Northeast Region SARE Program 1999

Comparing Soil Nutrient Levels to Seasonal Weather Fluctuations

Final Report

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Klaas and Mary-Howell Martens

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Project Title: Comparing Soil Nutrient Levels to Seasonal Weather Fluctuations

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Adequate soil nutrient levels are critical to healthy plant growth. As organic farmers, we are aware of the importance of the regular monitoring of soil nutrients and have questioned the validity of using one annual or biennial soil test, drawn at various times throughout the year with no adjustment made for season, weather, or stage of crop growth. Since this is not a topic we have seen dealt with in university or extension publications, we wanted this information for both our own use, and to share with other organic farmers. We also feel that standard university soil test recommendations are often not easily interpreted for long-term organic fertility management.

The possibility that natural seasonal nutrient fluctuations may affect soil test results and therefore their applicability raises many interesting questions. Might a single soil test need to be adjusted or re-calibrated for the time of year and stage of crop growth? For example, do cold wet winter or early spring conditions affect the measurable available nutrients? We know these conditions depress soil microbiological activity and with it, the breakdown of organic matter and mineral materials. Might a soil test taken at those times underestimate the levels of certain key nutrients, especially phosphorus, which are highly dependent on microbiological activity and temperature? If a soil test is drawn in the fall shortly after harvest before crop residue decomposes, would this also underestimate nutrient levels that will be available in the spring. Conversely, are nutrient levels ever high enough during the summer on organically farmed fields that runoff or leaching may be a concern? How effective and how fast are organic fertilizer materials in raising the availability of key nutrients at the time of peak nutrient need? How long does it take after an application of lime or other fertilizer materials until the soil test shows the full effect of the added nutrients?

As organic farmers, long term planning of crop rotations is an important part of our fertility program. A typical crop rotation includes alternating soil ~~crop~~ building and soil ~~crop~~ depleting crops, and might include a small grain with legume cover crop, followed by corn the next year, and then followed by soybeans in the third year. This crop is then followed by a winter small grain, underseeded to a legume which then often is used as a hay crop. This rotation has worked well for us, but we feel we are assuming many things about which crops are soil building, which crops are soil depleting, without really knowing if our assumptions are correct.

Project Methods:

For this project, we sampled from the 6 representative fields used in the 1999 study. They are at different points in the same rotation and therefore, will be growing different crops in 2000 than they did in 1999. All fields are of the same soil type, with similar drainage patterns and the same fertilizer program. The fields have been fully certified organic for at least 3 years and therefore have been without chemical fertilizer for at least 6 years. We have maintained detailed long term cropping, yield, and treatment records on each of the fields since 1988.

We contracted with Allan Buddle of the Fertrell Co. to draw soil tests every 6 weeks for 10 months from each location (March - December 1999). Each test was drawn from the same uniform 4 acre area within each of the fields to give the most consistant samples possible. Allan is trained to take such tests properly. The soil tests were analyzed by A & L Laboratories. These tests allowed us to obtain the base saturation of each cation, and gave a measurement of both the readily available phosphorus (P1) and longer term phosphorus (P2), as well as levels of key trace elements (S, Zn, B, Mn, Fe and Cu).

How we measured our results

We compared the results within each field, tracking the availability of each nutrient over time. For our report, we have graphed the fluctuations in nutrient availability, and have drawn rudimentary conclusions concerning the possible effects that cropping, seasonal fluctuations, and specific weather patterns may have on available nutrient levels. Our technical advisors have helped us analyze and interpret the data and extrapolate what the results may ~~might~~ mean for other farms in the Northeast.

Our results

The weather conditions in 1999 were somewhat unusual. Temperatures seemed to warm up earlier than in the season this year. This early warmth without significant periods with saturated soil may have stimulated soil biological activity earlier than usual and may have reduced water-soluble nutrient leaching and runoff. New York also experienced a severe drought during the summer of 1999 with very little rain, high temperatures and frequent desiccating wind during most of the growing season. The soil became very dry, although judging both from the appearance of the plants and the yields at harvest, organic crops definitely seem to have fared much better than the conventional crops grown by our neighbors. This may have indeed caused the soil test results to reflect non-typical conditions.

Analysis of the data collected in 1999 showed considerable fluctuations in nutrient levels. Phosphorus (Table 1), in particular, showed major changes in availability which is highly correlated to time of year. This makes much sense, in light of the fact that phosphorus availability is usually associated with an active soil microbial population. As the soil warmed up, and as the microbes became more active, the average of P1 phosphorus availability doubled on all fields sampled, peaking in late May right when the crop would have needed it the most. This strongly suggests that the time of year the sample was taken should be considered along with sample results, especially for phosphorus, when developing fertilizer recommendations.

Similar results are seen with other essential plant nutrients. We found that magnesium (Table 2) held very steady throughout the season, and calcium showed minor fluctuation, with a slight decline right after plowing. The slight decline in calcium and potassium levels probably reflect crop removal during the growing season. Applications of gypsum did not appear to have any rapid effect on magnesium or calcium levels, but gypsum did have a dramatic effect on sulfur levels (Table 5), with a sharp but short-lived spike both after fall and early August applications. This is about what we would expect, because as an anion, sulfur would have a strong tendency to move through the soil profile with water.

Nutrient levels for zinc, copper and boron (Table 3) may be indicative of crop removal. The early rise in zinc may have been due to the zinc in starter fertilizer materials, yet boron in the starter fertilizers did not give a similar increase. Levels of iron and manganese (Table 4) peaked early in the season before plowing, but then showed a steady decline. The relatively high manganese level is probably the result of high pH, as is the relatively low iron level, but none of the crops showed Fe or Mn deficiencies on our farm because of this, even in soybeans which tend to show iron deficiency easily.

