Nutrient Dense Project Results
from Corn Systems Research at Martinsville, IL for 2011

by Jim Porterfield CCA, Watershed/Water Quality Specialist

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Summary
Three systems for remineralizing soil and/or applying foliar nutrients to field corn were tested against a conventional corn system in a CCC rotation. The two treatments (T3&T4) where soil minerals were balanced by using calculations from the *IDEAL Soil Handbook* outyielded the prepackaged minerals/ocean water foliar treatment T2 and the conventional nitrogen fertilizer approach T1 by 24 to 82 percent.

Plant health as measured by leaf chlorophyll, brix, tissue tests, plant height and fired leaves was consistently better in the two Ideal Soil treatments. Grain nutrient content measured with the fruit test, and vitality measured via gas discharge visualization instrumentation in terms of biophotons and entropy generally showed increased values for the Ideal Soil treatments. Soil biological processes measured by the Formazan test and energy measured as ERGS were 5 percent and 98 percent higher respectively for T4 Ideal Soil plots than for T2 Agricola's Best prepackaged minerals plots which had the same total of 120 Lbs nitrogen per acre applied.

The T4 treatment produced increases in leaf chlorophyll of 15, 30.4 and 60.8 percent respectively at V-3, silking and R2 growth stages. And, it also produced a 62.5 percent increase in nitrate-N in the soil and leaf tissues and a 30.4 percent increase in nitrogen in the harvested grain while registering up to 82 percent increase in yield despite high daytime temperatures and a 46 day dry spell during key growth stages.

The major differences between Ideal Soil treatments T3 and T4 were in the starter fertilizers and foliar treatments. The best combination was Presto Gold when used as starter and two foliars as part of the T4 system. The two T4 reps significantly outyielded the immediately adjacent T3 reps by 35 and 43 bushels/ac, respectively

Fruit tests were conducted to determine mineral content of the corn grain for the Nutrient Dense Project to see if they correlated with higher brix levels. The two Ideal Soil treatments generally raised the mineral levels in the grain compared to Agricola's Best Minerals treatment (T2). However, mineral levels for all three treatments were less than those in the control plots (T1). Higher entropy of the grain in the Control suggested fewer minerals had been incorporated into organic form, thus being more easily extracted by the nitric acid used to perform the fruit test.

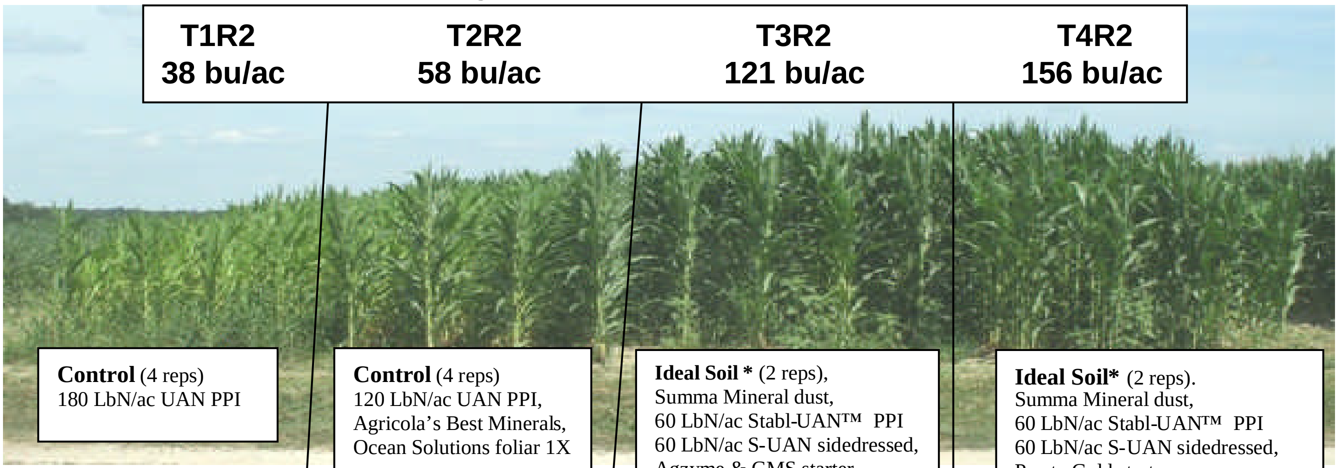
In the grain, all eight minerals for all four treatments were at or below USDA's Standard Nutrient Database for Yellow Corn No. 20014. And, they were way below standards for Dried, Yellow Northern Plains Indian Corn and Guatemala Maize.

T4's stalk brix level of 9.9 was slightly higher than the Control T1 at 9.5 and Agricola's Best T2 at 9.7. Treatment 3 had the lowest brix at 9.3.

If the grain nutrient information generated from the hybrid used for this project is representative of today's hybrids and soil mineral balances are not improved, then we are guaranteed to see further degradation of plant health and debasement of the mineral value of livestock feed and human food, further encouraging insects and disease. This will require increased expenditures for herbicides, fungicides, insecticides, mineral additives for livestock feed, and animal and human drugs. It will also cause lower yields and/or retard the rate of yield increase that is needed to support a growing population.

Results from Corn Systems Research at Martinsville IL for 2011

T1R2	T2R2	T3R2	T4R2
38 bu/ac	58 bu/ac	121 bu/ac	156 bu/ac



Control (4 reps)
180 LbN/ac UAN PPI

Control (4 reps)
120 LbN/ac UAN PPI,
Agricola's Best Minerals,
Ocean Solutions foliar 1X

Ideal Soil * (2 reps),
Summa Mineral dust,
60 LbN/ac Stabl-UAN™ PPI
60 LbN/ac S-UAN sidedressed,
Agzyme & GMS starter,
Gypsum, BioGold, WakeUP,
GMS Foliar 1X
Azotobacter + Liquid fish 2X

Ideal Soil* (2 reps).
Summa Mineral dust,
60 LbN/ac Stabl-UAN™ PPI
60 LbN/ac S-UAN sidedressed,
Presto Gold starter,
Gypsum, BioGold, WakeUP,
Presto Gold foliar 2X,
Azotobacter + Liquid fish 1X.

Plant Photo Aug 12
Root Photo Aug 18
Ear Photo Aug 23

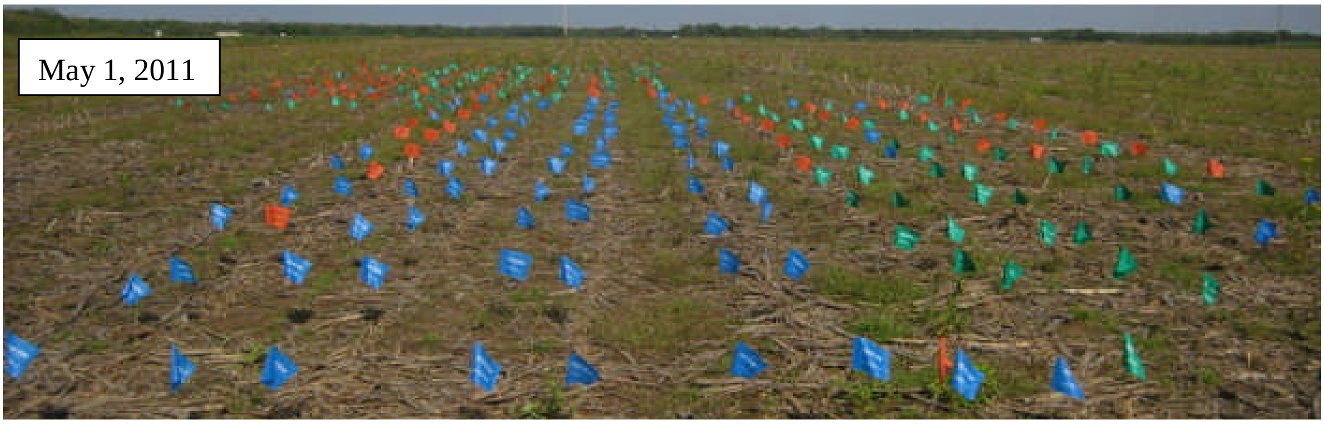
* Ideal Soil also includes application of Lime, Gypsum, MAP, KSO_4, MgO, $MnSO_4$, $CuSO_4$, $ZnSO_4$, Sea Salt, Borax and Ag Sulfur

Ounces per ear 0.2 0.7 2.8 3.7

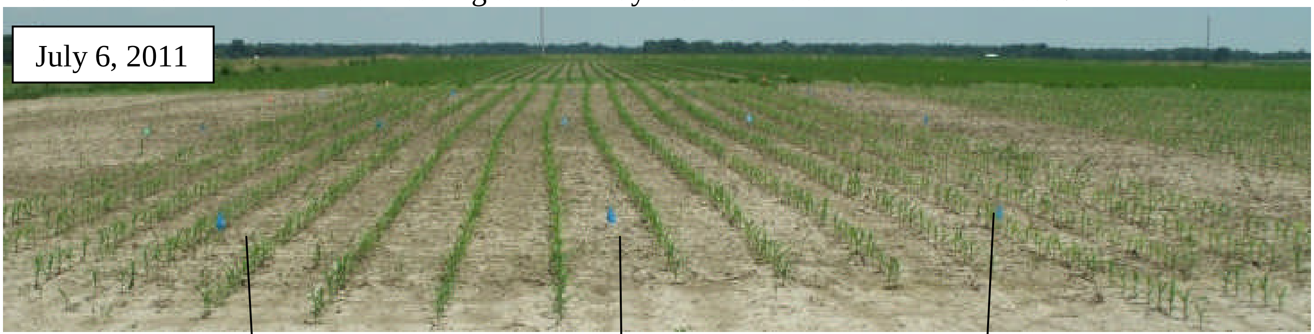
Plots planted June 21 due to a wet spring. Becks NonGMO 6077 was used. No herbicides, No insecticides and No fungicides were applied. Pollen shed was on Aug 18. Representative ears from these four plots were pulled August 23. There was virtually no rain for 46 days between July 29 and September 14.

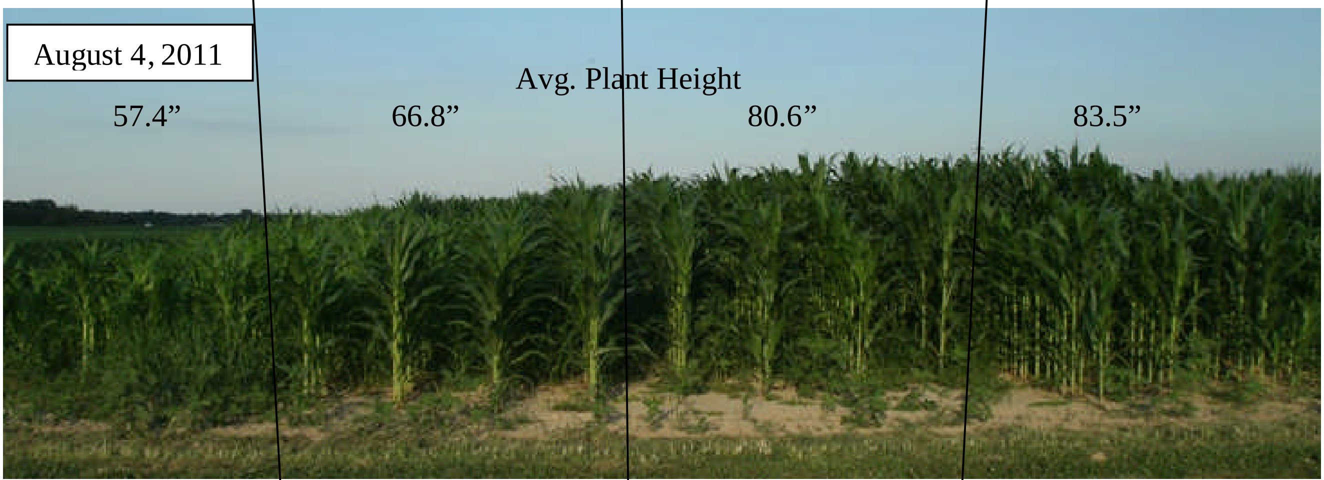
Objectives

Test systems for remineralizing soil vs. conventional corn system in CCC rotation.
Use *IDEAL Soil Handbook* to balance minerals from Mehlich 3 soil test for two treatments.
Increase brix, yield and mineral content of corn grain.
Develop systems that use 1/3 less N (120 LbN/ac) in a CCC rotation compared to control with 180 LbN/ac.
Use Formazan analysis to test for soil biological activity.
Test usefulness of Gas Discharge Visualization (GDV) technology for detecting differences in grain quality.
Test usefulness of several foliar applied products in a systems approach.



