THE EFFECT OF HIBRIX SOIL AMENDMENT APPLICATION ON THE GROWTH OF SOYBEANS UNDER FIELD CONDITIONS

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OBJECTIVE

Results of studies carried out under growth room conditions indicated that Hibrix soil amendment can provide significant increases in the growth of wheat, soybean and canola.
In the summer of 2013, a field trial was conducted using soybeans as the indicator crop to test the effectiveness of Hibrix soil amendment for increasing plant growth and productivity under field conditions using three types of application methods: 1) Hibrix applied to the soil only, 2) applied to foliage only and 3) applied to both soil and foliage 4) and an untreated control. The objective was to assess if the various application routes influence the growth of the soybeans. In 2013 the planting of the crop was delayed until mid-summer and the beans did not have sufficient time to reach maturity. As a result the study did not yield any significant differences between the 3 application methods or the control. However, the soil application alone did produce slightly higher yields than the other treatments. In the summer of 2014, the field trial was repeated on the same plots with the same treatments as the 2013 trial with one small change in that the foliar alone treatment was omitted and replaced with an additional soil only treatment. The trial was repeated on the same plots to test the cumulative effects that the treatments may have on yield.

METHODS

May and June 2014 – The field was cultivated prior to planting.

June 16 2014 – Planting: The trial was laid out in a randomized block design with 4 replicates. Plots were planted in 7 rows on 50 cm row spacing to a length of 10M with a 7 row John Deere plot planter. Plots measured 3.5m x 8m. The treatments were applied to a length of 10M and alleys were rototilled out to give a final plot length of 8m (Table 1).

Table 1: Application rates for each treatment in the soybean field trial.

TRT	Product
1	Control
2	Soil Appl. Hibrix @ 2.5l/ha
3	Soil Appl. Hibrix @ 5.0l/ha
4	Soil Appl. Hibrix @ 2.5l/ha + Foliar Applied Hibrix @ 2.5l/ha 2-3 leaf stage

Prior to planting, fertilizer was broadcast to provide the following nutrient levels:

Nitrogen 4.8kg/ha
Phosphorus 25kg/ha
Potassium 25 kg/ha

July 3 2014: Glyphosate was applied for weed control Touchdown Total – 1.8l/ha.

August 5, 2014 – Chlorophyll Readings and Sampling: Chlorophyll readings were measured using a Konica Minolta SPAD unit. Two measurements were taken from 25 plants in each plot for a total of 50 measurements per plot. A total of 10 plants per plot were harvested and taken back to the lab for analysis. Using a shovel, plants including their roots were dug up and placed in labeled plastic bags for transport. The soil that was adhering to the roots was also collected and brought back to the lab. At the lab the soil adhering to the roots was collected and the roots were rinsed with water. All plants were then photographed and placed in a 60°C oven to dry. Once dry, individual plant weights were recorded and petioles were collected for nutrient analysis.

Soil and Tissue Analysis: Composite soil samples were made by combining the soil from each plant from each plot. A total of 16 soil samples were sent for chemical and nutrient analysis.

Composite tissue samples were made by combining 5 petioles from each plant from each plot. A total of 16 tissue samples were sent for chemical and nutrient analysis.

November 2014 – Final Harvest: All plots were machine harvested.

Results

Soil Chemical and Nutrient Analysis

The Hibrix treatments did not appear to have a significant impact on the soil chemical and nutrient analysis. All of the plots were either low or very low in Phosphorus, Sodium, Sulfur, Boron, Soluble salts and Nitrate Nitrogen. All of the plots were high or very high in Calcium, Manganese and Iron (Table 2). The full soil reports for each plot can be found in Appendix 1.

Table 2: Chemical analysis data for soil collected from each treatment plot. The data listed in the table is the average of the 4 treatment replicates.

Treatment	P ppm	K ppm	Mg ppm	Ca ppm	Na ppm	Mn ppm	Fe ppm
Control	21.25	90	146.25	1767.5	7.75	125	57.75
Soil 2.5 l/ha	22.25	104.3	17.5	1957.5	13.25	13.5	60.25
Soil 5 l/ha	25.25	96.5	166.25	1890	10	131.75	59.25
Soil/Foliar	23.5	94.25	155	1855	8.25	95.5	59.5

Tissue Chemical and Nutrient Analysis

Similar to the results of the soil tests, the Hibrix treatments did not appear to have a significant impact on the chemical and nutrient analysis of the plant tissue. All of the plants were deficient in Nitrogen, low in Phosphorus and either high or very high in Magnesium, Calcium, Manganese and Iron (Table 3). It is important to note that the very high levels of Iron present could be due to soil or dust that got mixed in with the sample and may not reflect the true amount present in the tissue. The full tissue reports for each plot can be found in Appendix 2.

Table 3: Chemical and nutrient analysis data for plant tissue collected from each treatment plot. The data listed in the table is the average of the 4 treatment replicates.

Treatment	N %	S %	P %	K %	Mg %	Ca %	Mn ppm	Fe ppm
Control	2.1	0.25	0.22	3.8	0.94	3.1	116.8	668.5
Soil 2.5 l/ha	2.2	0.26	0.25	3.9	0.94	2.8	122.3	684.8
Soil 5 l/ha	2.2	0.27	0.26	4.2	0.94	2.9	120.5	758.8
Soil/Foliar	2.2	0.25	0.24	3.7	0.89	2.8	119.3	790
Normal Range	5.1-6.2	0.2-0.5	0.3-0.5	2-2.6	0.4-0.6	0.8-2.0	20-100	50-300

August 5 Field visit

During the August field visit there were no observable differences between any of the treatment plots. The growth in each plot was uniform with no distinctive differences in height or appearance. A total of 10 plants were randomly selected from each plot and brought back to the lab for analysis. Similar to the field, there were no observable differences between the plants from each treatment plot (Figure 1).

Figure 1: Individual plants harvested from each treatment plot on August 5 2014.

Statistical Analysis

Data for the various parameters measured were analyzed using the SAS program and the General Linear Model (GLM) Procedure. This procedure gives the results of three different statistical tests including T-Tests, Duncan's Multiple Range Test and Tukey's Studentized Range. The results from the Duncan's Multiple Range Test are provided below as they are the ones most commonly used for experiments such as this.

Dry Weight

The control plots had the highest average dry weight of all the treatments followed by the soil applied treatment at 2.5 l/ha and the soil applied treatment at 5 l/ha had the lowest average dry weight (Figure 2). However, none of the differences were significant.

