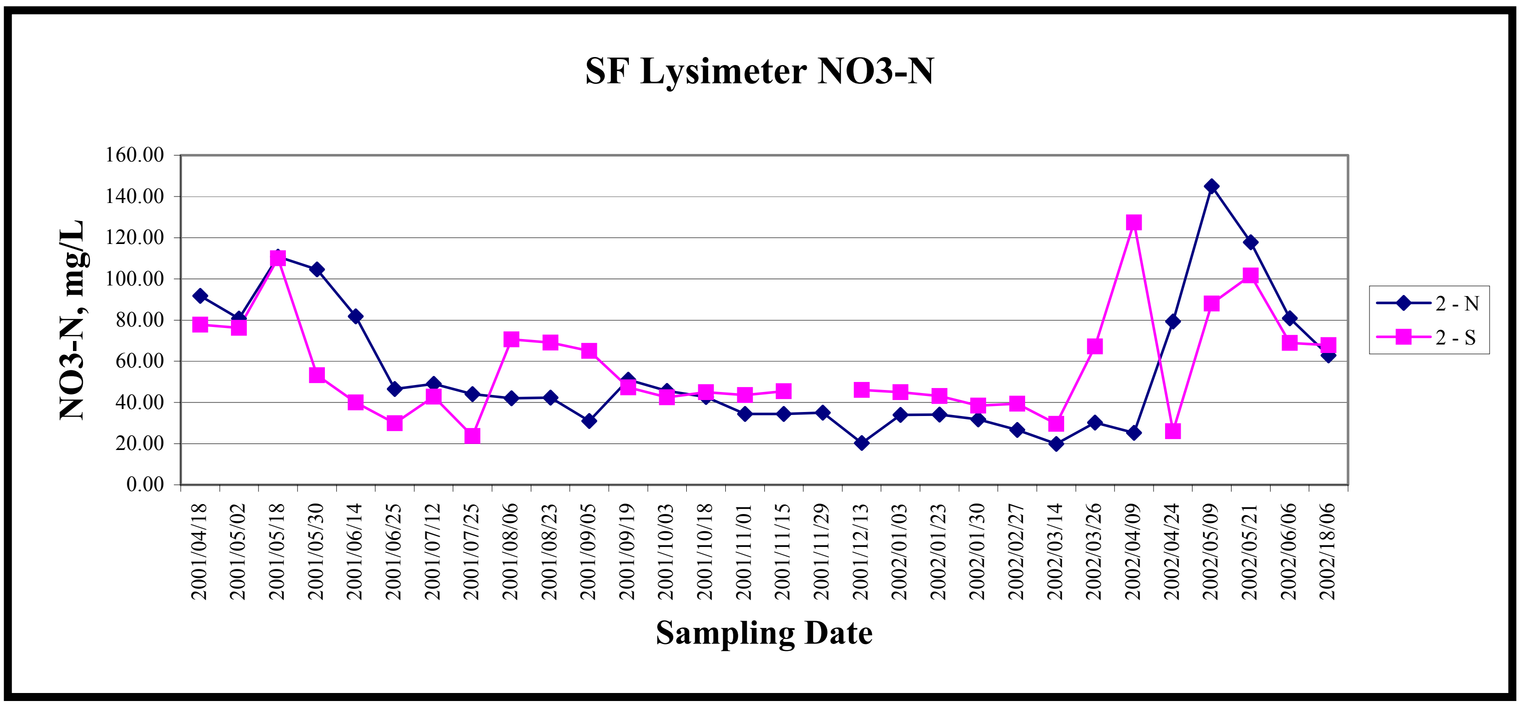
Sampling Date
1 - N
1 - S


SF Lysimeter NO3-N
NO3-N, mg/L
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140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
2001/04/18
2001/05/02
2001/05/18
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Sampling Date