Flags show where 10" wide strips of Hi Cal Lime were banded in treatments T3 and T4 on April 29. Photo taken after nice a 1 inch soaking rain on May 1 which moved lime into the soil.

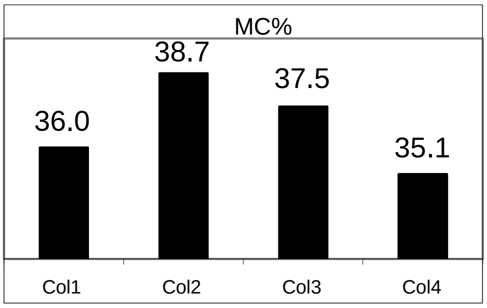


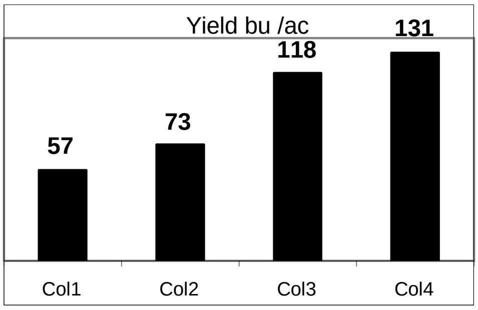


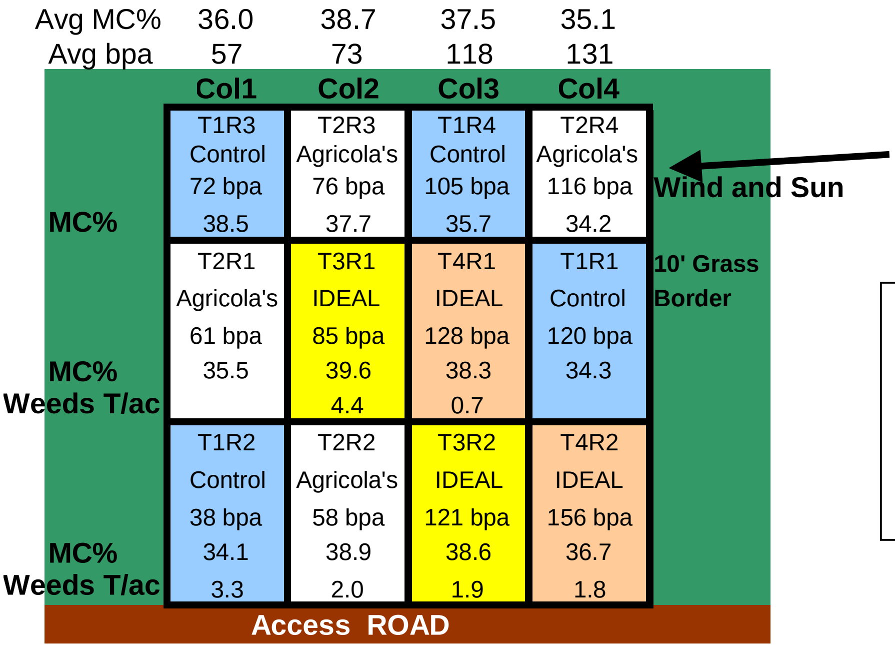
Plant height difference was noticeable in late July and continued on through harvest.

T1R2 T2R2 T3R2 T4R2

Plot Layout, Treatment, Corn Yield, Grain Moisture Content and Weed Biomass.







Soil Characteristics:
Piasa Silty Clay loam
5% Sand, 45% Clay
CEC 6
OM 1.1to 2.1%
Soil pH 7.0 to 7.2

- Wind direction and sunlight reduced grain moisture content on the outside plots next to the grass borders by an average to 2.55 percentage points (Columns C1 & C4 vs. C2 &C3).
- The highest average leaf chlorophyll levels were in the Ideal Soil treatments T3 and T4.
- Treatments T3 and T4 with the Ideal Soil treatment generally had less weed pressure, in part due to faster growth and quicker shading of the ground.
- Non GMO corn was used and no herbicide was applied. Weeds (mostly Wild Proso Millet) were more prolific on the plots on the left half of the field ranging from 2.0 to 4.4 tons of fresh biomass per acre as measured on a wet basis on September 9 and likely reduced yields since they were actively growing during the 46 day dry spell. In some plots there was more wet weight of weed biomass per acre than there was dry corn grain. There were actually more weeds in the six plots that were not weighed than in the six plots that were measured.

Methods

The *Ideal Soil Handbook* was used to calculate the amounts of products to be added to the soil in T3 &T4 to balance the mineral elements. Soil tests from the fall of 2010 from the same plots were converted to Mehlich 3 results (which the *Handbook* required) by using equations developed by the University of Missouri (Source http://aes.missouri.edu/pfcs/research/prop304a.pdf). Mineral products were applied on April 21, 29, May 4th and 5th. It was too wet to till them into the soil, so they were broadcast and scratched in lightly with a rake. Fertilizers and foliar treatments were applied as indicated in the table on page 6. No herbicides, insecticides or fungicides were applied until Sept 22, when earworm damage finally led to the decision to apply Procidic and Safe Strike (which probably should have been done a month sooner).

Plot Treatments

Trt 1 Corn Non GMO Becks 6077 **Control**	Trt 2 Corn Non GMO Becks 6077 **Agricola's Best**	Trt 3 Corn Non GMO Becks 6077 **IDEAL Soil (see below)**		Trt 4 Corn Non GMO Becks 6077 **IDEAL Soil (see below)**		Date Applied
	Agricola's Best 653 lb/ac					21-Apr
			Grams/Plot		Grams/Plot	
		Summa Minerals (1,000 Lb/ac)	4540	Summa Minerals (1000 lb/ac)	4540	21-Apr
		MAP 11-52-0 (400 Lb/ac)	1806	MAP 11-52-0 (400 Lb/ac)	1806	21-Apr
		Ag Sulfur (64 Lbs/ac)	340	Ag Sulfur (75 Lb/ac)	290	21-Apr
		Hi Cal Lime 250 Lb/ac 10" band on Row		Hi Cal Lime 250 Lb/ac 10" band on Row		29-Apr
		MgO 50% Mg (164 lb/ac)	745	MgO (50% Mg) 286 Lb/ac	1298	4-May
		K2SO4 0-51-0-17S (171 lb/ac)	778	K2SO4 0-51-0-17S (202 Lb/ac)	919	4-May
	Included w/ ABM above	Sea Salt 35% Na 198 Lb/a	898	Sea Salt 35% Na 249 Lb/ac	1131	4-May
	Borax 24 Lb/ac	Borax 9% (27Lb/ac)	121	Borax 9% (35 Lb/ac)	159	4-May
	FeSO4 100 Lb/ac	Iron 30% Sulfate18%	0	Iron 30% Sulfate18%	0	4-May
	MnSO4 47 Lb/ac	MnSO4 (68 Lb/ac)	310	MnSO4 32%/19% (90 Lb/ac)	409	4-May
	CuSO4 12 Lb/ac	CuSO4 25%/12.5% (22 Lb/ac)	102	CuSO4 25%/12.5% (29 lb/ac)	133	4-May
	ZnSO4 14.8 Lb/ac	ZnSO4 35%/17% (6 Lb/ac)	27	ZnSO4 35%/17% (10 Lb/ac)	44	4-May
		Hi Cal Lime 1,000 lb/ac Broadcast		Hi Cal Lime 1,000 lb/ac Broadcast		5-May
180 LbN/ac UAN PPI	120 LbN/ac UAN PPI	Stabl-UAN 60 LbN/ac (Structured) PPI		Stabl-UAN 60 LbN/ac (Structured) PPI		20-Jun
Mulch Till, TerraStar	Mulch Till, TerraStar	Stabl-N 5 lb/ton UAN		Stabl-N 5 Lb/ton UAN		20-Jun
		BioGold 12.8 oz/ac(w/Structured water) PE		BioGold 12.8 oz/ac (With Structured water) PE		20-Jun
Planted Corn 32K pop	Planted Corn 32K pop	Planted Corn 32K pop		Planted Corn 32K pop		21-Jun
				Presto Gold 1 qt/ac +5 gal H20/ac Starter in furrow		21-Jun
		AgZyme 8 oz/ac Starter (Structured)				21-Jun
		GMS 4 gal/ac Starter in Furrow				21-Jun
		Gypsum 1000 lb/ac broadcast PE		Gypsum 1000 lb/ac broadcast PE		21-Jun
		WakeUP^2 5oz/ac+10 gal H2OStructured at V-2		WakeUP^2 5oz/ac+10 gal H2OStructured at V-2		3-Jul
				Presto Gold V-3 foliar 1 gal/ac		8-Jul
		Stabl-UAN Sidedressed 60 LbN/ac knee High		Stabl-UAN Sidedressed 60 LbN/ac knee High		15-Jul
		Stabl-N 5 lb/ton UAN		Stabl-N 5 Lb/ton UAN		15-Jul
		GMS foliar at 2 gal/ac at knee high				16-Jul
		Azotobacter + Liquid fish (foliar knee High)				19-Jul
	Ocean Solutions at V-10					12-Aug
	12.8 oz/ac			Presto Gold at V11/12 foliar 1 gal/ac		12-Aug
		Azotobacter 8.8 oz/ac foliar at V-11/12		Azotobacter 8.8 oz/ac foliar at V-11/12		12-Aug
		Liquid Fish 1 gal/ac foliar at V11/12		Liquid Fish 1 gal/ac foliar at V11/12		12-Aug
Procidic 8oz /ac	Procidic 8oz /ac	Procidic 8oz /10 gal water/ac		Procidic 8oz /10 gal water/ac		22-Sep
SafeStrike 10 oz/ac	SafeStrike 10 oz/ac	SafeStrike 10 oz/10 gal water/ac		SafeStrike 10 oz/10 gal water/ac		22-Sep

Tests Conducted on 12 Plots

Grain Yield, Moisture, Test Weight.
0-6" Formazan Soil Test weekly 1st 5 weeks
0-6" Soil Test weekly for 1st 5 weeks
6-12" Soil Test At R2
0-6" Soil test by Mehlich 3, at Harvest
Leaf Tissue analysis (V-2, & at R2)
Stalk Brix at Silking
Leaf Chlorophyll (V-2, at Silking, and at R2)
Root Mass Evaluation at Tassel
Fall Stalk Nitrate Test
Corn Grain Mineral Analysis at harvest
GDV Analysis of Grain

Becks Non-GMO 6077 111 Day Corn

General Characteristics | **Ear Traits**

Exp #:	2	Ear Height:	Med. High
Year Released	Spring 2011	Ear Type:	Med. Flex
Heat Units:	2545	Kernel Rows:	14-18
Yield	8.9	Kernel Depth:	Med. Deep
Test Weight:	8	Kernel Size:	Medium
Rec Soil Type	HP-LP	Dry Down:	Fast
No-Till Adapted	8.6	Husk Cover:	Med. Loose
Emergence:	8.9	Cob Diameter:	Medium
Seedling Vigor	8.8	Cob Color:	Red
Drought Tol.:	8.1		
Emerg./ Pollin	61 Days		
Irrigation:	8.1		

Plant Traits

Stalk Strength:	8.7
Root Strength:	8
Fung. Response:	Medium
Plant Health (CAC)	8.3
Gray Leaf Spot:	8.3
N. Corn L.Blight:	7.5
Rec. Nitrogen App.	Pre-V4
Stay Green:	8
Plant Height:	Tall
Leaf Color:	Dk. Green
Leaf Angle - Early:	Erect
Leaf Angle - Tassel	Semi-E.