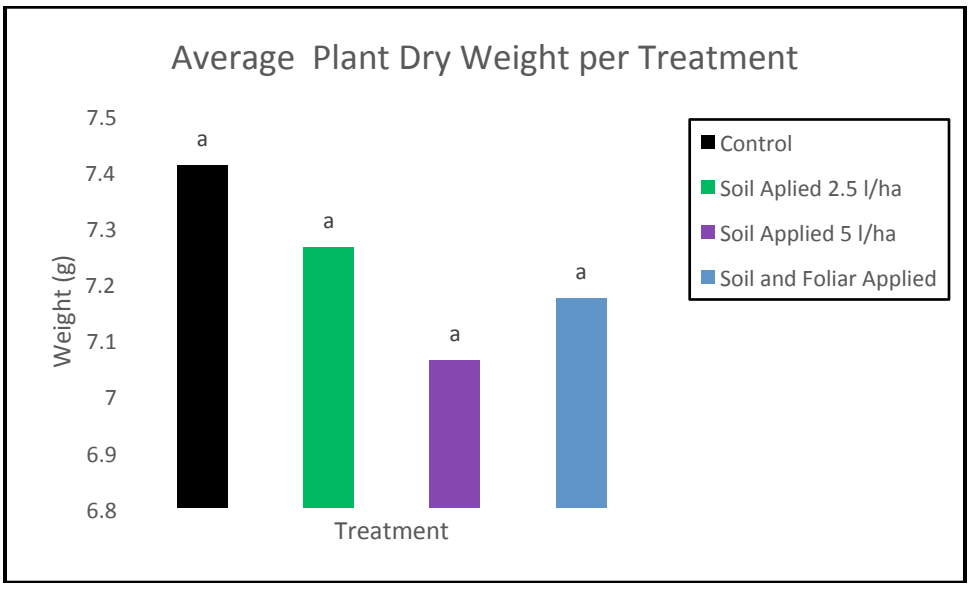
Duncan's Multiple Range Test for Dry weight

Alpha	0.05
Error Degrees of Freedom	151
Error Mean Square	3.585572
Harmonic Mean of Cell Sizes	39.74522

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Treatment
A	7.42	39	Control
A	7.26	40	Soil Applied 2.5 l/Ha
A	7.17	40	Soil and Foliar Applied
A	7.06	40	Soil Applied 5 l/Ha

Figure 2: Average dry weight of individual plants harvested from each treatment plot. There were10 plants per plot harvested for a total of 40 plants per treatment.



Chlorophyll

The soil applied treatment at 2.5 l/ha had the highest average chlorophyll reading followed by the control and the soil applied at 5 l/ha had the lowest average chlorophyll readings (Figure 3). However, similar to the dry weights, the differences were not significant.

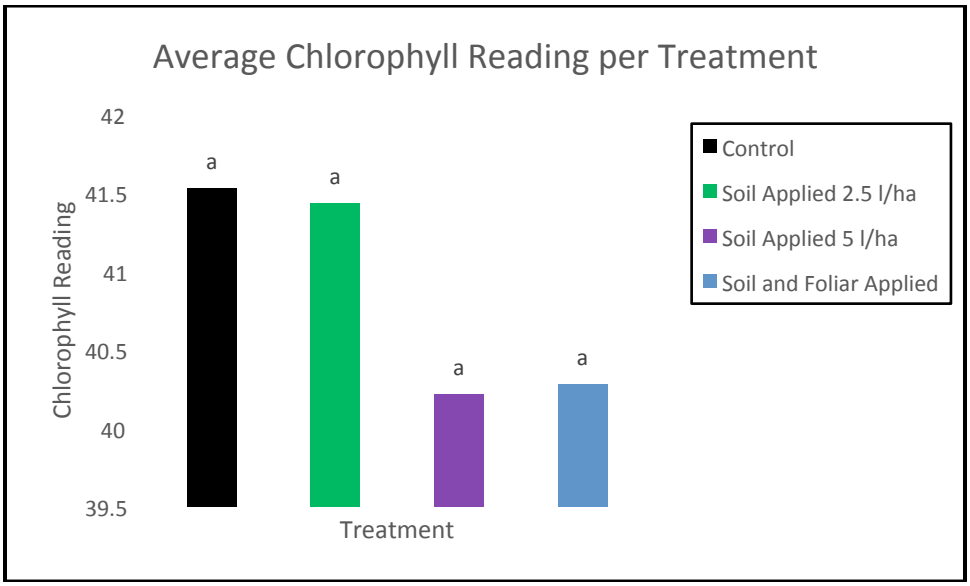
Duncan's Multiple Range Test for Chlorophyll

Alpha	0.05
Error Degrees of Freedom	392
Error Mean Square	94.54688

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Treatment
A	41.6	100	Soil Applied 2.5 l/Ha
A	41.5	100	Control
A	40.6	100	Soil and Foliar Applied
A	40.4	100	Soil Applied 5 l/Ha

Figure 3: Chlorophyll readings were generated by taking 2 measurements per plant from 25 plants in each plot for a total of 100 plants per treatment.



Total Yield

The soil applied treatment at 2.5 l/ha and the soil/foliar applied treatment had the highest yields of the 4 treatments (Figure 4). All Hibrix treatments had significantly higher yields than the control plot (Figure 4). However, the yields from the three Hibrix treatments were not significantly different from each other.

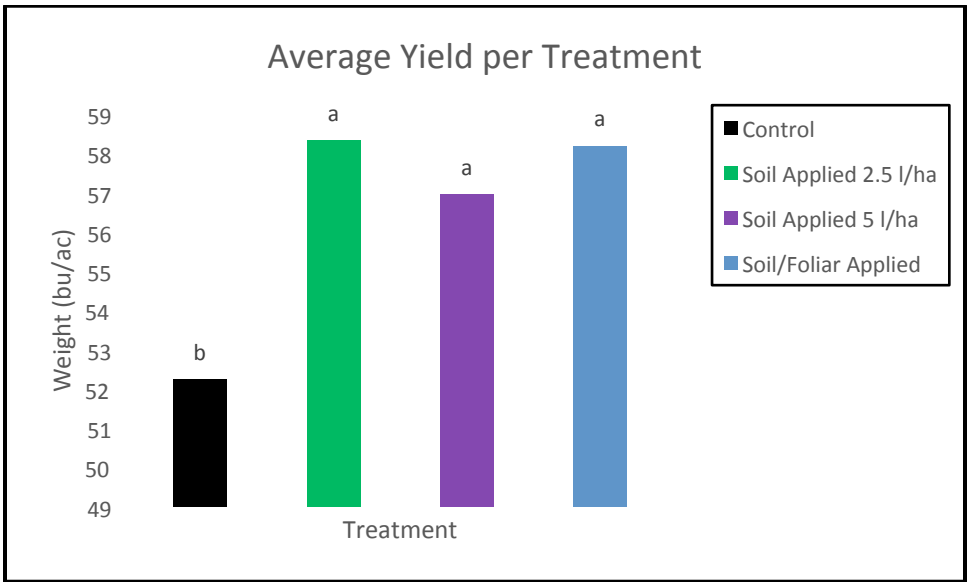
Duncan's Multiple Range Test for Yield

Alpha	0.05
Error Degrees of Freedom	12
Error Mean Square	1.65642

Means with the same letter are not significantly different.