Soil organic matter (Table 6) has us somewhat puzzled. It also fluctuated over the season, after remaining virtually unchanged from February through may, it seemed to climb slowly in early summer and then "spiked" in August. This is almost the inverse of what we had expected and was noted in every field regardless of crop and previous crop history. Because the organic matter levels were so consistent among the 6 fields, we do not feel this is simply the result of sampling error. The large amount of fresh material that was plowed into the soil in May didn't raise organic matter levels in the late May soil test at all. During the summer, when we would have expected a decline in organic matter due to microbial breakdown, we saw it climb steadily. Drought conditions early in the season would have slowed decomposition, then timely rains in early August may have stimulated microbial and earthworm activity in the upper layers of soil. It is possible that the living portion of organic matter may be somewhat mobile in the soil, especially in times of drought. Significant root mass of the plants in the fields may have also contributed to the overall organic matter, exudates from which may have then stimulated microbial growth in the rhizosphere. Naturally, this is mostly speculation, but it indicates that there is a lot we do not know about fluctuations of soil organic matter levels.

After discussing soil testing with several other farmers and researchers at the 1999 MOFGA conference, we realize that the particular lab doing the testing can produce results very different from what other labs would obtain. For this reason, the November 1999 samples were each split in 2 parts - one set went to A &L Labs for analysis, the lab that has done the rest of the samples. The other set was sent to the University of Vermont soil testing program, after consultation with Dr. Fred Magdoff. While we never received a full report on these tests, they seemed to confirm the same patterns of nutrient availability as the A&L samples did.

We have received a second year of SARE funding for this project. This is allowing us to have a better idea whether the considerable nutrient level fluctuations we saw in 1999 are indeed typical and whether they will be repeated under extremely different weather conditions. Because of excessive rainfall and extreme cold in 2000, this second year of data may not help us reduce some of the inherent sampling error that can occur in soil testing, but it is letting us look at soil test results under opposite conditions than 1999. The continued SARE funding in 2000 is providing additional testing for a second year to confirm and will expand our results. We feel that more replication of similar tests is necessary before they should be used to modify soil test recommendations.

Ideally, a study such as this should, of course, be conducted for a number of years to account for many different types of weather and cropping fluctuations and to further reduce sampling error. However, we feel that two year's worth of data can produce sufficient preliminary results to provide some useful soil testing guidance to this organic farmers of this region.

The Farm Operation

We currently are farming over 1100 acres, all under organic management. All but 60 acres are be fully certifiable in 2000. Our principle crops include corn, soybeans, edible dry beans, small grains, hay, and sweet corn. We have been certified organic since 1994, and currently are certified by OCIA and Organic Forum. Approximately 380 of our acres are owned, with the balance rented. A large percentage of the rented land had been abandoned by commercial farmers, due to poor yields. Since we started farming the land organically, soil condition and yields have improved dramatically. We are full time farmers. Most of the land is of the Honeoye and Lima soil group.

Klaas, a life long farmer, has extensive experience with growing field crops. He holds an AAS from SUNY Cobleskill. He is the past president of New York Certified Organic, Inc., an organic farmers education and certification group which is the New York Chapter of OCIA and currently serves as the Education/Program Director for the group. Mary-Howell holds a MS from Cornell University in Vegetable Breeding. She worked 10 years in grape breeding at the New York State Agricultural Experiment Station and is currently an Instructor at Finger Lakes Community College teaching Plant Structure and Function. She is also the Chapter Administrator of New York Certified Organic, she is a full partner in the farm operation, and serves on the USDA Advisory Committee for Agricultural Biotechnology.

How will the project help Northeast farmers:

Soil testing and fertility programs are often a bit of a mystery to many farmers. We have shared this soil fertility information this year through our certification Chapter, New York Certified Organic, Inc, both orally at chapter meetings and as periodic updates in our monthly newsletter. We also spoke about this information at the Nov. 1999 MOFGA conference in Bar Harbor, ME, at the Dec. 1999 Acres USA conference in Minneapolis, and the Feb. 2000 Pennsylvania Certified Organic conference in Bird-in-Hand, PA. The information was also shared at a meeting of the Leatherstocking Organic Network of New York farmers in Cooperstown, NY in March 2000, at several meetings of the Yates County Soil and Water Conservation District, and a meeting with the staff and clients of Agricultural Consulting Services of Rochester, NY. We also collaborated with Eric and Anne Nordell, contributing both data and ideas for an article they wrote for the Small Farm Journal. Klaas also spoke of the research at a meeting hosted by Dr. Thomas Bjorkman and Dr. Steve Reiners in Geneva NY, mainly involving commercial vegetable producers. This particular meeting primarily concerned a different SARE funded project on phosphorus leaching.

Our Chapter has hosted lectures on soil chemistry and soil microbiology, and will be considering soil physical structure at a meeting during the winter. As we and other members of our Chapter have learned more about soil fertility, we have become aware that time of sampling may be a critical variable in interpreting soil test results and we have seen no research where this factor has been studied. As organic farmers, we are not relying on highly soluble and rapidly available fertilizers and therefore must plan fertility programs further in advance and must learn to work with the natural cycling of nutrients. The better we can understand our soil test results, the better we can plan effective rotations and fertility amendments.

From these results in this research project, we feel it is important to recognize that a soil test provides a 'snap shot' of soil conditions at a particular date which may indeed not reflect soil conditions at other times throughout the growing season. Soil fertility levels appear to be quite dynamic, and this should be taken into account, particularly before applying large amounts of amendments based on the results from just one test. The yields on all these fields were extremely high in 1999 with very low applications of fertility amendments. Had we followed standards soil test interpretations, based on soil tests taken on most of the dates, we would have over-applied fertilizers well beyond what was needed for optimum crop growth.

However, the results of this project will not only benefit organic farmers. By understanding the natural fluctuations of nutrients, any farmer would be able to use soil test information to precisely more optimize plant response while minimizing the possibility of applying excessive amounts of fertilizer which would be expensive and might harm the environment.