Due to a wet spring, corn planting was delayed until June 21. On June 20, plots were tilled 3 times with a rotovator with TerraStar imprint wheels following immediately behind. UAN was preplant incorporated in treatments T1 and T2 at 180 and 120 LbN/ac respectively, and structured Stabl-UAN ™ was preplant incorporated at 60 LbN/ac in treatments T3 and T4 and the MAP added another 44 LbN/ac.
An additional 60 LbN/ac of structured Stabl-UAN ™ was dribbled on close to the row in T3&4 in mid-July.

Composite soil samples were collected weekly from three of the four treatments (T2, T3 &T4) for the first five weeks, including one sample taken the day prior to planting, and sent to International Ag Labs because they use LaMotte tests and the Morgan Extract procedure. Their reagents are not as acidic as those used for other tests and more closely measure what is available to the plant roots as opposed to measuring the total amount of a nutrient in the soil. The lab also measures ERGS which is a measure of electrical conductivity and energy in the soil and Formazan which measures relative biological activity, both of which were of interest to the project.

Also, composite topsoil (0-6"), subsoil (6-12") and leaf tissue samples from the 4 treatments were collected 80 days after planting on September 9, near the end of a 46 day dry spell.

Weeds were hand hoed out of all plots on Sept. 9 to make it easier to combine at harvest. 90% of the weeds were Wild Proso Millet. All above ground weed growth was collected from between rows 2 and 3 from six of the plots and weighed. The weeds in the other six plots were simply cut and left for mulch on the soil surface.

Soil compaction was measured with a hand held, 3-foot long, 0.25-inch diameter cold rolled steel rod with a T-handle and a 0.50 inch diameter pointed tip. Measurements were taken in Plots T4R2 and T1R2 to see if soil compaction had any effect on root growth. A tape measure was stretched diagonally on the ground starting with the zero mark in row 2 and the 15 foot mark in row 3 for the non-wheel tracked measurements and between rows 3 and 4 for the wheel tracks. The probe was pushed into the soil at each foot maker. If the probe flexed more than one inch off its centerline, soil was considered too compacted for root growth at that depth in the soil.

Leaf chlorophyll was also measured three times, (V-3, V-8 and again on Sept 9). Also, at V-3, eight entire plants were removed from each rep of T1 and T2 and 16 plants were removed from each rep of T3 and T4, making a total of 32 plants per treatment sent off for tissue analysis. Removal of these plants reduced yields by an estimated 2 bu/ac for the lowest yielding plots to as much as 10 bu/ac for the highest yielding plot T4R2.

Brix measurements were made on September 9 from sap squeezed from the stalks just below the ear.

Plots were harvested with a plot combine on October 25 after the first frost. Grain moisture content was still high (between 34 and 39% MC).
After harvest, stalk samples were cut from plots T1R1, T1R2, T2R4 and T4R2 for the Fall Cornstalk N test to see whether the plants had enough nitrogen during their growing cycle to reach their full potential.

Topsoil samples were collected after harvest from all 12 plots and were analyzed with the Mehlich 3 test to ascertain ending mineral reserves and provide a basis for determining next year's additions of nutrients to balance the minerals according to the *Ideal Soil Handbook* written by Michael Astera.

Composites of shelled corn from the four treatments were also sent to Logan Labs for a fruit test to produce results comparable to the grain mineral results published by USDA in their Standard Nutrient Database.

Seeds from one representative ear from each of plots T1R2, T2R2, T3R2 and T4R2 were also analyzed with a Gas Discharge Visualization (GDV) machine to demonstrate biophotonic energy and entropy of the grain to see if it would show differences in grain quality.

Rainfall was adequate up until July 12 followed by 17 days with no rain and daytime highs well over 90 degrees. The dry spell was punctuated with 0.8 inch of rain on July 29, after which a 46 day drought ensued, finally ending with 0.8 inch of rain on September 14. Between planting and harvest on Oct 25, at total of 2,359 GDD were recorded, 186 less than 2,545 GDD needed to mature this hybrid.

LEFT: A rotovator followed by the TerraStar soil imprinter was used to prepare the soil. **RIGHT:** The darker wet spots running left to right across the photo are the microwells of biological activity created by the TerraStar imprinter's last pass, (perpendicular to the rows), before planting. The 3.0 inches of rain that fell in the 15 days between June 21 and July 6 had filled in the imprints with soil, as would be expected. The imprinter consolidates the tilled soil but does not compact it.

ABOVE: A water structuring unit was used to structure the water used in all the foliar sprays that were applied to the plots. It was also used to structure the Stabl-UAN™ that was applied to treatments T3 &T4. The normal bond angle of the hydrogen atom to the oxygen atom in a water molecule is 104.5 degrees. The swirling action within the structuring unit changes the bond angle to 114 degrees and reduces the surface tension of the water. The greater the angle, the more reactive the water molecule and the more energy it has in it.

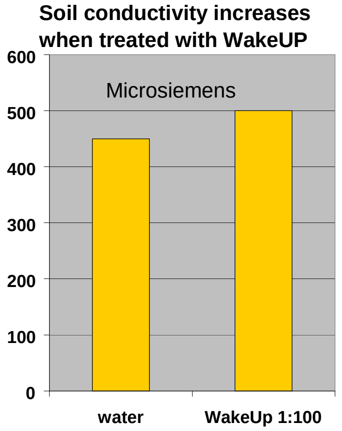
Stabl-N™ was added to 28% UAN at a rate of 5 Lbs of Stabl-N per Ton of UAN along with a suspension agent. Normally, UAN is a clear solution with a pH of about 7.0. Adding the black powdered Stabl-N and suspension agent turns the UAN black and increases the pH to 8.0 to 8.5. It stabilizes the urea and the ammonium in the UAN. It does not stabilize the nitrate. (UAN is 25% nitrate, 50% Urea and 25% Ammonium.)

28% UAN also contains about 30 % water which is why we felt that the structuring unit would be useful to structure the Stabl-UAN. Work in South Dakota in 2010 indicated a 20 bu/ac yield increase when liquid fertilizer was structured.

WakeUP[2®] is a non-toxic surfactant to improve absorption and translocation of moisture and nutrients in crops. WakeUP is formulated from botanically based food additives on FDA's "Everything Used in Food in the United States", known as the EAFUS list. WakeUP[2] increases conductivity in the soil and reduces surface tension in water.

Guaranteed analysis
3.5 - 0 - 0 - (.01 Zn)

Total Nitrogen	3.5%
Ammoniacal nitrogen	0.1%
Urea nitrogen	0.1%
Organic nitrogen	3.3%
Zinc	0.01%
Magnesium	0.01%
Calcium	0.02%
Sulfur	0.08%
Sodium	0.30%



WakeUP reduced Surface tension of water on right and it stayed put In upper jar.

Source: 2012 WakeUP Research Report

Bio-Gold™ is a complete total microbial package. It is a highly concentrated certified organic compound containing free-living soil microbes that are both aerobic and anaerobic, including nitrogen fixers.

Guaranteed Analysis

Azotobacter	12.0%
Clostridium	14.0%
Non–Pathogenic Proprietary Ingredients	74.0%

*Mininmum of 300,000 CFUs per mL.

AgZyme® is a complex of: enzymes, trace elements, vitamins, and natural plant extracts.

Growers Mineral Solution analysis is 10-20-10

PRUDENT™ PRESTO Gold Label is patented. 6-18-5 It also includes: Hormones, Microbes, Surfactants, and Sugar

GUARANTEED ANALYSIS
Total Nitrogen (N)……………………..…….6.0%
6.0% Ammoniacal Nitrogen
Available Phosphate (P2O5)…..……..18%
Soluble Potash (K2O)…………….……….5%
Boron (B)……………………………..0.21%
0.21 Water Soluble Boron (B)
Copper (CU)…...……………………..0.11%
0.11 Chelated Copper (Cu)
Iron (Fe)………………………………0.21%
0.21% Chelated Iron (Fe)
Manganese (Mn)…………………..…0.21%
.21% Chelated Manganese (Mn)
Zinc (Zn)……………………………..0.07%
0.07 Chelated Zinc (Zn)

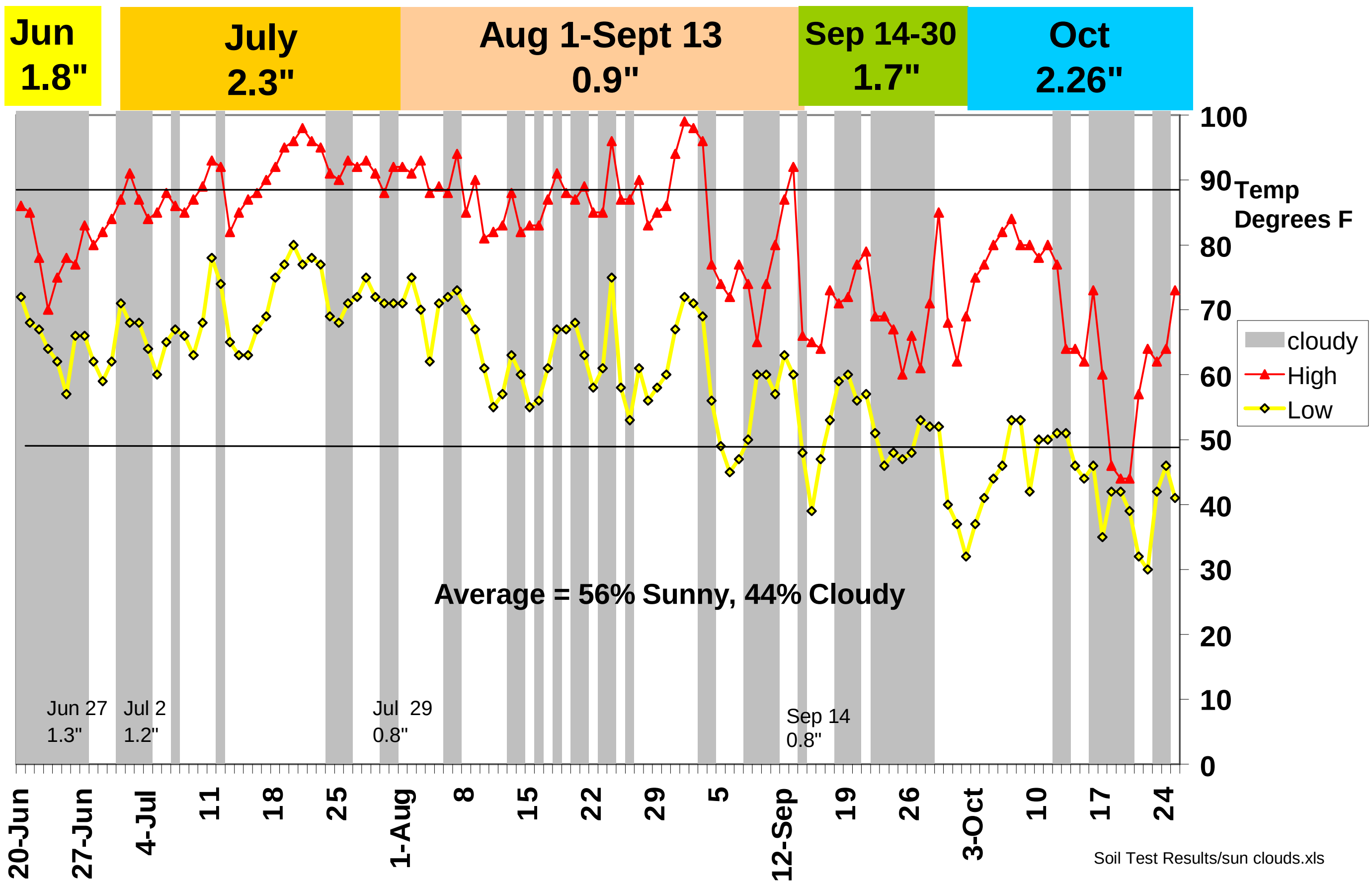
Discussion

Weather played a significant role in planting and crop development. A wet April, May and June delayed timely application and incorporation of the minerals in treatments T2, T3, and T4. Agricola's Best prepackaged mineral mix, Summa Minerals, MAP and ag sulfur were broadcast applied on April 21. On May 4 and 5 the sulfated minerals and Hi Cal Lime were broadcast applied. While we would have liked to immediately mix them thoroughly in the top 6 inches with the rotovator, the best we could do was lightly hand rake them into the top 0-1 inches of soil. The biological Archaea microbes in the prepackaged mineral mix are sensitive to exposure to sunlight, so they may have been compromised somewhat. Finally, on June 20 we were able to mulch till with the rotovator and TerraStar imprint the plots and then plant the next day.