Duncan Grouping	Mean	N	Treatment
A	58.34	4	Soil Applied 2.5 l/Ha
A	58.20	4	Soil and Foliar Applied
A	56.95	4	Soil Applied 5 l/Ha
B	52.26	4	Control

Figure 4: Average yields harvested from each treatment plot in bushels/acre. All of the plants in each plot were harvested and a total yield per plot was generated for a total of 4 yields per treatment.



Conclusions

- Hibrix applications did not affect soil and tissue chemical compositions compared to control plants.
- No statistically significant differences were observed for chlorophyll or dry weight at mid-season sampling.
- All Hibrix treatment had significantly higher yields than the control plot but no significant differences were observed among the three treatments.
- The Soil applied Hibrix at 2.5l/ha had the highest yield, average chlorophyll reading and average dry weight out of the 3 Hibrix treatments used in this study.
- Although not significant, the soil applied Hibrix at 5 l/ha had the lowest yield, average chlorophyll readings and average dry weights of the three treatments. This could indicate that an application rate of 5 l/ha is not an ideal rate for soybeans.

- The final yield results showed the same trend as the one observed in the 2013 trial with the soil alone treatment providing the highest yields followed by the soil/foliar treatment.
- The results of the 2014 trial support the concept that consecutive Hibrix treatments result in a cumulative beneficial effect on yield increases when compare to the control plots. On a per hectare basis this would be a significant benefit to the grower's income.

Appendix 1
Soil Nutrient and Chemical Reports for Each Treatment Plot

101 – Soil 2.5 l/ha, 102-Control, 103-Soil 5 l/ha, 104-Soil/Foliar

Reported Date:2014-08-08 Printed Date:2014-08-08

SOIL TEST REPORT

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Sample Number	Lab Number	Organic Matter	Phosphorus - P ppm Bicarb	Phosphorus - P ppm Bray-P1	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH	pH Buffer	CEC meq/100g	Percent Base Saturations % K	% Mg	% Ca	% H	% Na
101	20764	3.4	15 L	22 VL	92 M	220 M	1800 M	9 VL	7.1		12.2	1.9	15.0	73.8	8.9	0.3
102	20765	3.1	14 L	27 L	96 M	185 H	1600 H	7 VL	7.4		9.8	2.5	15.7	81.6		0.3
103	20766	3.1	16 L	29 L	80 M	180 H	1590 H	9 L	7.4		9.7	2.1	15.5	82.2		0.4
104	20767	3.1	22 L	29 L	103 M	155 M	1460 H	9 L	7.4		8.9	3.0	14.5	82.2		0.4

Sample Number	Sulfur S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Soluble Salts ms/cm	Saturation %P	Aluminum Al ppm	Saturation %Al	Nitrate Nitrogen NO3-N ppm	K/Mg Ratio	ENR	NH4N ppm	Chloride Cl ppm
101	8 VL	4.2 M	151 VH	65 VH	1.2 H	0.5 L	0.2 VL	3 VL	828	0.1 G	8 L	0.13	46	5	33 H
102	7 VL	4.3 M	137 VH	65 VH	1.0 M	0.4 L	0.2 VL	2 VL	828	0.1 G	5 L	0.16	43	3	19 M
103	8 VL	4.3 M	128 VH	64 VH	1.2 H	0.5 L	0.2 VL	2 VL	829	0.1 G	10 M	0.14	43	3	25 M
104	9 VL	4.1 M	109 VH	62 VH	1.2 H	0.5 L	0.2 VL	2 VL	779	0.1 G	8 L	0.21	43	2	24 M

OE VL = VERY LOW, L = LOW, M = MEDIUM, H = HIGH, VH = VERY HIGH, G = GOOD, MA = MARGINAL, MT = MODERATE PHYTO-TOXIC, T = PHYTO-TOXIC, ST = SEVERE PHYTO-TOXIC

201-Soil/Foliar, 202-Soil 5 l/ha, 203-Soil 2.5 l/ha, 204-Control

Reported Date:2014-08-08 Printed Date:2014-08-08

SOIL TEST REPORT

Page:2

Sample Number	Lab Number	Organic Matter	Phosphorus - P ppm Bicarb	Phosphorus - P ppm Bray-P1	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH	pH Buffer	CEC meq/100g	Percent Base Saturations % K	% Mg	% Ca	% H	% Na
201	20768	3.1	17 L	25 L	104 M	155 M	1840 VH	8 VL	7.6		10.8	2.5	12.0	85.4		0.3
202	20769	3.1	22 L	30 L	95 M	140 M	1760 VH	9 L	7.5		10.2	2.4	11.4	86.0		0.4
203	20770	3.1	19 L	30 L	98 M	135 M	1790 VH	8 VL	7.4		10.3	2.4	10.9	86.5		0.3
204	20771	3.0	15 L	24 L	78 M	130 M	1680 VH	9 L	7.5		9.7	2.1	11.2	86.5		0.4

Sample Number	Sulfur S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Soluble Salts ms/cm	Saturation %P	Aluminum Al ppm	Saturation %Al	Nitrate Nitrogen NO3-N ppm	K/Mg Ratio	ENR	NH4N ppm	Chloride Cl ppm
201	8 VL	3.9 M	137 VH	62 VH	1.2 H	0.5 L	0.2 VL	2 VL	808	0.1 G	7 L	0.21	43	3	25 M
202	8 VL	3.9 M	124 VH	57 VH	1.1 M	0.5 L	0.2 VL	2 VL	715	0.1 G	9 L	0.21	43	3	21 M
203	8 VL	3.8 M	124 VH	58 VH	1.1 M	0.5 L	0.2 VL	2 VL	760	0.1 G	7 L	0.22	43	2	31 H
204	7 VL	3.5 M	114 VH	58 VH	1.1 M	0.4 L	0.2 VL	2 VL	734	0.1 G	7 L	0.19	42	2	23 M