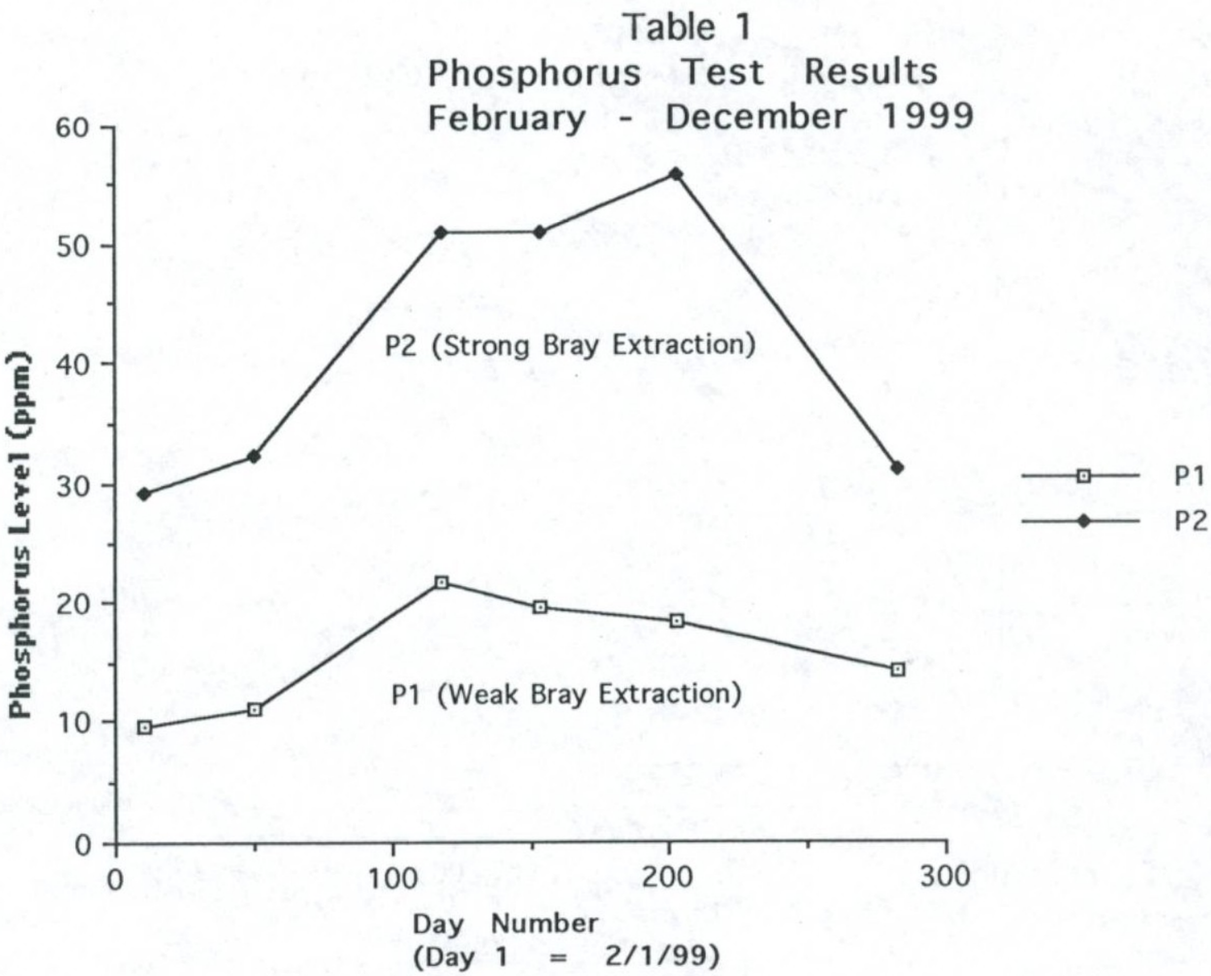


Table 1
Phosphorus Test Results
February - December 1999
Phosphorus Level (ppm)
60
50
40
30
20
10
0
P2 (Strong Bray Extraction)
P1 (Weak Bray Extraction)
P1
P2
0
100
200
300
Day Number
(Day 1 = 2/1/99)