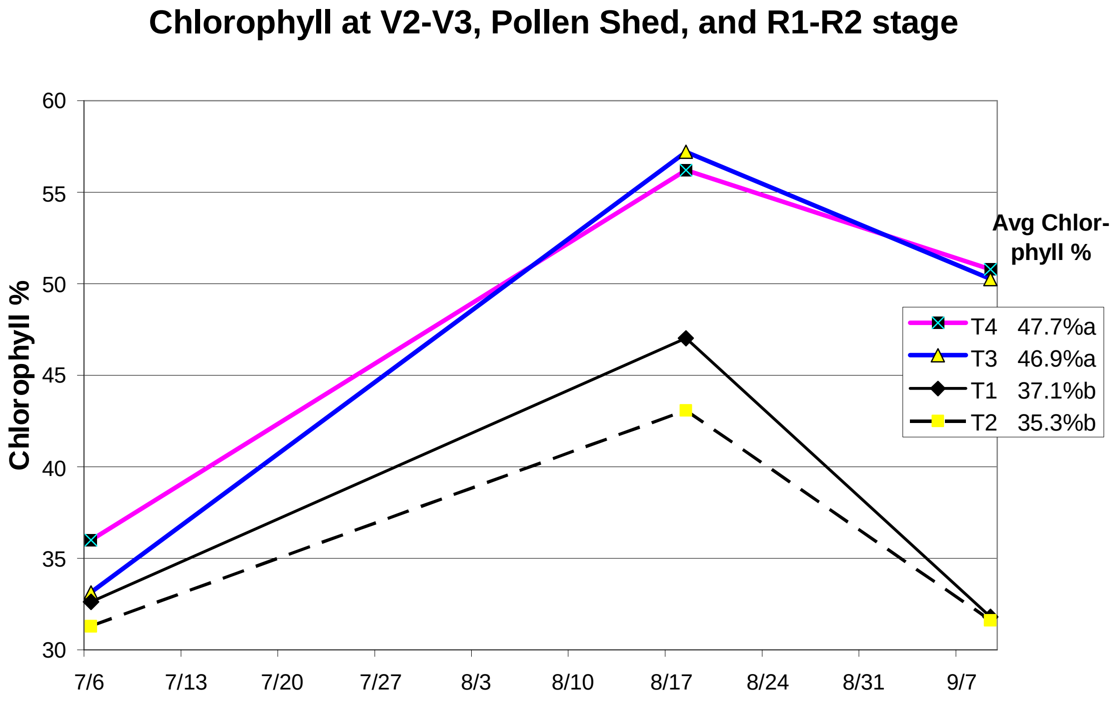
The graph below shows high and low daily temperatures and shows days listed as cloudy and/or rainy based on the weather data shown on the Weather Underground's web site for nearby Paris, Illinois. Rainfall was measured on-site near the plots for the first three months and by My Rain Scout.com for October. Pollen shed occurred around August 18 which was better than if it had occurred in the heat of mid-July. However, the cool temperatures and cloudy rainy days that occurred during the last two weeks of October delayed dry down and maturity.

With 3.0 inches of rain in the first two weeks after planting, some of the nitrogen applied as 28% UAN in the Control (T1) and Agricola's Best (T2) may have been leached out. The compacted layer created by the rotovator also was evident based on shallow rooting structure and compaction measurements. The wet windy weather near the end of October actually partially uprooted numerous plants, again indicating shallow rooting due to compaction and dry weather stress.

Temperatures, Rainfall and Cloudy Days, Jun 20-Oct 25, 2011

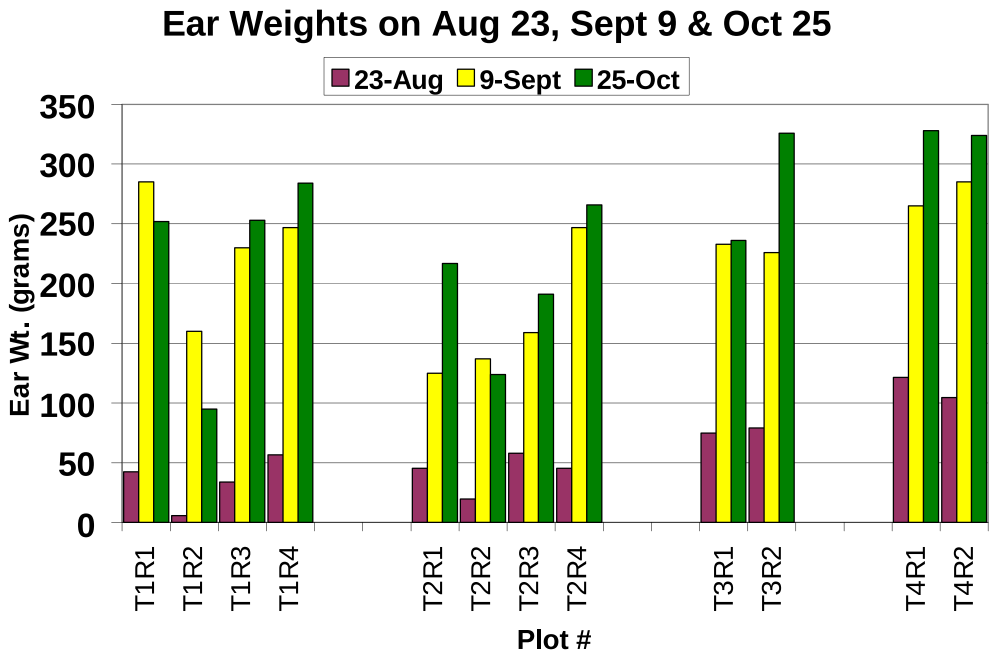


Even at the early growth stages of V-2/V-3, leaf chlorophyll tests were higher for T3 and T4 than either of the controls and were the most correlated (r^2 = 0.9589) with yield. At silking, chlorophyll levels in both the T3 and T4 treatments were at least 10 percentage points higher than the other two treatments, but r^2= 0.6386. At the R-2 growth stage, the correlation of chlorophyll to yield was slightly better (r^2= 0.717) but the chlorophyll in the controls had dropped to an average of 31.7%, nearly 19 percentage points less than T3 and T4. The two Ideal Soil Treatments had significantly higher average leaf chlorophyll levels than the controls.



Arise 2011/chlorophyll/Chart 7.xls

Averages followed by the same letter are not signifcalntly different at $P_{0.05}$ LSD = 9.64



Arise 2011/chlorophyll/Chart 8.xls

Although only one representative ear was picked from each plot on Aug. 23, Sept. 9 and Oct. 25, it was clearly important to get them off to a healthy start as demonstrated by Ideal Soil treatment T4's ear weights which started higher and stayed higher as shown in the ear weights graph above, and in the photos on page 27.