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301-Control, 302-Soil 2.5 l/ha, 303-Soil 5 l/ha, 304-Soil/Foliar

Reported Date:2014-08-08 Printed Date:2014-08-08

SOIL TEST REPORT

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Sample Number	Lab Number	Organic Matter	Phosphorus - P ppm Bicarb	Phosphorus - P ppm Bray-P1	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH	pH Buffer	CEC meq/100g	Percent Base Saturations % K	% Mg	% Ca	% H	% Na
301	20772	3.4	17 L	26 L	114 M	135 M	1780 VH	7 VL	7.5		10.3	2.8	10.9	86.1		0.3
302	20773	3.3	21 L	40 L	133 M	165 M	2270 VH	9 VL	7.4		13.1	2.6	10.5	86.7		0.3
303	20774	3.5	26 M	39 L	124 M	175 M	2150 VH	13 L	7.4		12.6	2.5	11.6	85.6		0.4
304	20775	3.6	21 L	26 L	98 M	165 M	2170 VH	9 VL	7.4		12.5	2.0	11.0	86.8		0.3

Sample Number	Sulfur S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Soluble Salts ms/cm	Saturation %P	Aluminum Al ppm	Saturation %Al	Nitrate Nitrogen NO3-N ppm	K/Mg Ratio	ENR	NH4N ppm	Chloride Cl ppm
301	7 VL	3.4 M	122 VH	55 VH	1.2 H	0.4 L	0.2 VL	2 VL	721	0.1 G	5 L	0.26	46	3	35 H
302	9 VL	4.4 M	146 VH	59 VH	1.6 H	0.6 M	0.2 VL	3 L	823	0.1 G	7 L	0.25	45	3	22 M
303	8 VL	4.5 M	142 VH	59 VH	1.7 H	0.5 L	0.2 VL	3 VL	827	0.1 G	7 L	0.22	47	3	23 M
304	7 VL	4.1 M	151 VH	60 VH	1.5 H	0.5 L	0.2 VL	2 VL	852	0.1 G	5 L	0.18	48	2	17 M

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401-Soil 2.5 l/ha, 402-Soil 5 l/ha, 403-Soil/Foliar, 404-Control

Reported Date:2014-08-08 Printed Date:2014-08-08

SOIL TEST REPORT

Sample Number	Lab Number	Organic Matter	Phosphorus - P ppm Bicarb	Phosphorus - P ppm Bray-P1	Potassium K ppm	Magnesium Mg ppm	Calcium Ca ppm	Sodium Na ppm	pH pH	pH Buffer	CEC meq/100g	Percent Base Saturations % K	% Mg	% Ca	% H	% Na
401	20776	3.6	16 L	24 L	94 M	190 M	1970 H	27 M	7.4		11.8	2.0	13.5	83.7		1.0
402	20777	3.6	16 L	23 VL	87 M	170 M	2150 VH	9 VL	7.4		12.4	1.8	11.4	86.6		0.3
403	20778	3.5	19 L	25 L	72 L	145 M	2010 VH	7 VL	7.6		11.5	1.6	10.5	87.7		0.3
404	20779	3.5	17 L	24 L	72 L	135 L	2010 VH	8 VL	7.5		11.4	1.6	9.9	88.3		0.3

Sample Number	Sulfur S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Soluble Salts ms/cm	Saturation %P	Aluminum Al ppm	Saturation %Al	Nitrate Nitrogen NO3-N ppm	K/Mg Ratio	ENR	NH4N ppm	Chloride Cl ppm
401	7 VL	4.0 M	137 VH	59 VH	1.5 H	0.5 L	0.2 VL	2 VL	822	0.1 G	5 L	0.15	48	2	19 M
402	7 VL	3.5 M	133 VH	57 VH	1.4 H	0.4 L	0.3 VL	2 VL	803	0.1 G	11 M	0.16	48	3	29 M
403	8 VL	4.0 M	125 VH	54 VH	1.6 H	0.5 L	0.2 VL	2 VL	737	0.0 G	4 VL	0.15	47	2	17 M
404	7 VL	3.8 M	127 VH	53 VH	1.5 H	0.5 L	0.2 VL	2 VL	698	0.1 G	5 L	0.16	47	2	17 M

OE VL = VERY LOW, L = LOW, M = MEDIUM, H = HIGH, VH = VERY HIGH, G = GOOD, MA = MARGINAL, MT = MODERATE PHYTO-TOXIC, T = PHYTO-TOXIC, ST = SEVERE PHYTO-TOXIC

Appendix 2
Tissue Nutrient and Chemical Reports for Each Treatment Plot

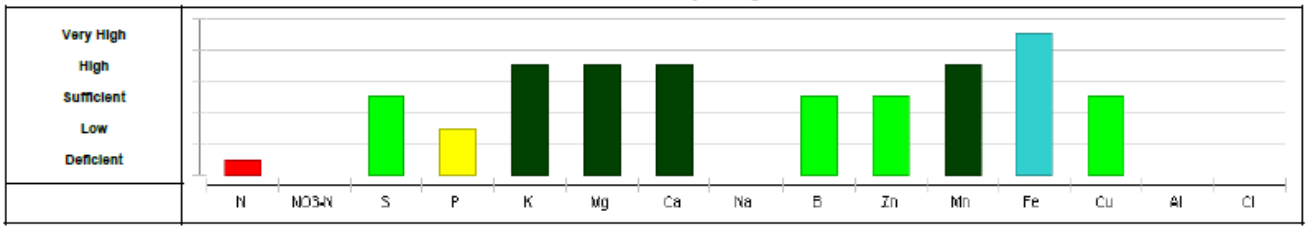
Control Plots

102

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260009	2.24	0.7725	0.25	0.22	3.57	0.97	2.79		27	22	115	642	14	365	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	9.1	0.6	0.9	98	3.7	312	5.6	1045
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