Table 2
Nutrient Level
Potassium, Magnesium, Calcium

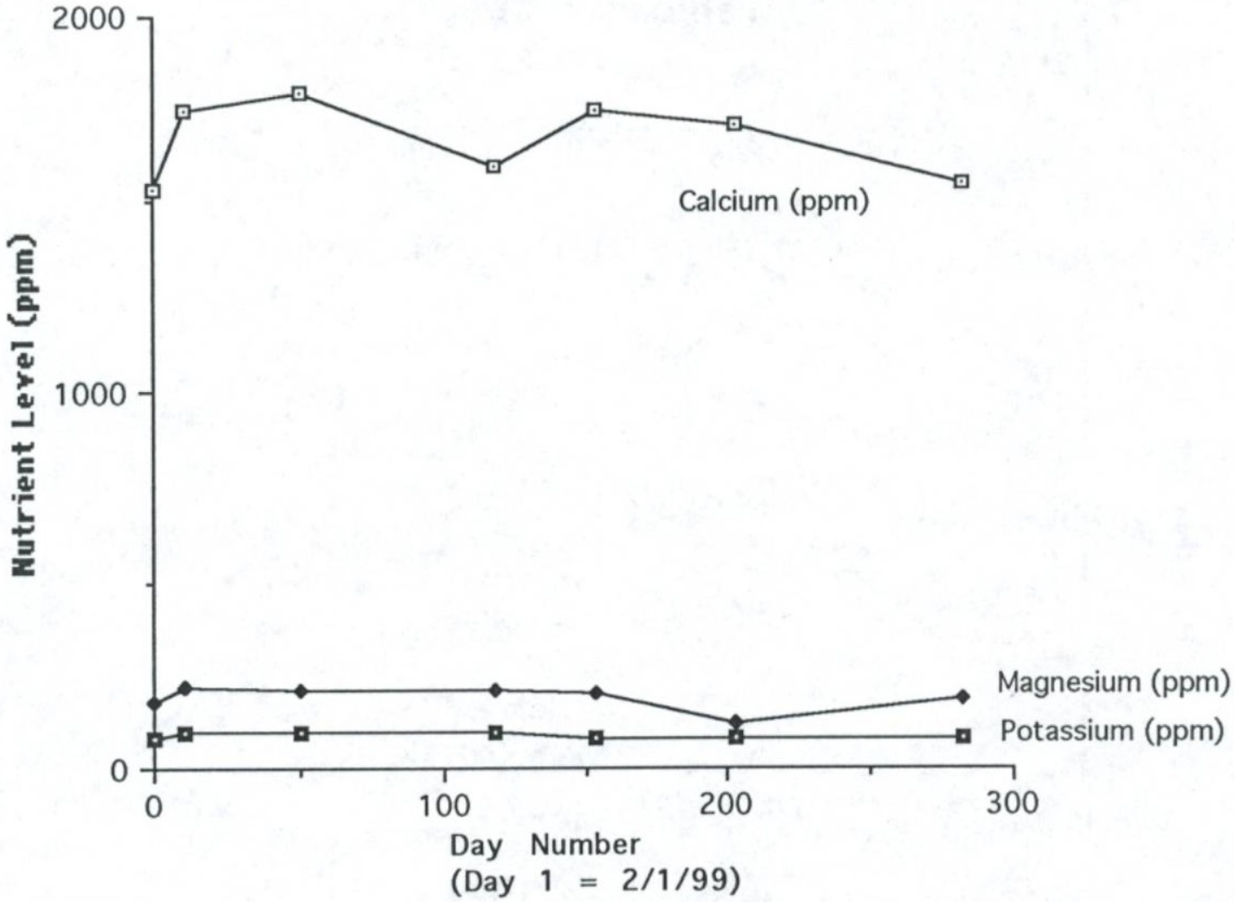


Table 3