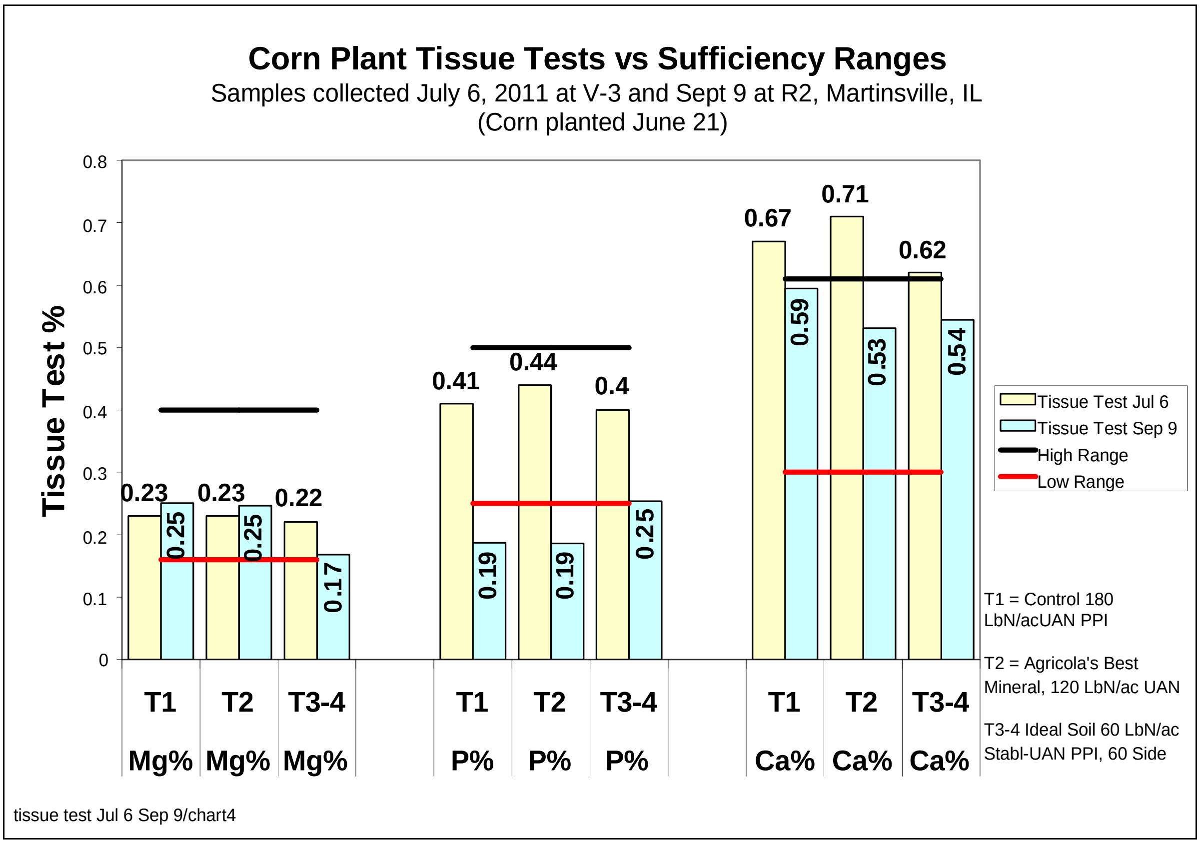
Tissue Tests

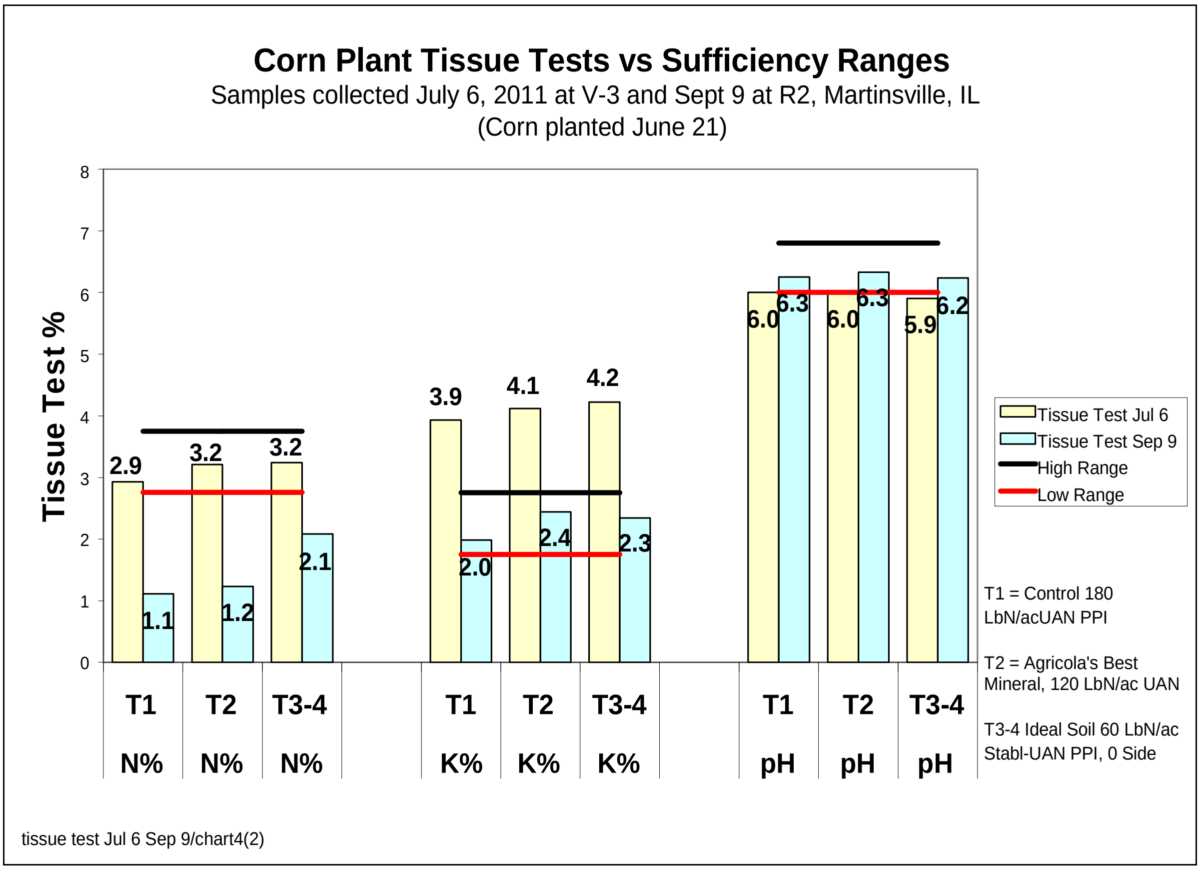
Ear leaves of treatments T3 & T4 were longer, wider, greener and healthier looking than Controls T1 and Agricola's Best (T2), Photos on September 9, 2011.



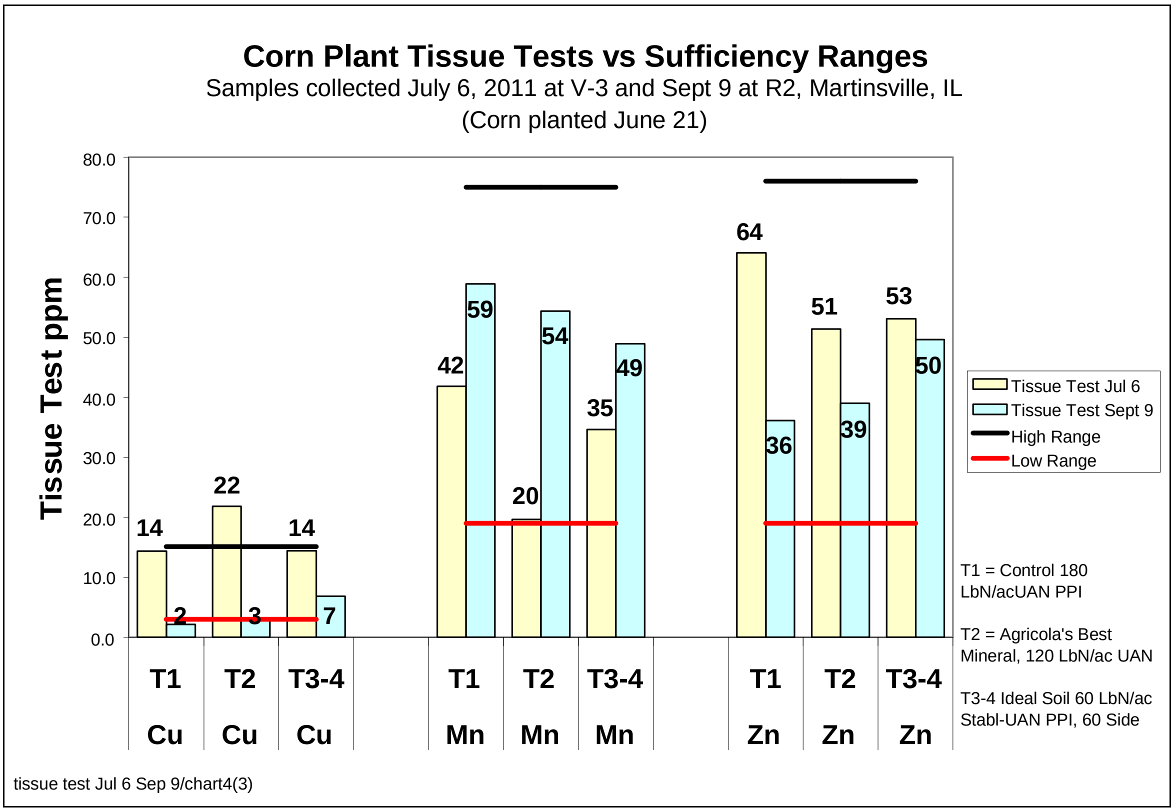

T4R2	**T3R2**	**T2R3**	**T1R2**
2	**3**	**5**	**6.5**

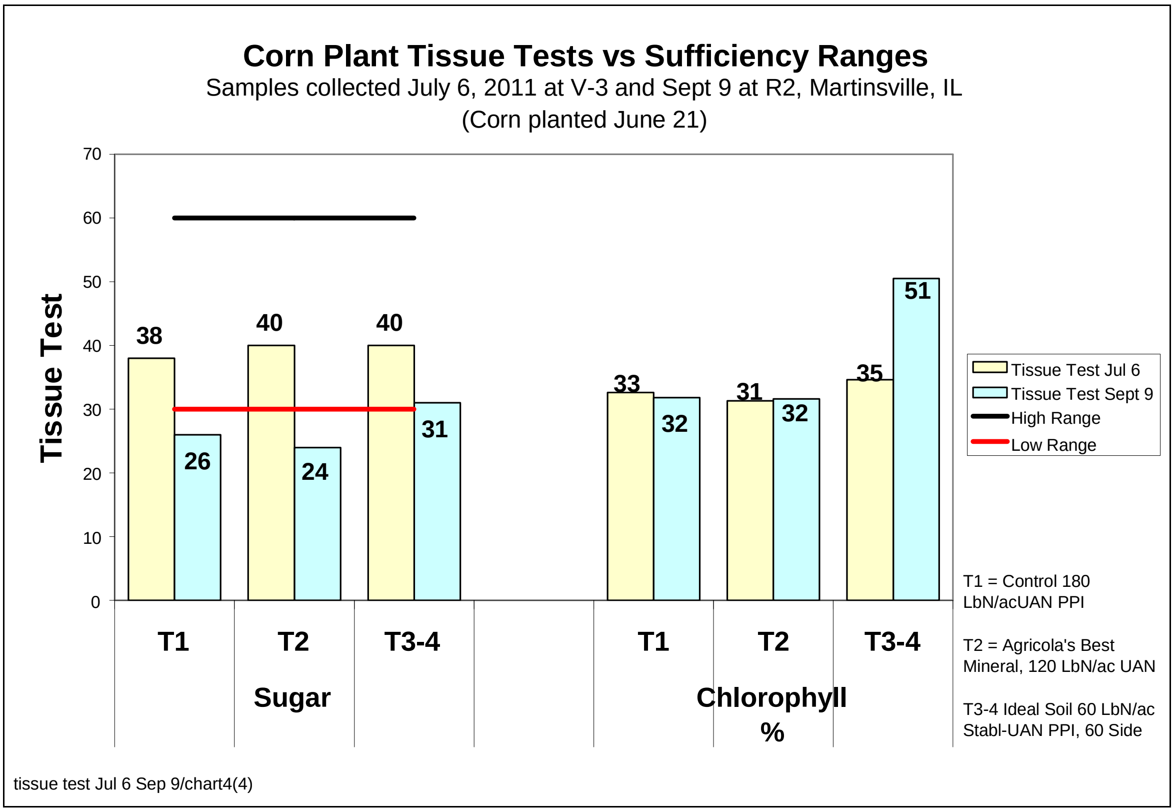
Average Number of Leaves Fired as of October 13 (this is after the weeds were hoed and weighed.)





Tissue tests at V-3 started out within or above acceptable ranges. However, by the time the plants reached R-2, phosphorus and nitrogen were below the lower acceptable range. Ideally, sap pH should be 6.4.





Copper, manganese, zinc, nitrogen and sugar in the leaf tissue were all within acceptable levels at V-3. However by R-2, copper, nitrogen and sugar had fallen below the low sufficiency range. Leaf sugar content increased as mineral treatments increased in T3-T4, as did chlorophyll. Zinc increased in the tissue samples at

R-2 as the amount of zinc sulfate increased in the treatments, but manganese decreased as the amount of manganese sulfate added to the soil was increased.

"Sometimes adding Mn to the soil stimulates the Mn-oxidizing organisms to reduce its availability. Both Zn and Cu can antagonize Mn uptake depending on sufficiency level and time applied.

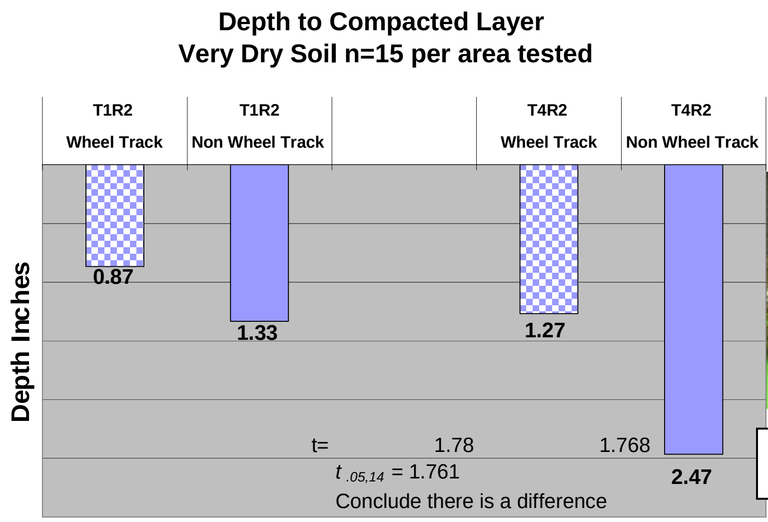
Between a pH of 5.2 and 7.8, the pH effect is on the Mn reducing or oxidizing organisms in the root zone. Beyond that range it is both biological and redox chemistry mediated. Adding it to the soil stimulates those organisms for their own behalf and at lower pH it is more selective for Mn reducers and at higher pH it is more selective for oxidizers." Don Huber Personal Communication Nov 2011

In our case, as the pH went up, the manganese reading went down, and visa versa. Meanwhile, iron levels also decreased in the topsoil as pH increased. This is demonstrated in the five soil tests after planting. As shown in the table below, concentrations of Mn and Fe in the leaves were both lower for T4 vs. the Control T1.