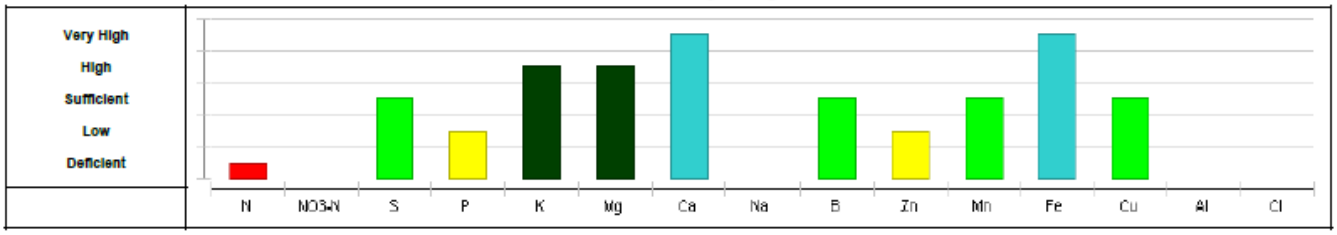
- These plants are deficient in NITROGEN. This condition could be due to inadequate nitrogen fertilization, poor drainage, excessive rainfall or leaching.
- These plants are low in PHOSPHORUS. Possible causes include low soil phosphorus levels, high soil pH, poor drainage, root damage or cool soil temperatures.
- The very high level of IRON in this sample is probably due to contamination with dust or soil particles, and may not reflect the true iron content.
- A&L recommends a foliar application when Mg, B, P, Zn or Mn are low or deficient at this plant stage. Follow the recommended product label rates.
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

204

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260015	2.04	0.6558	0.25	0.21	3.48	0.90	3.05		28	19	99	410	13	226	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	8.3	0.6	0.8	105	3.9	352	4.1	1086
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



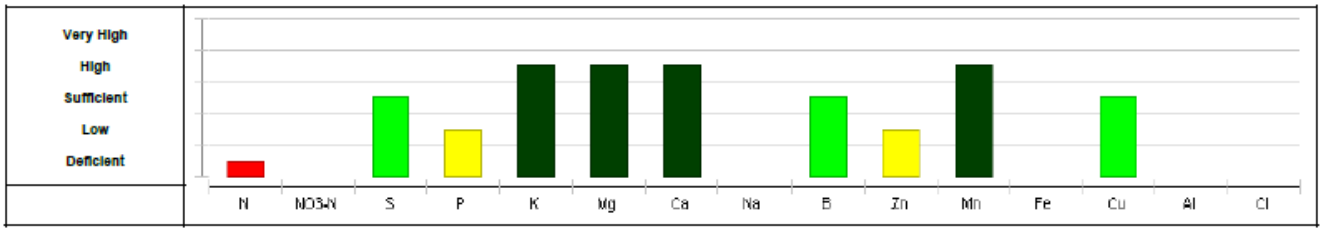
- These plants are deficient in NITROGEN. This condition could be due to inadequate nitrogen fertilization, poor drainage, excessive rainfall or leaching.
- These plants are low in PHOSPHORUS. Possible causes include low soil phosphorus levels, high soil pH, poor drainage, root damage or cool soil temperatures.
- These plants are low in ZINC. Possible causes include low soil zinc availability, high pH or high soil phosphorus levels.
- The very high level of IRON in this sample is probably due to contamination with dust or soil particles, and may not reflect the true iron content.
- A&L recommends a foliar application when Mg, B, P, Zn or Mn are low or deficient at this plant stage. Follow the recommended product label rates.
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

301

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260016	1.96	0.6111	0.25	0.20	3.62	0.87	2.91	0.01	30	18	120	1049	14	618	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	7.8	0.5	0.8	110	4.2	301	8.7	969
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



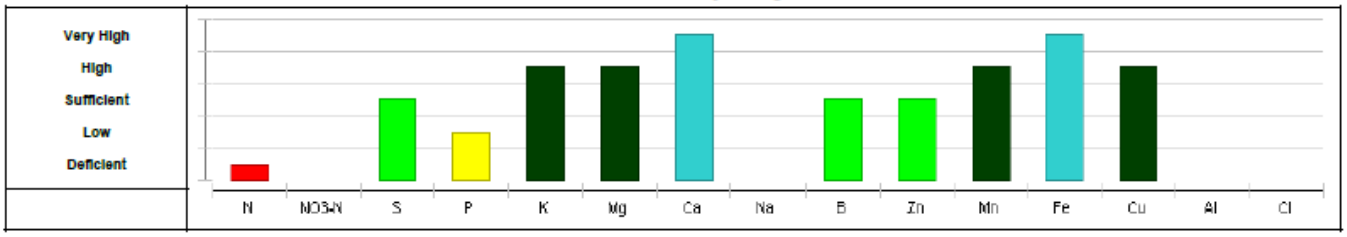
- These plants are deficient in NITROGEN. This condition could be due to inadequate nitrogen fertilization, poor drainage, excessive rainfall or leaching.
- These plants are low in PHOSPHORUS. Possible causes include low soil phosphorus levels, high soil pH, poor drainage, root damage or cool soil temperatures.
- These plants are low in ZINC. Possible causes include low soil zinc availability, high pH or high soil phosphorus levels.
- A&L recommends a foliar application when Mg, B, P, Zn or Mn are low or deficient at this plant stage. Follow the recommended product label rates.
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

404

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260023	1.98	0.6180	0.26	0.24	4.46	1.00	3.51		32	20	133	573	17	300	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	7.6	0.4	0.9	116	4.5	337	4.3	1105
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



- These plants are deficient in NITROGEN. This condition could be due to inadequate nitrogen fertilization, poor drainage, excessive rainfall or leaching.
- These plants are low in PHOSPHORUS. Possible causes include low soil phosphorus levels, high soil pH, poor drainage, root damage or cool soil temperatures.
- The very high level of IRON in this sample is probably due to contamination with dust or soil particles, and may not reflect the true iron content.
- A&L recommends a foliar application when Mg, B, P, Zn or Mn are low or deficient at this plant stage. Follow the recommended product label rates.
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

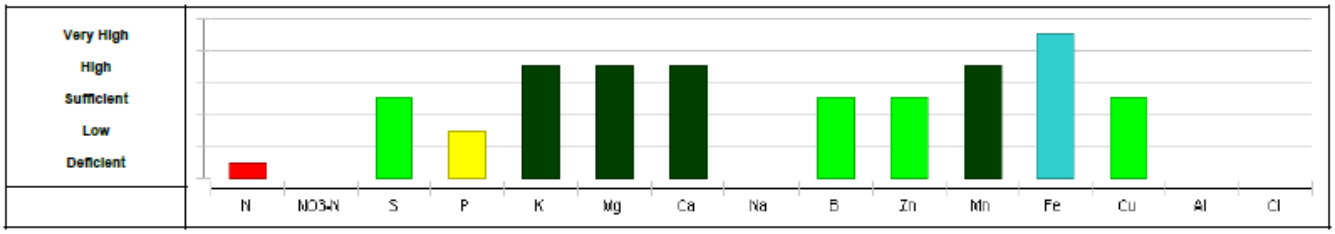
Soil Applied Treatment Plots (2.5 l/ha)