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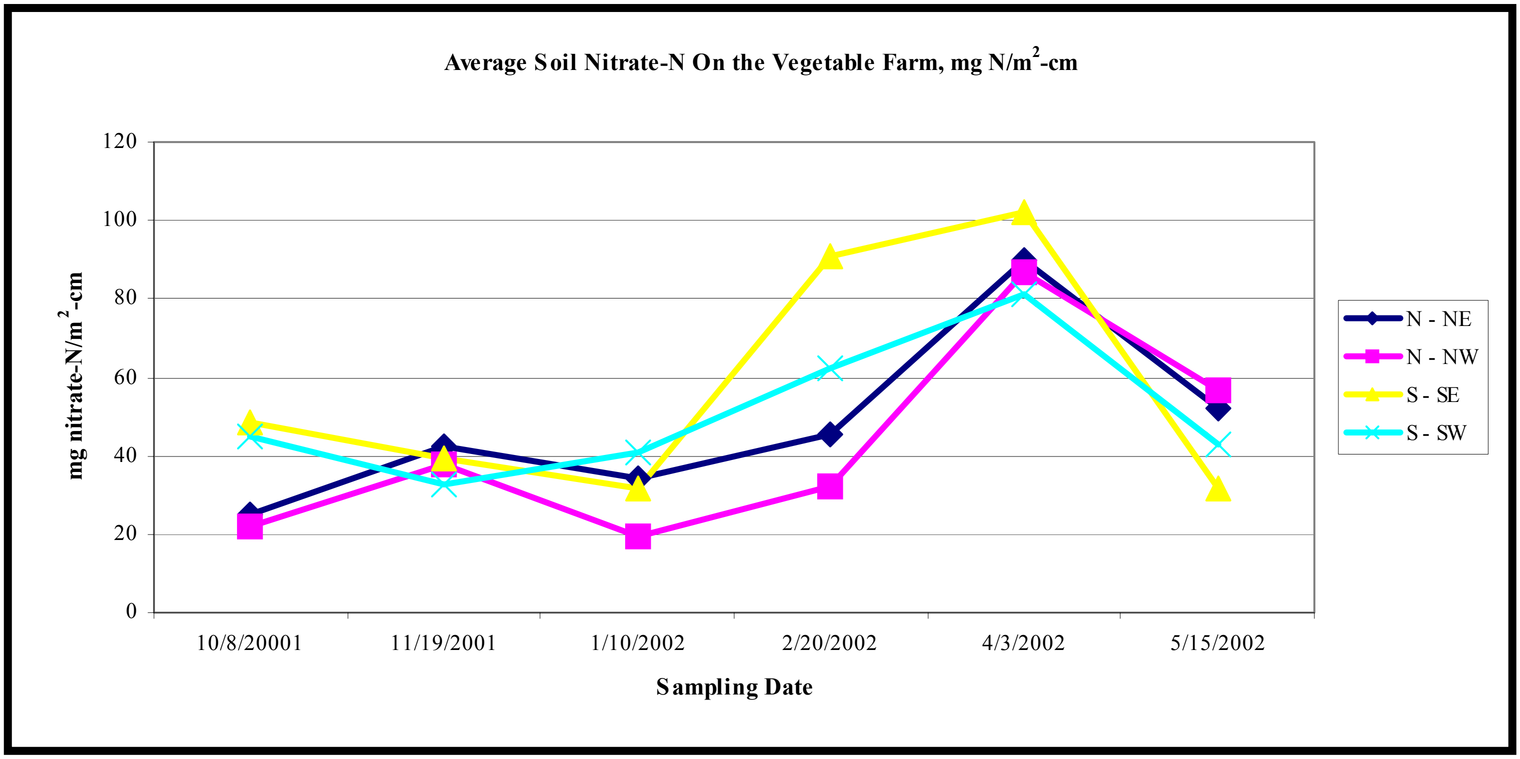
Average Soil Nitrate-N On the Vegetable Farm, mg N/m2-cm
mg nitrate-N/m 2-cm
120
100
80
60
40
20
0
10/8/20001
11/19/2001
1/10/2002
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Sampling Date
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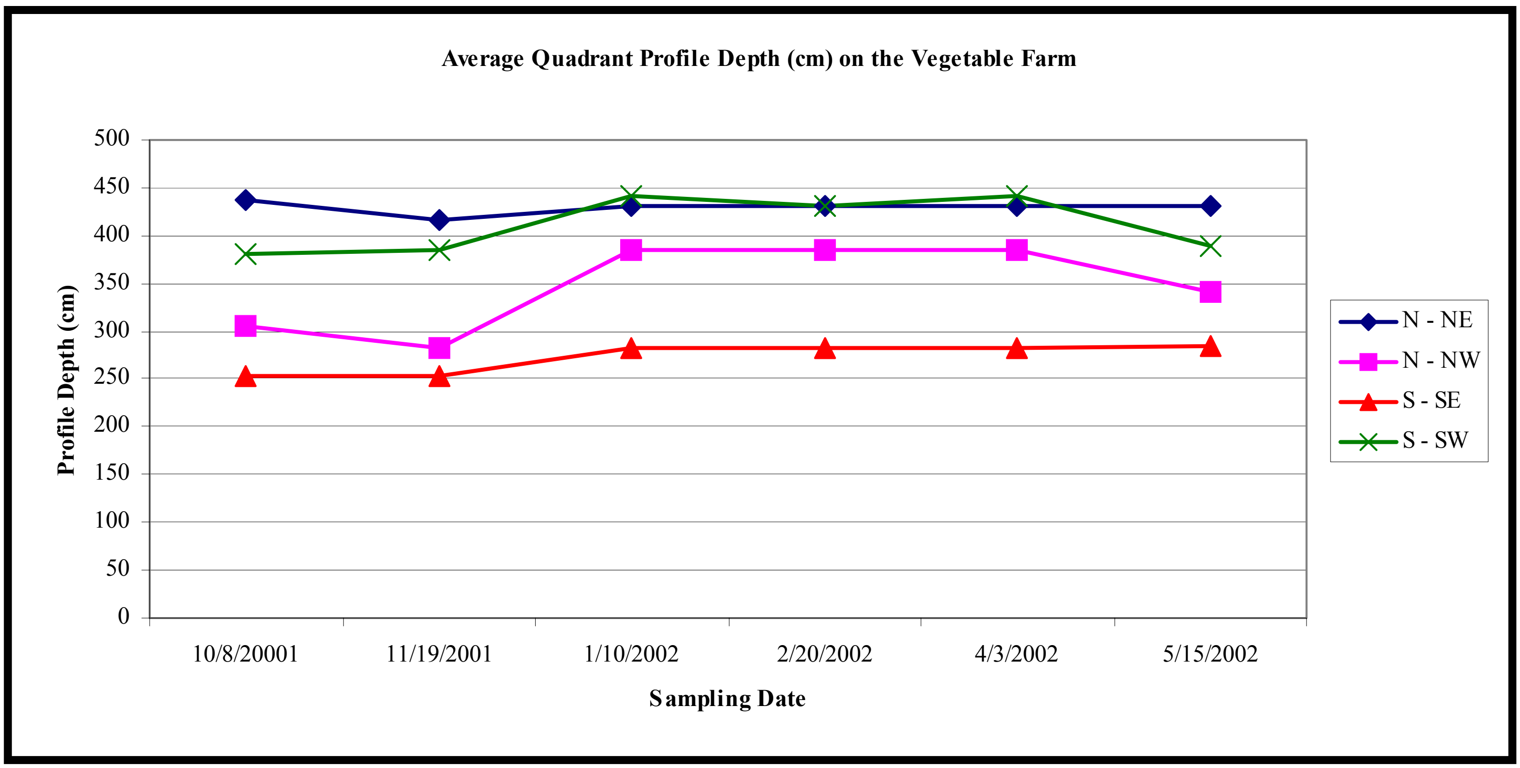
N - NW
S - SE
S - SW


Average Quadrant Profile Depth (cm) on the Vegetable Farm
Profile Depth (cm)
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450
400
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300
250
200
150
100
50
0
10/8/20001
11/19/2001
1/10/2002
2/20/2002
4/3/2002
5/15/2002
Sampling Date
N - NE
N - NW
S - SE
S - SW