Nutrient Level
Zinc, Copper, Boron

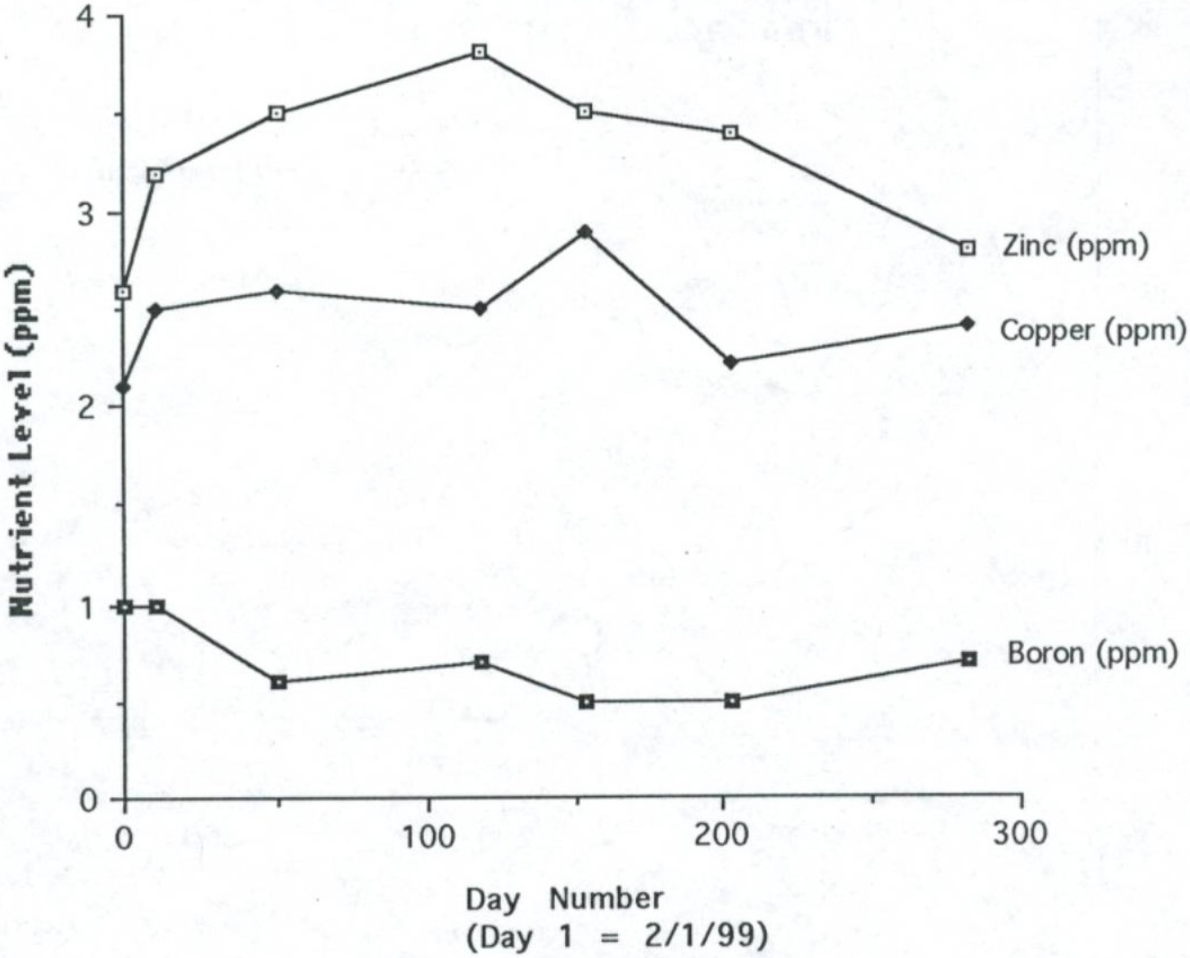
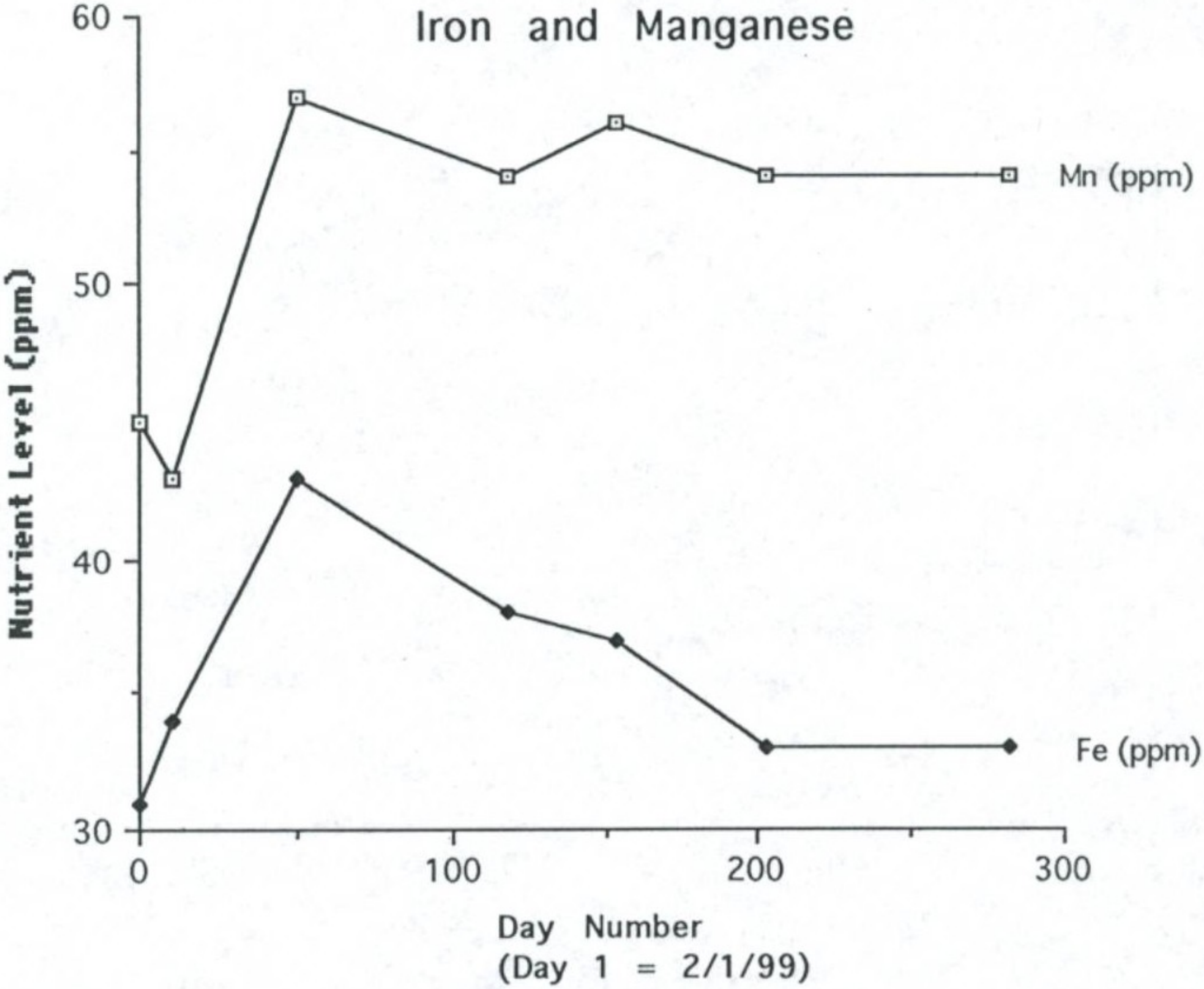