101

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260008	2.40	0.9819	0.27	0.25	4.28	0.99	2.75	0.01	30	27	120	483	15	260	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	8.9	0.6	0.9	93	4.4	356	4.0	903
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



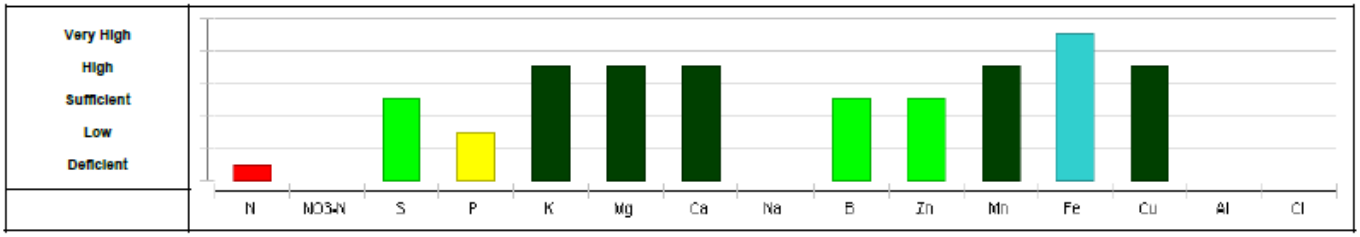
- These plants are deficient in NITROGEN. This condition could be due to inadequate nitrogen fertilization, poor drainage, excessive rainfall or leaching.
- These plants are low in PHOSPHORUS. Possible causes include low soil phosphorus levels, high soil pH, poor drainage, root damage or cool soil temperatures.
- The very high level of IRON in this sample is probably due to contamination with dust or soil particles, and may not reflect the true iron content.
- A&L recommends a foliar application when Mg, B, P, Zn or Mn are low or deficient at this plant stage. Follow the recommended product label rates.
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

203

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260014	2.20	0.6970	0.27	0.24	4.01	0.87	2.87	0.01	29	25	122	839	16	495	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	8.1	0.6	0.9	93	4.6	330	6.9	976
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



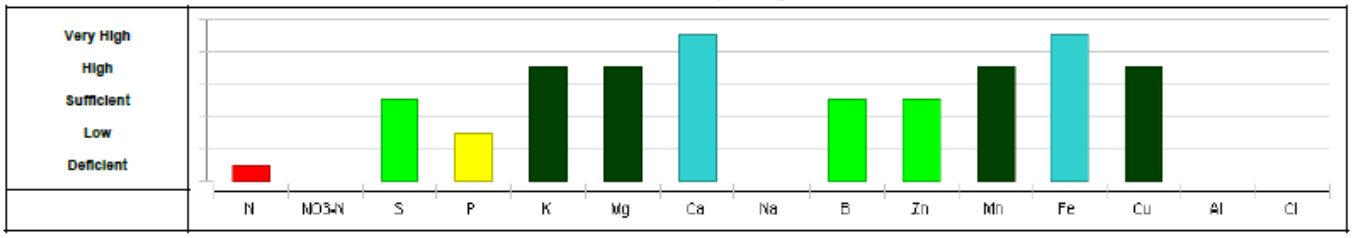
- These plants are deficient in NITROGEN. This condition could be due to inadequate nitrogen fertilization, poor drainage, excessive rainfall or leaching.
- These plants are low in PHOSPHORUS. Possible causes include low soil phosphorus levels, high soil pH, poor drainage, root damage or cool soil temperatures.
- The very high level of IRON in this sample is probably due to contamination with dust or soil particles, and may not reflect the true iron content.
- A&L recommends a foliar application when Mg, B, P, Zn or Mn are low or deficient at this plant stage. Follow the recommended product label rates.
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

302

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260017	2.16	0.6146	0.27	0.27	4.13	0.94	3.06		31	23	141	732	18	426	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	8.1	0.5	1.0	115	4.4	293	5.2	980
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



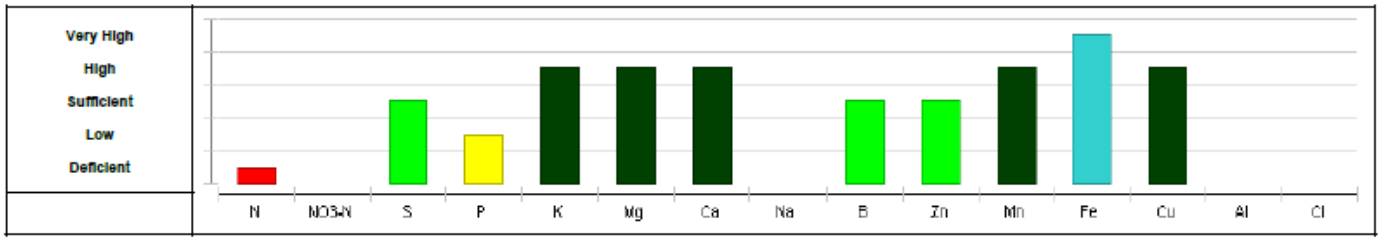
- These plants are deficient in NITROGEN. This condition could be due to inadequate nitrogen fertilization, poor drainage, excessive rainfall or leaching.
- These plants are low in PHOSPHORUS. Possible causes include low soil phosphorus levels, high soil pH, poor drainage, root damage or cool soil temperatures.
- The very high level of IRON in this sample is probably due to contamination with dust or soil particles, and may not reflect the true iron content.
- A&L recommends a foliar application when Mg, B, P, Zn or Mn are low or deficient at this plant stage. Follow the recommended product label rates.
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

401

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260020	2.17	0.5013	0.23	0.24	3.31	0.95	2.64		29	20	106	685	16	372	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	9.3	0.7	1.0	115	3.5	314	6.5	902
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



- These plants are deficient in NITROGEN. This condition could be due to inadequate nitrogen fertilization, poor drainage, excessive rainfall or leaching.
- These plants are low in PHOSPHORUS. Possible causes include low soil phosphorus levels, high soil pH, poor drainage, root damage or cool soil temperatures.
- The very high level of IRON in this sample is probably due to contamination with dust or soil particles, and may not reflect the true iron content.
- A&L recommends a foliar application when Mg, B, P, Zn or Mn are low or deficient at this plant stage. Follow the recommended product label rates.
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