Tissue Sept 9 at R1-R2									T4 Increase or Decrease	
	T1		T2		T3		T4			
* % converted to ppm	Tissue ppm	% of Total	Tissue ppm	% of Total	Tissue ppm	% of Total	Tissue ppm	% of Total	vs T1 ppm	vs T1 % of Total
Mg ppm *	2,508	6.007%	2,465	5.271%	1,713	3.045%	1,651	3.146%	-34.2%	-47.6%
Mn ppm	59	0.141%	54	0.116%	52	0.092%	46	0.088%	-21.6%	-37.7%
Ca ppm *	5,947	14.247%	5,312	11.362%	5,986	10.639%	4,904	9.342%	-17.6%	-34.4%
Fe ppm	97	0.233%	84	0.179%	113	0.201%	91	0.173%	-6.4%	-25.6%
Na ppm	240	0.575%	240	0.513%	260	0.462%	260	0.495%	8.3%	-13.8%
K ppm *	19,837	47.518%	24,383	52.147%	23,907	42.491%	22,931	43.687%	15.6%	-8.1%
Zn ppm	36.1	0.086%	39.0	0.083%	50.6	0.090%	48.7	0.093%	34.9%	7.3%
P ppm *	1,867	4.473%	1,862	3.983%	2,535	4.505%	2,538	4.836%	35.9%	8.1%
N ppm *	11,153	26.716%	12,316	26.340%	21,641	38.463%	20,011	38.124%	79.4%	42.7%
Cu ppm	2.2	0.005%	3.1	0.007%	5.9	0.011%	7.8	0.015%	258.8%	185.4%
Total Minerals ppm	41,746	100.0%	46,758	100.0%	56,264	100.0%	52,489	100.0%	25.7%	
Avg Yield Bu/ac at 15% MC	**83.7**		**77.9**		**103**		**142**		69.3%	
Ca Mg K Na in tissue	28,532		32,400		31,867		29,746			
Total N in Tissue	11,153		12,316		21,641		20,011			
Total other in Tissue	2,062		2,042		2,756		2,732			
Total Tissue	41,746		46,758		56,264		52,489			

Total minerals in the leaf tissue increased by 25.7% for T4 Ideal Soil plots compared to T1 Control. Absolute values of Mg, Mn, Ca and Fe decreased for T4 vs. T1 and declined as a percent of the total minerals in the leaf tissues. Absolute values for Na and K increased for T4 by 8 and 16 percent, but decreased as a percentage of the total nutrients in T4 tissues. Absolute values for Zn, P, N, and Cu increased substantially and as a percentage of the total minerals. Of the net increase of 10,743 ppm for T4 over T1, nitrogen accounted for 82 percent of the increase.

Balancing the minerals in the soil changed the balance in the leaf tissue and indicated that the corn was definitely not being able to extract as much copper and zinc from the control plots as it needed. Copper and zinc levels increased in both the soil and leaf tissue as more of the mineral was added to the soil. Subsoil levels for Cu and Zn also increased slightly.



T1 T2 T3 T4

Compaction and Erosion are big issues when soil is rotovated. The rotovator tines tend to compact soil at the depth that the tines reach, which is about 6 inches. The tilled soil is loose and easily eroded. Our plots were on fairly level ground so erosion was not an overriding issue. However, to combat erosion we imprinted the soil with a roller called TerraStar imprint wheels. The serrated plastic wheels leave thousands of little ponds per acre about 2 inches deep, 1.5 inches wide and 8 inches long. It increases the surface area of the soil by 30 percent. This allows air and water to infiltrate sideways into the soil as well as downward. The imprint wheels consolidate the soil, but do not compact it. The bottoms of the imprints are microwells of biological activity as they remain moister, warm up faster and provide protection for the bacteria from the wind. Imprinting increases infiltration, reduces runoff and reduces erosion by 50 to 90 percent.

We tried several things to combat the compaction, including Wake-UP a surfactant that promotes root growth and Bio-Gold, a biological product with microbes. Wake-UP is supposed to promote root growth, which should be a particularly helpful insurance policy in dry weather. It was applied on July 3rd, just after the rains stopped. Hopefully, some roots penetrated the compacted layer. The root mass that we were able to dig from the dry soil spread over twice the area in T3 T4 compared to T1 T2.

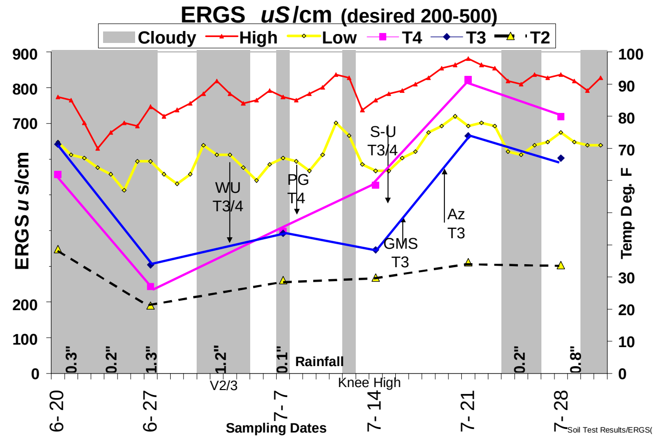
Bio-Gold contains bacteria that are supposed to produce nitrogen, thereby reducing the need for commercial nitrogen by as much as 50 percent, as well as adding to the tilth of the soil. Biological activity increased dramatically between the 3rd and 4th week, which was also the week that the Stabl-UAN was sidedressed. Microbe activity slows down above 95 degrees and is greatly reduced in dry soils. The dry hot spell during August undoubtedly slowed their activity just when it was needed most.

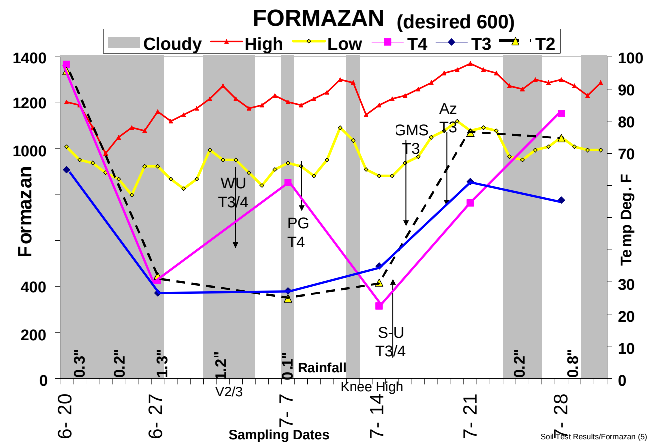
Both products were applied in treatments T3 and T4. The Formazan test indicated a big jump in biological activity during the second week for T4, but not for T3.

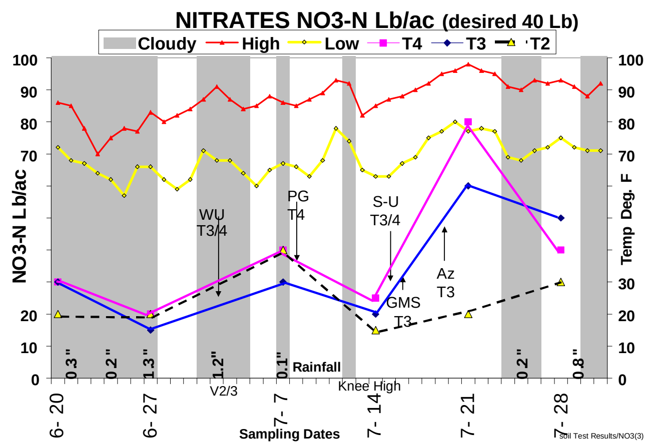
Also, gypsum was also broadcast after planting in T3 and T4. It should help flocculate the soil and prevent crusting. As well as supplying some sulfur, it should work its way down with every rainfall and eventually help penetrate the compacted layer. Each inch of rainfall will move about 35 Lbs of gypsum downward. However, with minimal rainfall after the first three weeks, it may not have been as beneficial as it could have been it there had been more rain.

Even though the soil was very dry when tested, there was a statistically significant difference between compaction in the both the wheel tracked and non-wheel tracked areas of the T4 plot versus the Control T1. As dry as it became, every little bit of root growth helps as can be seen in the accompanying root photo above.

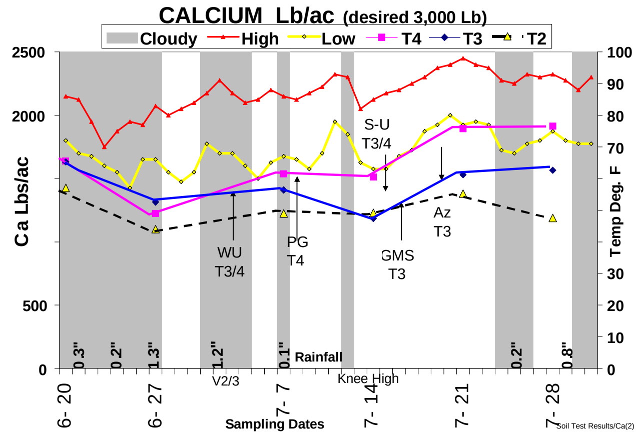
Composite soil samples were collected weekly from treatments T2, T3,& T4 for the first five weeks, including one sample taken June 20 (the day prior to planting), and sent to International Ag Labs because they use LaMotte tests and the Morgan Extract procedure. Their reagents are not as acidic as other tests and more closely measure what is available to the plant roots as opposed to measuring the total amount of a nutrient in the soil. The lab also measures ERGS which is measure of electrical conductivity and energy in the soil and Formazan which measures relative biological activity, both of which were of interest to the project. **WU=WakeUP, PG=Presto Gold, S-U= Stabl-UAN, GMS=Growers Mineral Solution, Az= Azotobacter.**