Table 4
Nutrient Level
Iron and Manganese



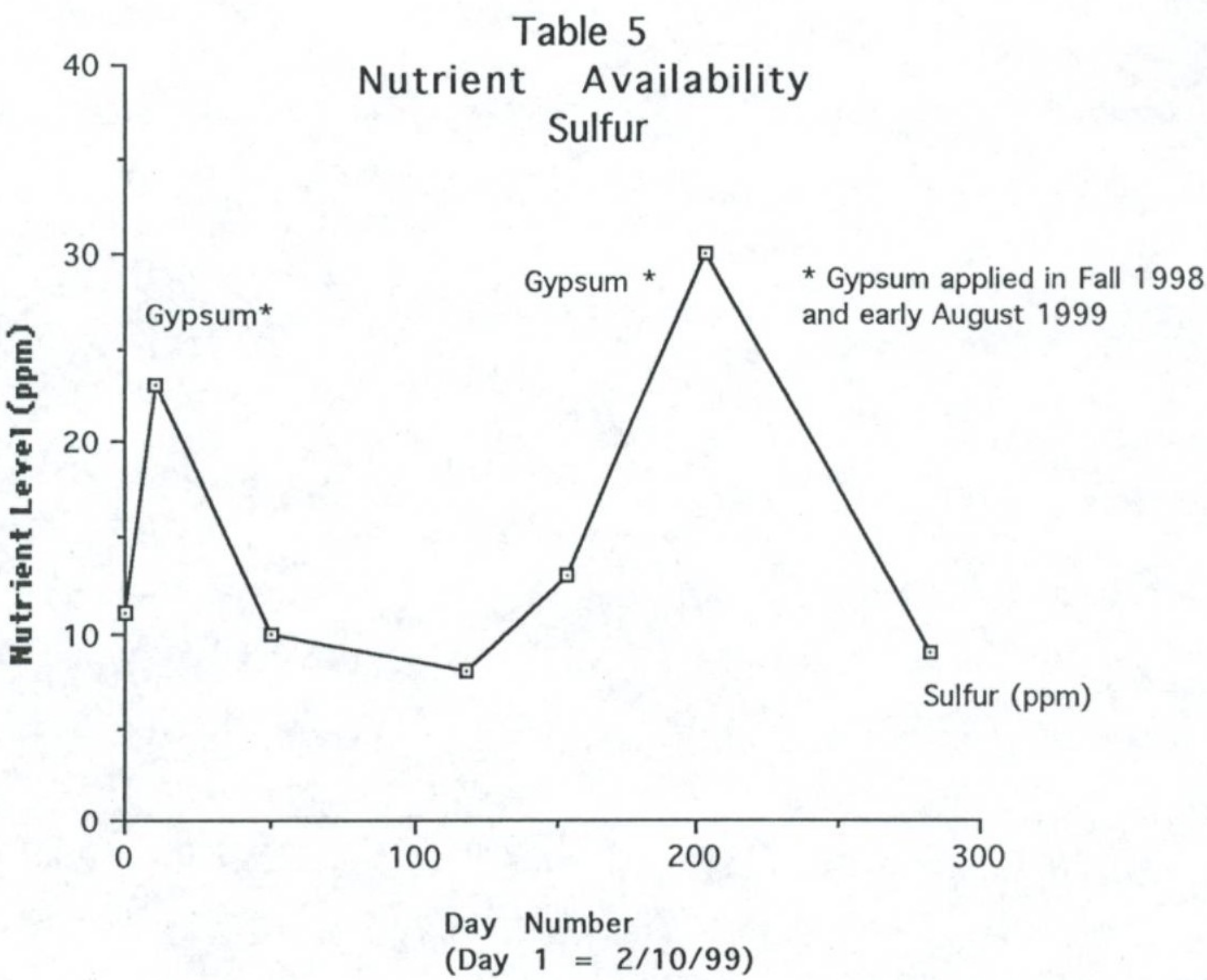
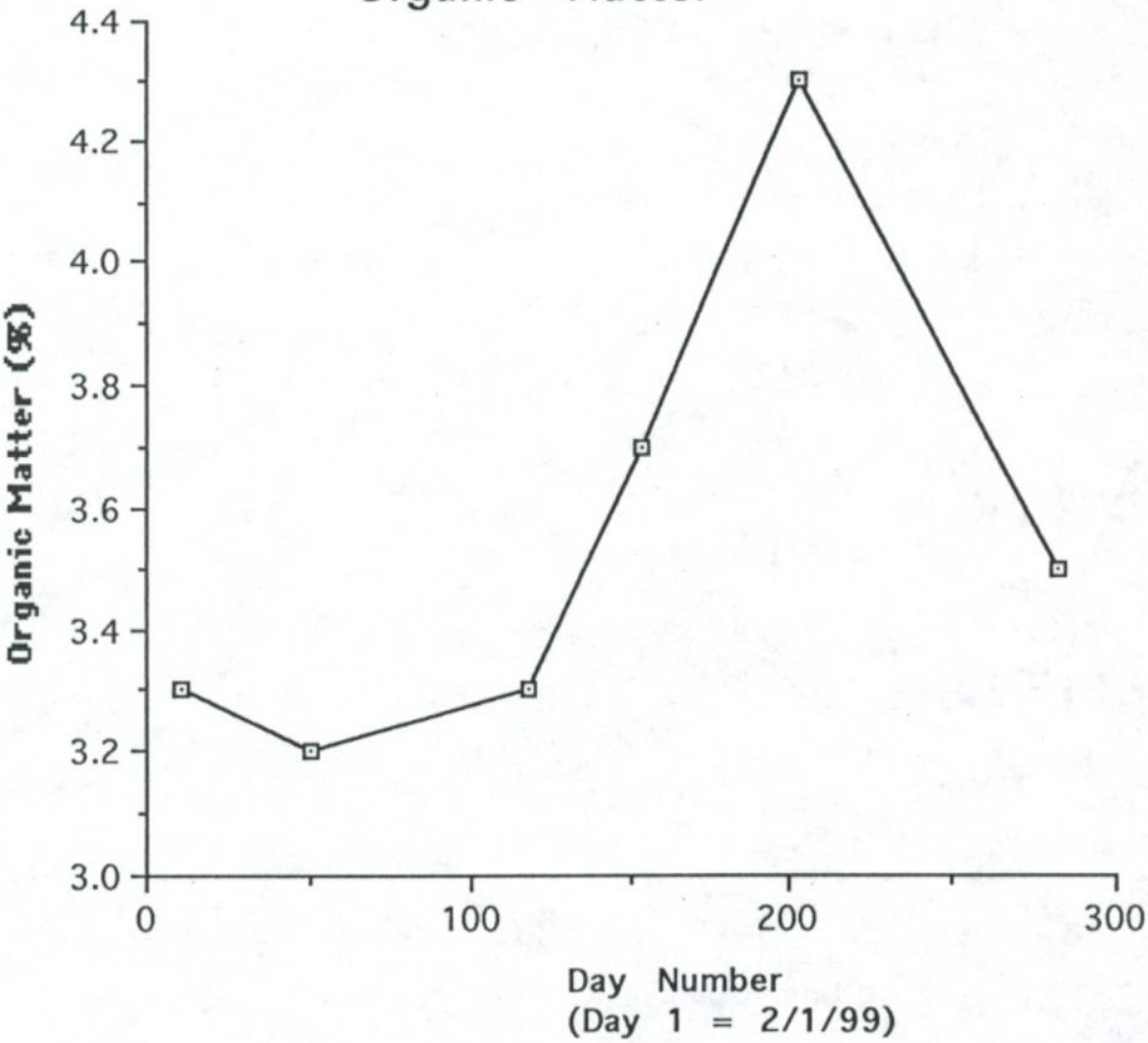


Table 5
Nutrient Availability
Sulfur
Nutrient Level (ppm)
40
30
20
10
0
0
100
200
300
Day Number
(Day 1 = 2/10/99)
Gypsum*
Gypsum *
* Gypsum applied in Fall 1998
and early August 1999
Sulfur (ppm)

Table 6
Organic Matter



field# avg

1999 Crop: 1998 Crop: 1997 Crop:

date	OM	P1*	P2*	K*	Mg*	Ca*	pH	CEC	S*	Zn*	Mn*	Fe*	Cu*	B*	K%	Mg%	Ca%
pre 1999	3.3	12.0	33.0	79	173	1540	6.8	9.7	11	2.6	45	31	2.1	1.0	2.1	14.8	79.2
2-10	3.3	9.5	29.3	99	214	1750	6.8	11.2	23	3.2	43	34	2.5	1.0	2.3	16.1	78.2
3-20	3.2	11.0	32.3	93	204	1803	6.8	11.3	10	3.5	57	43	2.6	0.6	2.1	15.0	79.4
5-28	3.3	21.5	51.0	95	206	1600	6.7	10.4	8	3.8	54	38	2.5	0.7	2.4	16.5	76.9
7-4	3.7	19.5	51.0	84	202	1750	6.8	11.0	13	3.5	56	37	2.9	0.5	2.0	15.3	79.5
8-23	4.3	18.3	55.7	81	188	1716	6.9	10.7	30	3.4	54	33	2.2	0.5	2.0	14.9	80.1
11-12	3.5	14.2	31.2	79	187	1550	6.9	9.7	9	2.8	54	33	2.4	0.7	2.1	16.0	79.6
2/10	4.7	11.2	32.2	85	195	1683	6.9	10.5	20	3.4	46	29	2.3	0.7	2.1	15.5	80.2

Soil Amendments/Fertilizer

	P1	P2
Feb 10	: 100 (2.3)	: 100 (1.7)
March 20	: 116 (1.9)	: 110 (1.6)
May 28	: 226 (1.0)	: 174 (1.0)
July 4	: 205 (1.1)	: 174 (1.0)
Aug 23	: 193 (1.2)	: 190 (0.9)
Nov 12	: 149 (1.5)	: 106 (1.6)