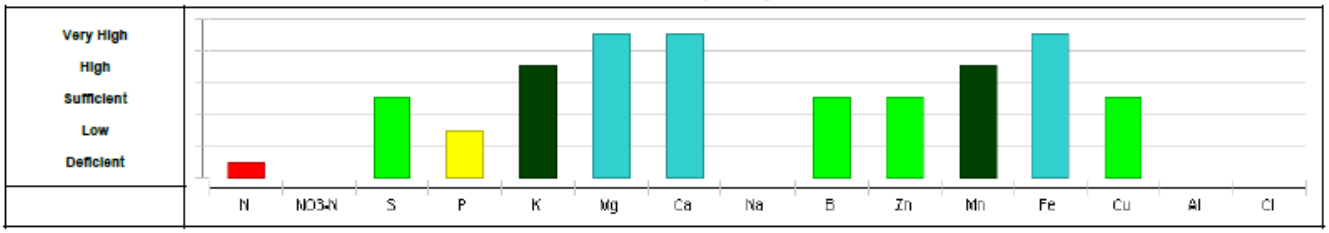
Soil Applied Treatment Plots (5 l/ha)

103

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260010	2.04	0.6970	0.27	0.26	4.58	1.06	3.03	0.01	33	23	116	565	14	316	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	7.5	0.5	1.0	115	4.3	394	4.9	918
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



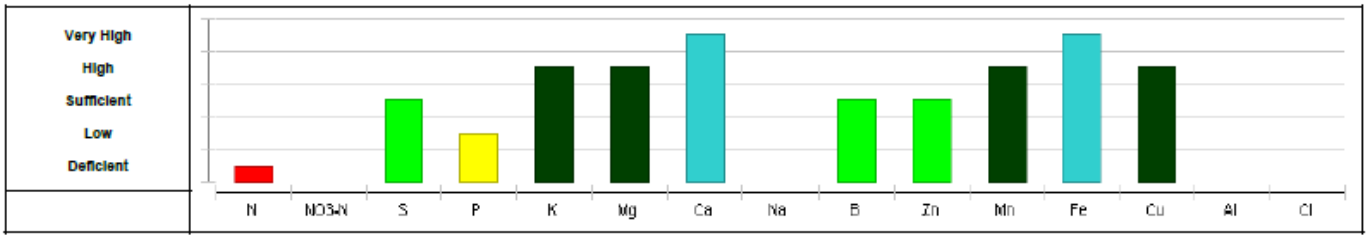
- These plants are deficient in NITROGEN. This condition could be due to inadequate nitrogen fertilization, poor drainage, excessive rainfall or leaching.
- These plants are low in PHOSPHORUS. Possible causes include low soil phosphorus levels, high soil pH, poor drainage, root damage or cool soil temperatures.
- The very high level of IRON in this sample is probably due to contamination with dust or soil particles, and may not reflect the true iron content.
- A&L recommends a foliar application when Mg, B, P, Zn or Mn are low or deficient at this plant stage. Follow the recommended product label rates.
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

202

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260013	2.32	0.6386	0.27	0.24	3.93	0.92	3.04		31	23	121	808	16	476	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	8.5	0.6	0.9	102	4.3	324	6.7	996
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



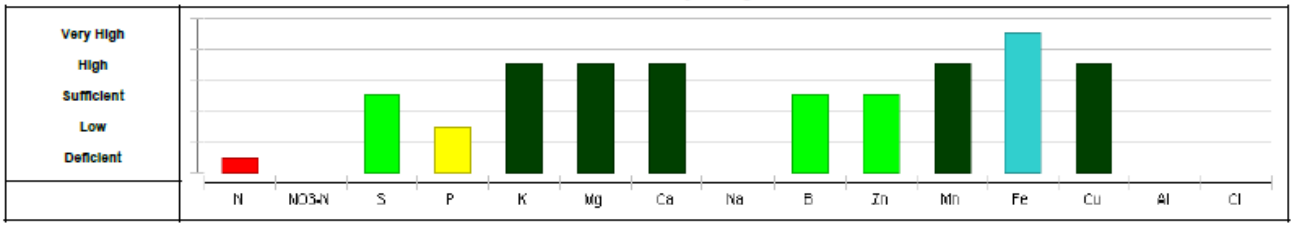
- These plants are deficient in NITROGEN. This condition could be due to inadequate nitrogen fertilization, poor drainage, excessive rainfall or leaching.
- These plants are low in PHOSPHORUS. Possible causes include low soil phosphorus levels, high soil pH, poor drainage, root damage or cool soil temperatures.
- The very high level of IRON in this sample is probably due to contamination with dust or soil particles, and may not reflect the true iron content.
- A&L recommends a foliar application when Mg, B, P, Zn or Mn are low or deficient at this plant stage. Follow the recommended product label rates.
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

303

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260018	2.20	0.7279	0.27	0.26	4.31	0.89	2.91		32	22	136	916	20	503	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	8.3	0.5	1.0	117	4.8	317	6.8	914
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



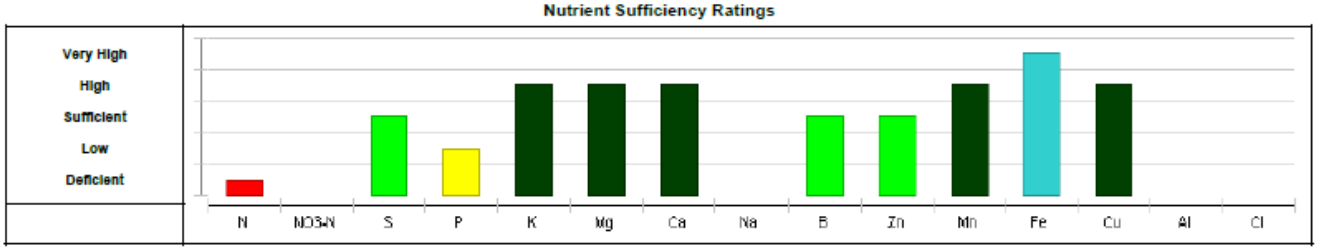
- These plants are deficient in NITROGEN. This condition could be due to inadequate nitrogen fertilization, poor drainage, excessive rainfall or leaching.
- These plants are low in PHOSPHORUS. Possible causes include low soil phosphorus levels, high soil pH, poor drainage, root damage or cool soil temperatures.
- The very high level of IRON in this sample is probably due to contamination with dust or soil particles, and may not reflect the true iron content.
- A&L recommends a foliar application when Mg, B, P, Zn or Mn are low or deficient at this plant stage. Follow the recommended product label rates.
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