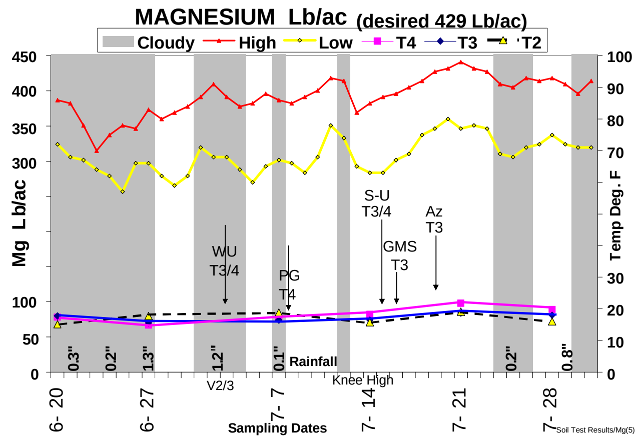


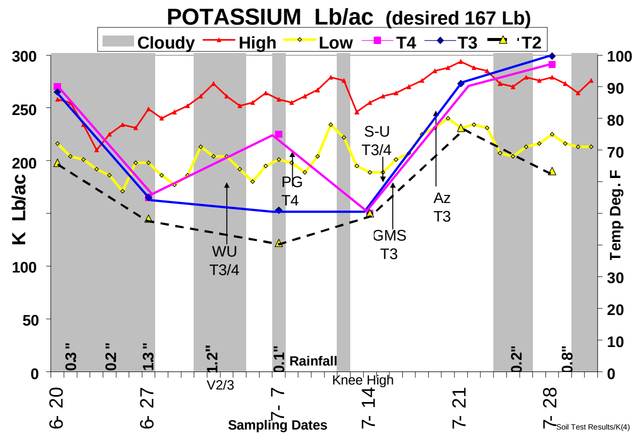


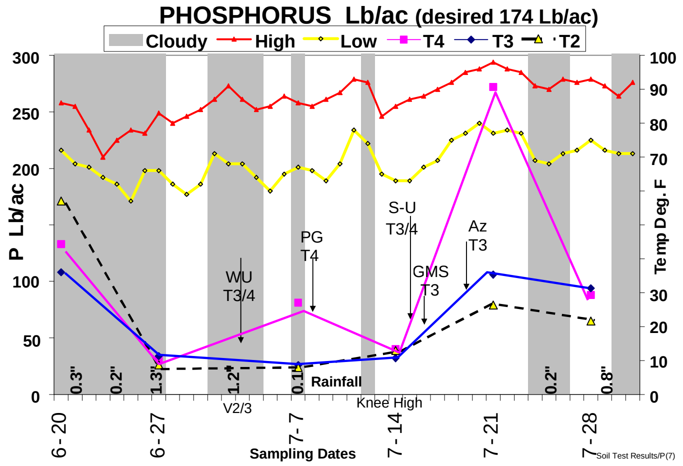


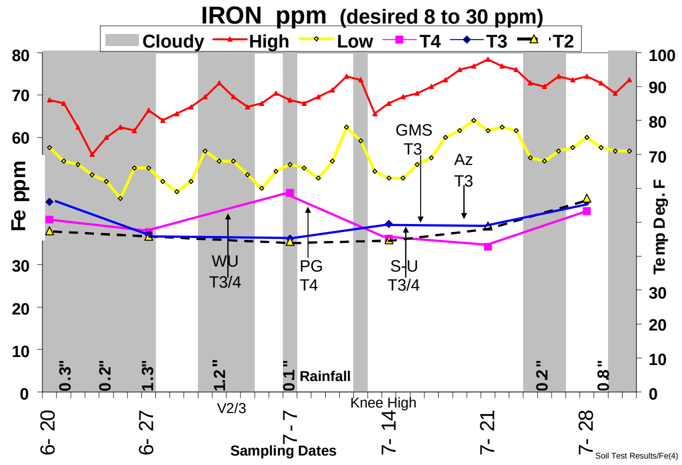
The first week after planting there was a sharp decrease in available soil nutrients (except Mn which actually increased). The big decreases seem likely due to tillage, two days of nighttime lows below 60 degrees and daytime highs below 70 degrees, seven days of cloudy weather and/or rainfall which occurred the morning of June 27 before the soil samples were collected. There was also a sharp rise between July 14 and July 21 for treatments T3 and T4 for most nutrients but only a slight increase for the treatment T2. However, the Formazan test indicated that the soil biology kicked into gear for all three treatments that week corresponding to a rise in daily temps. and a sunny week. Stabl-UAN was also sidedressed in T3&T4 that week.

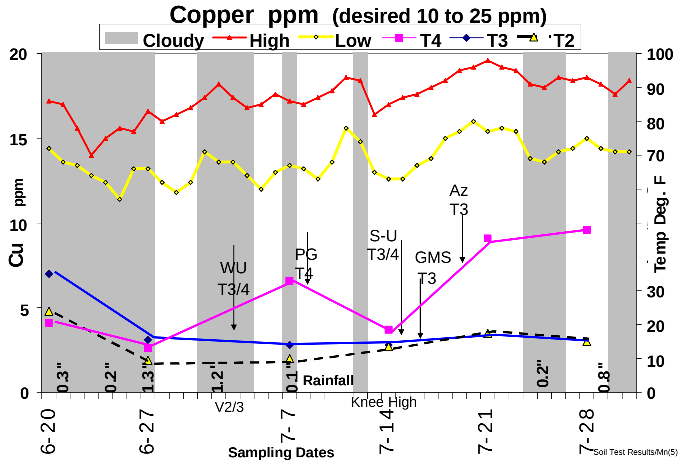


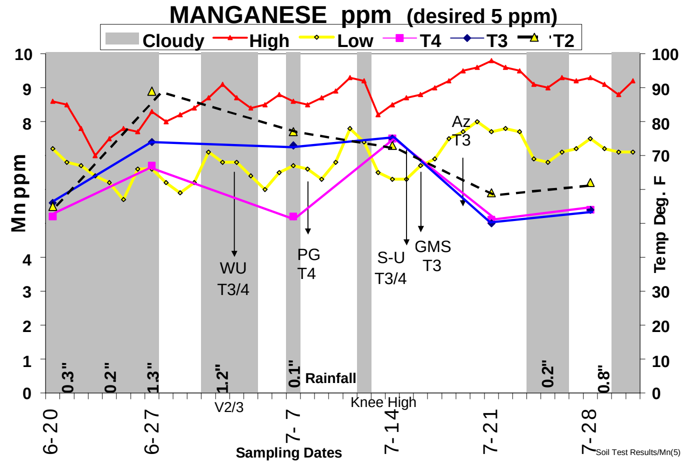


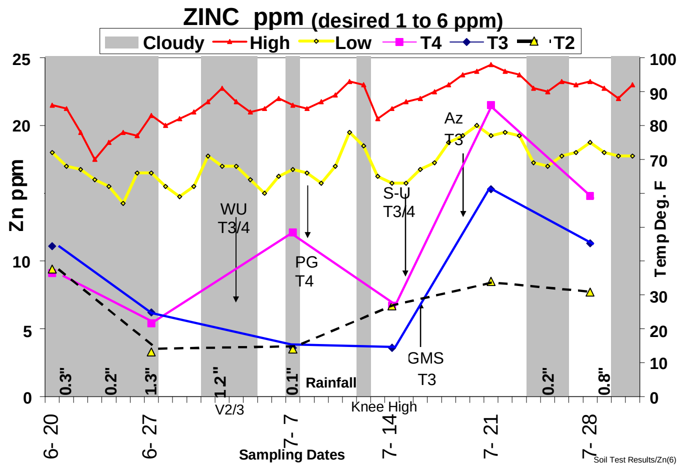


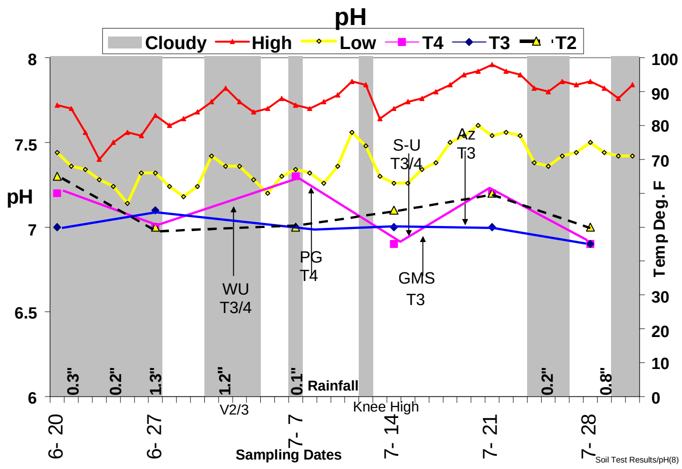










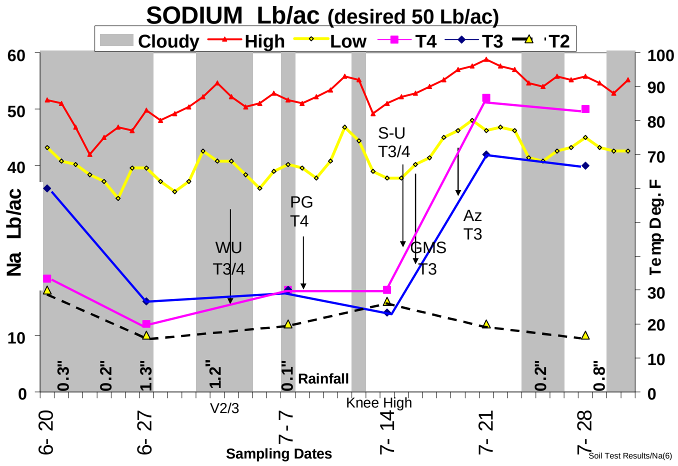


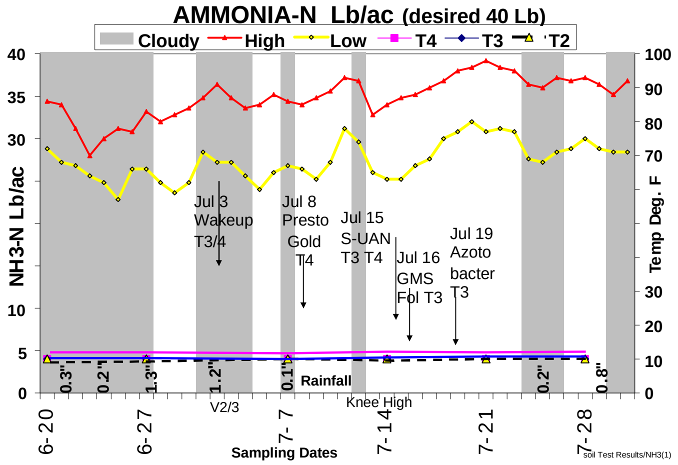
Of the eleven nutrients graphed for the soil tests analyzed by IAL, five had levels that were significantly below IAL's desired test levels:

Ammonia (90% below)
Calcium, (60 to 48% below)
Magnesium, (84 to 82% below)
Phosphorus (63 to 44% below) and
Copper (89 to 44% below).

Meanwhile, five soil parameters were measured as being higher than IAL's desired levels:

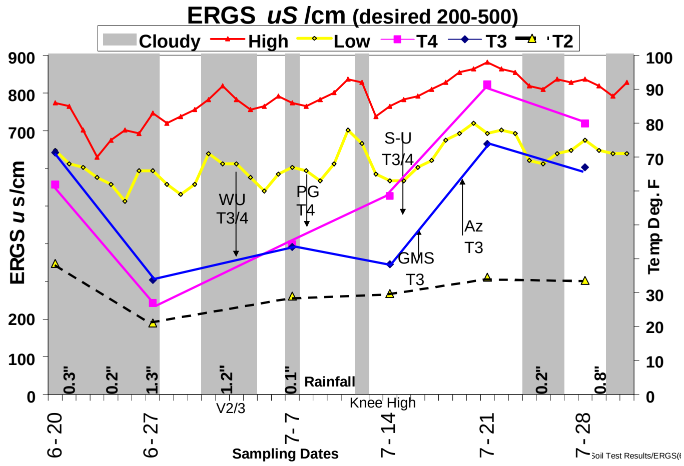
ERGS (5% above)
Formazan (5 to 30% above)
Iron (19 to 365% above)
Potassium (1 to 34% above)
Zinc (5 to 980% above)



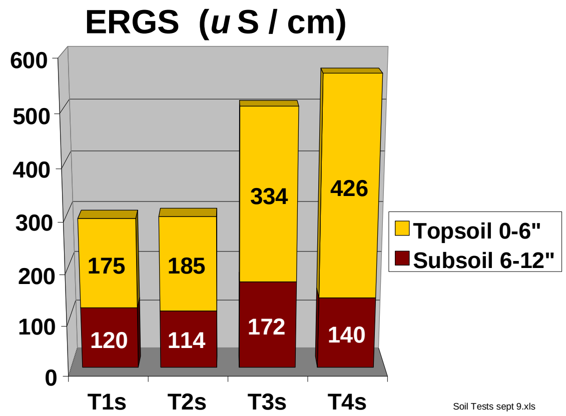


According to the *2012 WakeUP Research Report*, "Our lab and field tests indicate that WakeUP enhances nutrient flow two ways from leaves to growth points: 1. Increases conductivity in soil water and plant nutrient solutions. 2. Reduces the "stickiness" or surface tension of liquids. Recent studies show that variations in soil conductivity explain 40% of variations in crop yields."