Rainfall record

1999:
April 1.05"
May 1.05"
June 1.84"
July 1.82"
(0.9"on7/31)
Aug 2.09"
Sept 5.02"
Oct 2.38"
Nov 2.45"

Observations

* nutrient levels reported in parts per million (ppm)

field# 23A 1999 Crop: Spelt 1998 Crop: DRK'S 1997 Crop: Soybeans

date	OM	P1	P2	K	Mg	Ca	pH	CEC	S	Zn	Mn	Fe	Cu	B	K%	Mg%	Ca%
4/97	3.3	12L	34M	63L	185VH	1570H	7.1	9.6	11M	2.9M	48H	38H	2.4H	0.9M	1.7	16.1	82.2
2/10	3.3	10L	30M	70L	211VH	1820H	6.9	11.2	17H	3.7H	57VH	42H	2.6H	0.9M	1.6	15.7	81.3
3/20	2.6	13L	35M	75L	203VH	1870H	7.0	11.2	8M	3.7H	62VH	49H	2.8H	0.5L	1.7	15.1	83.2
5/28	3.2	23M	54H	62L	209VH	1700H	7.2	10.4	6L	4.3H	71VH	47H	2.8H	0.6M	1.5	16.7	81.7
7/04	3.9	17L	48H	58L	192VH	1700VH	7.0	10.2	10M	3.5H	64VH	48H	3.1VH	0.7M	1.5	15.6	82.9
8/23	4.1	13L	49H	51VL	185VH	1600H	7.1	9.7	42VH	3.5H	54VH	44H	2.3H	0.5L	1.4	15.9	82.7
11/12	4.0	12L	35M	62L	165VH	1500VH	7.0	9.0	8M	2.6M	57VH	41H	1.9H	0.6M	1.8	15.2	83.0
2/10	4.1	15L	36M	77L	164VH	1500H	6.9	9.2	9M	3.3M	48H	36H	2.2H	0.7M	2.1	14.9	81.6

Soil Amendments/Fertilizer

3-97 - 8 tons leaves
5/9/97 - 1000# compost 2-4-2.5
6/23/98 - 200# GSS/gyp
11/10/98 -13oz Vitazyme
8/6/99 - 1300# Gypsum
8/10/99 - 350# 2-4-4/G

Rainfall record

1999:
April 1.05"
May 1.05"
June 1.84"
July 1.82"
(0.9"on7/31)
Aug 2.09"
Sept 5.02"
Oct 2.38"
Nov 2.45"

Observations

1996 - corn: 169bu/a
cut field badly at harvest/
tiled wet areas next spring -
the field was unmanageably
lumpy in 1997
1997 - soybeans: 30bu/a
1998 - DRK's 2160#/a
1999 - spelt 3520#/a
1999 -heavy growth of
clover about 2 tons DM/a by
winter

field# 23B

1999 Crop: Corn   1998 Crop: Wheat   1997 Crop: Oats

date	OM	P1	P2	K	Mg	Ca	pH	CEC	S	Zn	Mn	Fe	Cu	B	K%	Mg%	Ca%
4/97	3.7	13L	33M	78L	178VH	1530H	6.7	9.8	11M	2.7M	39H	30H	2.5H	0.9M	2.0	15.2	78.3
2/10	3.1	13L	33M	129M	219VH	2140H	6.9	13.0	43VH	3.9H	47H	36H	2.8H	1.1M	2.5	14.0	82.1
3/20	3.0	14L	38M	111M	205VH	2000VH	7.0	12.0	13H	4.1H	62VH	49H	3.2VH	0.8M	2.4	14.2	83.4
5/28	3.1	27H	57H	124M	205VH	1700H	6.9	10.7	9M	4.6H	54VH	39H	3.0H	0.7M	3.0	16.0	79.6
7/04	3.8	22M	65VH	94L	199VH	1900VH	7.1	11.4	17H	5.5H	63VH	38H	3.6VH	0.7M	2.1	14.5	83.3
8/23	3.9	24M	69VH	104M	166M	2300VH	7.5	13.2	21VH	4.1H	72VH	31H	2.3H	0.6M	2.0	10.5	87.5
11/12	3.3	18M	39M	98M	191VH	1700VH	7.0	10.3	7L	4.2H	56VH	32H	2.3H	0.8M	2.4	15.4	82.2
2/10	4.6	13L	33M	84L	198VH	1900VH	6.9	11.5	28VH	4.2H	46H	26H	2.6H	0.7M	1.9	14.3	82.4

Soil Amendments/Fertilizer

1/23/97- 700#wood ash .2-.6-2.2
3-97 - 6 tons leaves
8-97 - 1000# compost 2-4-2.5
9/5/97 - 200# blue Hi K
9/16/97- 200# GSS 2-4-2
2/7/98 - 150# Blue N
8-98 - 100# K2SO4
8-98 - 1000# compost 2-4-2.5
9-98 - 500# Gypsum
5/7/99- 200# GSS/gyp
6/19/99: 1.0 Qt Fertrel folier #3

Rainfall record

1999:
April 1.05"
May 1.05"
June 1.84"
July 1.82"
(0.9"on7/31)
Aug 2.09"
Sept 5.02"
Oct 2.38"
Nov 2.45"

Observations

1997- combined 65 bu/a oats
1998- combined 48 bu/a wheat- very heavy clover + straw plow down (7 tons DM) for 1999
1999-combined180 bu/a corn

field# 23D   1999 Crop: DRK'S   1998 Crop: CORN   1997 Crop: RYE

date	OM	P1	P2	K	Mg	Ca	pH	CEC	S	Zn	Mn	Fe	Cu	B	K%	Mg%	Ca%
4/14/ 1997	3.3	13L	25L	115M	184VH	1460H	6.4	10.0	11M	2.8M	46H	25H	2.2H	1.8H	2.9	15.3	72.8
2/10	3.4	12L	31M	135H	218VH	1620H	6.8	10.6	14H	3.6H	53VH	36H	2.7H	0.9M	3.3	17.2	76.6
3/20	4.1	16L	39M	113M	214VH	1740H	6.7	11.3	9M	3.4M	61VH	40H	2.5H	0.4L	2.6	15.8	77.1
5/28	2.9	22M	53H	131H	198VH	1400H	6.5	9.4	7L	3.5H	53VH	41H	2.3H	1.0M	3.6	17.5	74.4
7/04	3.9	26M	49H	130M	195VH	1500H	6.4	10.4	12M	3.2M	48H	31H	2.6H	0.4L	3.2	15.6	72.2
8/23	4.4	23M	61VH	113M	198VH	1500H	6.9	9.6	16H	3.7H	60VH	31H	2.3H	0.5L	3.0	17.2	78.4
11/12	3.7	16L	27M	118M	190VH	1400H	6.7	9.3	7L	2.7M	49H	27H	3.1VH	0.7M	3.3	17.0	75.2
2/10	4.5	13L	32M	103M	217VH	1600H	6.9	10.2	9M	4.0H	51H	24H	2.3H	0.5L	2.6	17.7	78.3