402

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260021	2.02	0.5837	0.27	0.28	4.08	0.89	2.70	0.01	33	22	109	746	17	407	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	7.6	0.5	1.0	126	4.6	373	6.8	815
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



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- The very high level of IRON in this sample is probably due to contamination with dust or soil particles, and may not reflect the true iron content.
- A&L recommends a foliar application when Mg, B, P, Zn or Mn are low or deficient at this plant stage. Follow the recommended product label rates.
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

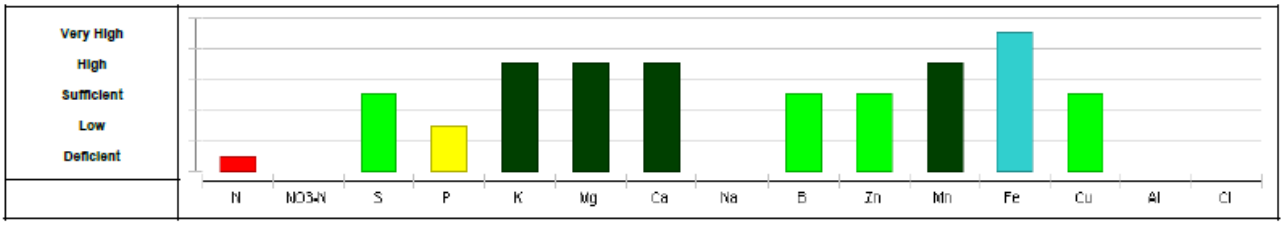
Soil and Foliar Treatment Plots

104

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260011	2.42	1.0884	0.25	0.24	4.16	0.81	2.55		30	22	103	587	14	305	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	9.6	0.6	1.0	109	5.1	403	5.7	840
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



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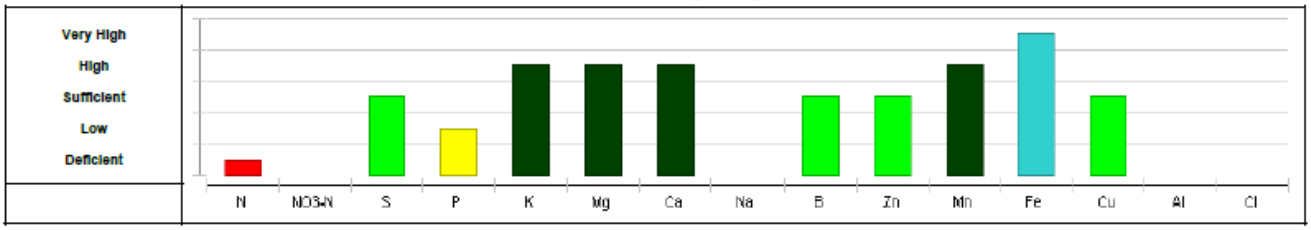
- These plants are low in PHOSPHORUS. Possible causes include low soil phosphorus levels, high soil pH, poor drainage, root damage or cool soil temperatures.
- The very high level of IRON in this sample is probably due to contamination with dust or soil particles, and may not reflect the true iron content.
- A&L recommends a foliar application when Mg, B, P, Zn or Mn are low or deficient at this plant stage. Follow the recommended product label rates.
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

201

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260012	2.30	0.6523	0.24	0.23	3.45	0.82	2.68	0.01	28	21	116	735	12	435	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	9.4	0.7	1.0	110	4.2	297	6.3	944
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



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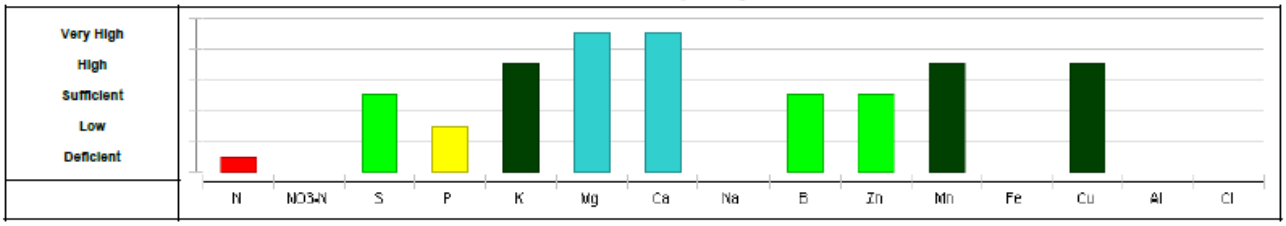
- The very high level of IRON in this sample is probably due to contamination with dust or soil particles, and may not reflect the true iron content.
- A&L recommends a foliar application when Mg, B, P, Zn or Mn are low or deficient at this plant stage. Follow the recommended product label rates.
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

304

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260019	1.97	0.4395	0.26	0.23	3.58	1.01	3.20	0.01	32	21	146	1219	16	671	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	7.7	0.6	0.9	108	3.6	246	8.4	1001
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



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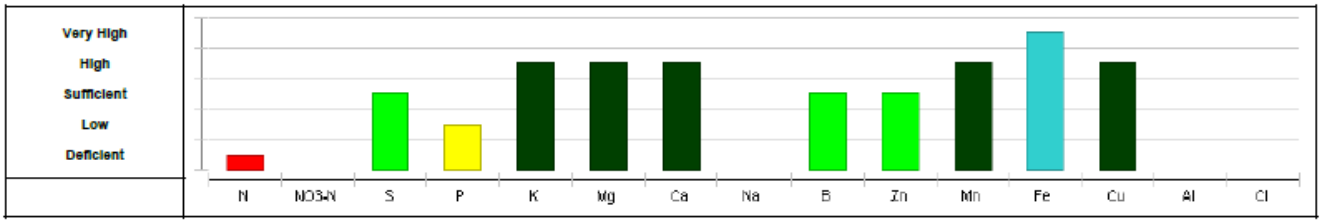
- A&L Recommends a followup tissue sample 14 days after foliar treatment to monitor progress.

403

Date Sampled	Lab Number	Nitrogen (%)	Nitrate Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Chloride (%)
2014-08-05	2260022	2.14	0.4738	0.25	0.25	3.56	0.90	2.77		33	22	112	622	16	341	
Normal Range		5.10 6.20		0.20 0.50	0.30 0.50	2.00 2.60	0.40 0.60	0.80 2.00		20 70	20 60	20 100	50 300	7 15		

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Fe/Mn	Ca/B
Actual Ratio	8.7	0.6	1.0	115	4.0	318	5.6	831
Expected Ratio	15.7	2.3	1.1	100	4.6	330	2.1	240

Nutrient Sufficiency Ratings



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