Soil Amendments/Fertilizer

8-97: 15 tons/a cow manure
9-97: 1000# compost 2-4-2.5
9/6/97- 50#/a K2SO4
5/8/98: 200#/a GSS
12/28/98:700#/a compost2-4-2.5
6/8/99: 300#/a 2-4-4 gyp

Rainfall record

1999:
April 1.05"
May 1.05"
June 1.84"
July 1.82"
(0.9"on7/31)
Aug 2.09"
Sept 5.02"
Oct 2.38"
Nov 2.45"

Observations

1999- planted spelt in Oct
1999- 2960# DRK's
1998- 200bu/a corn
1997- 44bu/a Rye (removed 2t straw) - heavy clover plowed down about 5 t DM by spring 98

field# 27E 1999 Crop: Spelt 1998 Crop: DRK's 1997 Crop: Alfalfa

date	OM	P1	P2	K	Mg	Ca	pH	CEC	S	Zn	Mn	Fe	Cu	B	K%	Mg%	Ca%
4/3/ 1998	2.8	15L	39H	70L	149H	1500VH	6.9	9.0	11M	2.5M	47H	35H	1.8H	0.6M	2.0	13.7	82.9
2/10	3.8	10L	29M	71L	204VH	1580H	6.8	10.1	15H	2.3M	32H	34H	2.1H	1.0M	1.8	16.9	78.4
3/20	3.5	10L	32M	74L	195VH	1760H	6.8	10.9	10M	2.2L	71VH	45H	2.4H	0.4L	1.7	14.9	80.5
5/28	3.1	23M	54H	77L	210VH	1600H	6.8	10.2	5L	3.5H	50H	46H	2.2H	0.6M	1.9	17.1	78.1
7/4	3.8	22M	58H	76L	189VH	1700VH	7.2	10.3	9M	2.5M	60VH	42H	2.6H	.3VL	1.9	15.3	82.8
8/23	4.0	22M	62VH	78L	201VH	1700H	6.9	10.5	59VH	3.1M	47H	40H	2.1H	0.4L	1.9	15.9	80.8
11/12	3.3	17L	38M	66L	183VH	1600H	7.1	9.7	17H	2.5M	63VH	38H	2.7H	0.6M	1.7	15.7	82.5
2/10	5.7	11L	34M	90L	199VH	1600H	6.7	10.4	9M	3.2M	52VH	34H	2.3H	0.6M	2.2	16.0	77.3

Soil Amendments/Fertilizer

8/10/99 - 350# 2-4-4 G
8/06/99 - 1250# Gypsum
11/10/98 - 10 oz. Vitazyme
06/23/98 - 200# GSS 2-4-2
07/XX/97 - 140# K2SO4
04/30/97 - 1000# Compost
01/23/97 - 400# Wood Ash

Rainfall record

1999:
April 1.05"
May 1.05"
June 1.84"
July 1.82"
(0.9"on7/31)
Aug 2.09"
Sept 5.02"
Oct 2.38"
Nov 2.45"

Observations

7/99 3714# spelt /a+ 2000# straw(seeding smothered in some spots-good late growth
10/98 1928#DRK'S /a
1997 sold 2.5 t /a alfalfa (left one cutting in field)
1996 sold 6.1 t /a alfalfa

field# 27F

1999 Crop: Corn — 1998 Crop: Clover — 1997 Crop: Wheat

date	OM	P1	P2	K	Mg	Ca	pH	CEC	S	Zn	Mn	Fe	Cu	B	K%	Mg%	Ca%
4/3	3.1	9L	28M	71L	169VH	1580H	6.8	9.8	11M	1.9L	45H	34H	1.4H	0.8M	1.9	14.4	80.8
1998																	
2/10	3.1	4VL	24L	85L	206VH	1510H	6.6	10.1	14H	1.8L	29H	33H	2.0H	1.0M	2.2	17.0	74.9
3/20	2.8	6VL	25L	88L	191VH	1550H	6.5	10.3	6L	1.9L	39H	42H	2.1H	0.5L	2.2	15.4	75.0
5/28	3.9	12L	44H	83L	215VH	1600H	6.4	11.0	8M	2.7M	49H	35H	2.2H	0.8M	1.9	16.3	72.8
7/4	3.4	14L	38M	72L	205VH	1700H	6.7	10.9	11M	2.1L	49H	37H	2.5H	.2VL	1.7	15.7	78.1
8/23	3.8	11L	42M	62L	172VH	1400H	6.7	9.0	23VH	2.2L	44H	35H	2.0H	0.6L	1.8	15.9	77.8
11/12	3.5	10L	28M	61L	199VH	1500H	6.7	9.8	7L	1.5L	51VH	38H	2.2H	0.8M	1.6	17.0	76.9
2/10	4.9	6VL	28M	80L	194VH	1700VH	7.0	10.3	26VH	2.3M	42H	34H	2.0H	0.9M	2.0	15.7	82.4

Soil Amendments/Fertilizer

05/11/99 - 250#GSS/gyp
08/XX/98 - 200# BlueHiK
08/XX/98 - 1000# Compost
08/XX/97 - 1000# Compost

Rainfall record

1999:
April 1.05"
May 1.05"
June 1.84"
July 1.82"
(0.9"on7/31)
Aug 2.09"
Sept 5.02"
Oct 2.38"
Nov 2.45"

Observations

1999 145 bu /a corn
1998 sold 2.1 t clover /a
(left second cutting)
1997 sold 51 bu wheat /a
(left straw and heavy
seeding)