By itself, WakeUP has boosted soil conductivity levels by 50 microsiemens as shown on page 9. However, the Ideal Soil treatments appeared to boost levels of soil conductivity by 240 to 500 microsiemens over T2, as shown in the two graphs on the right side of this page.



ERGS energy levels in the soil were also much higher during the first five weeks where mineral amendments were added according to the Ideal Soil calculations in T3&T4. In fact, they tracked very nearly parallel to the trend lines for sodium. Later on in the growing season on September 9 the ERGS values in the topsoil were still 1.9 to 2.4 times higher than for T1 or T2.

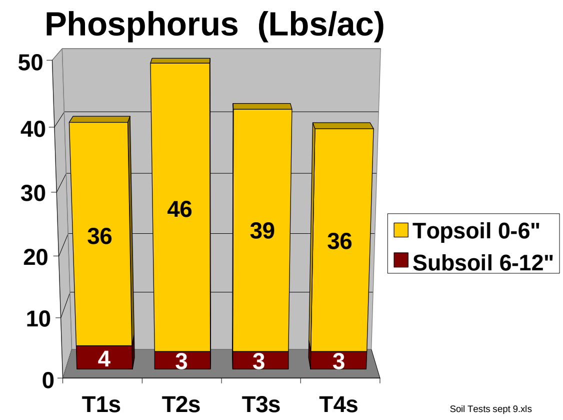


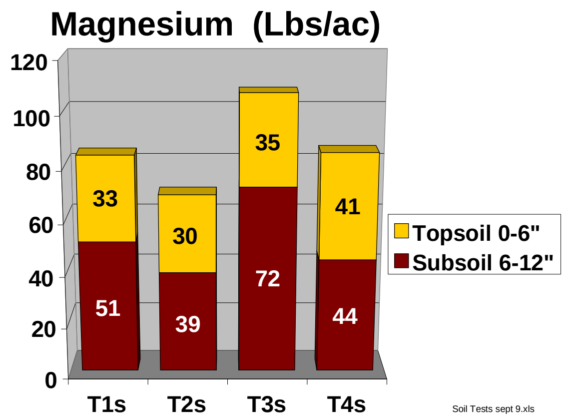
ERGS levels in soil on September 9th.

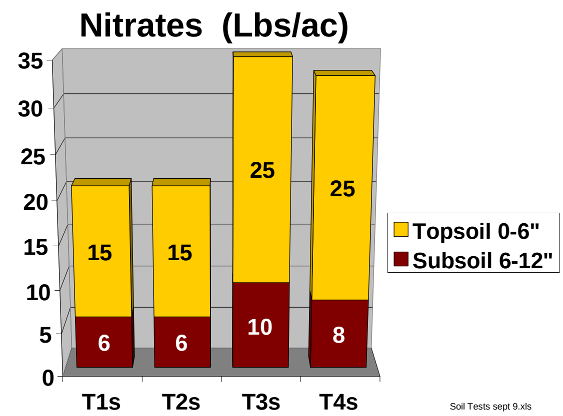
On the following two pages, soil samples from the topsoil 0-6" and subsoil 6-12" were collected on Sept. 9. Nitrates, sodium, copper, zinc and ERGS all had higher levels in the topsoil of the Ideal Soil plots than the Controls. Copper and zinc appeared to be working down below 6 inches to some extent. Subsoils were much lower in humus, copper, zinc, nitrates and potassium than topsoils. These samples were also tested at International Ag Labs using the LaMotte test from the Morgan extracts.

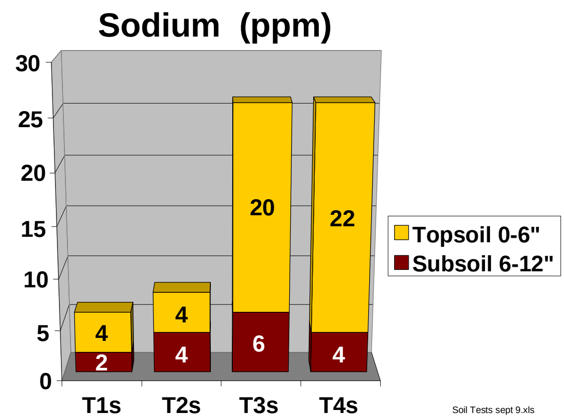
Correlations between adding zinc and copper sulfate and increased levels in the soil and leaf tissue were very strong.

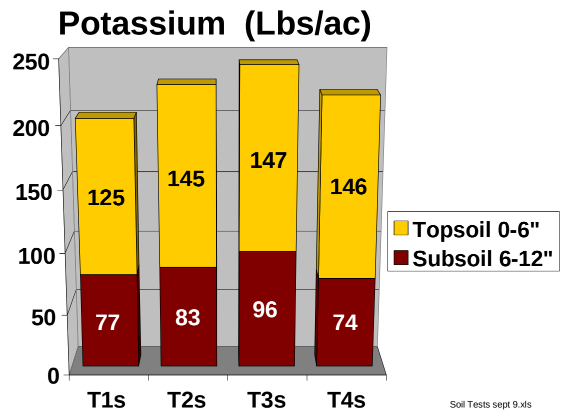
Graphs of Nutrients in Topsoil and Subsoil Sept 9 (Tests performed by International Ag Labs)

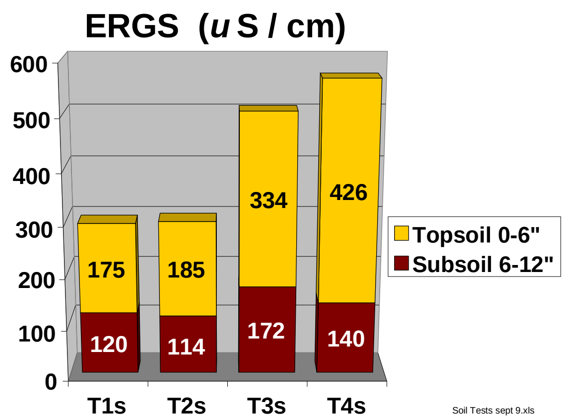


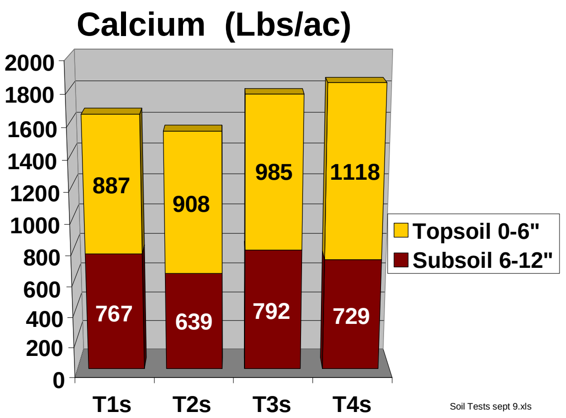


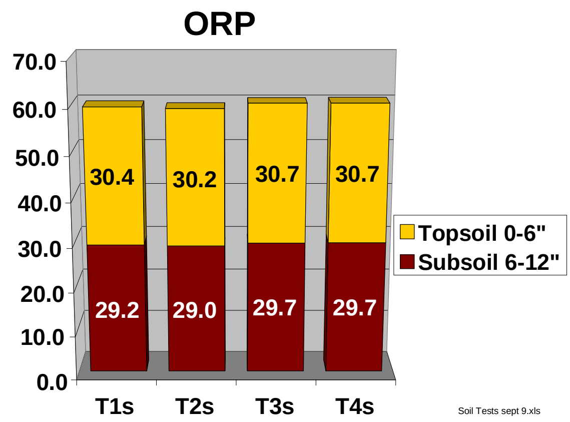


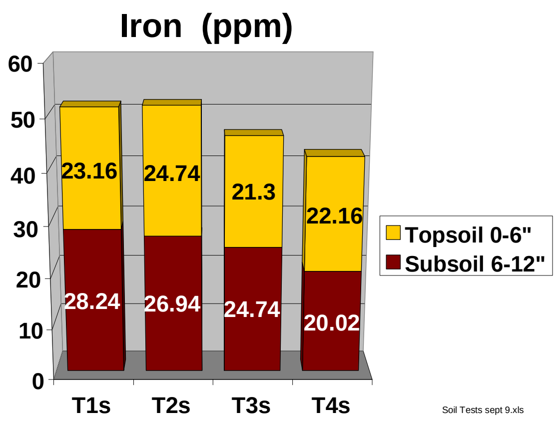


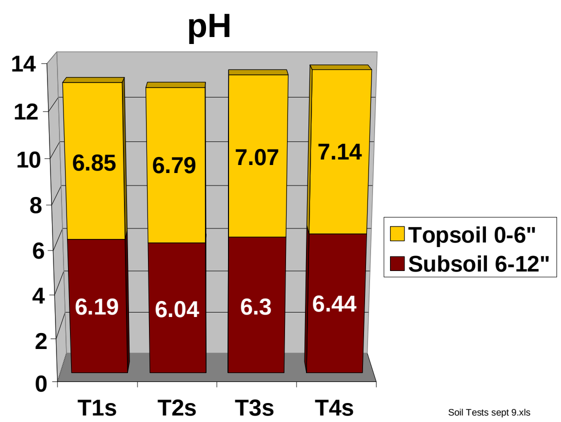


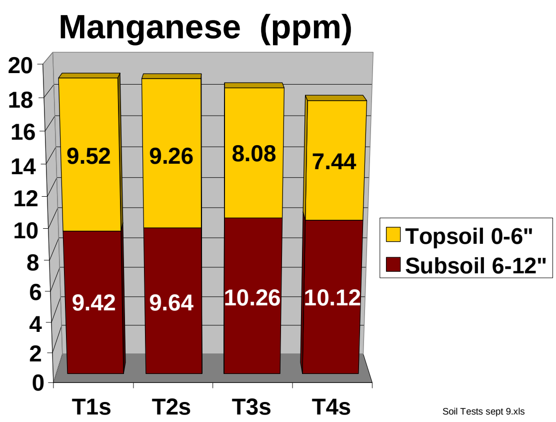


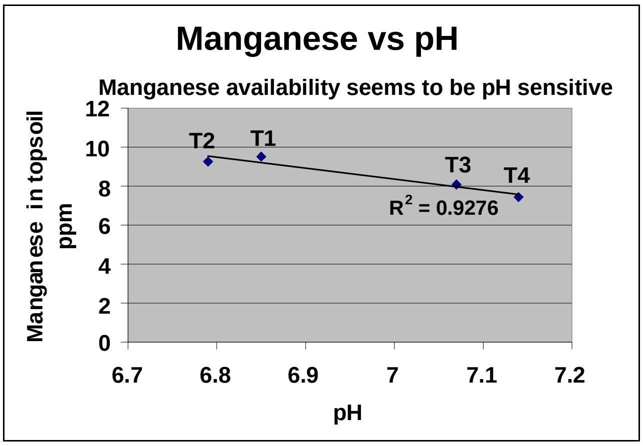


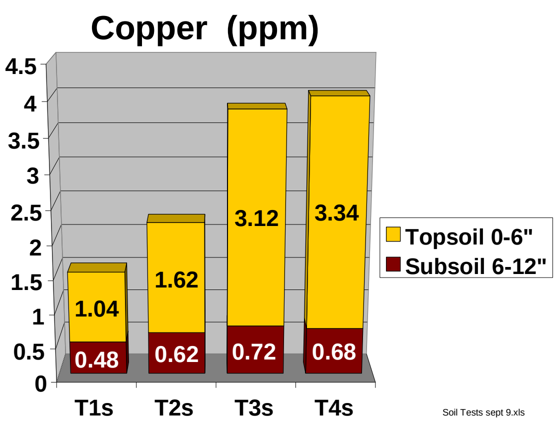


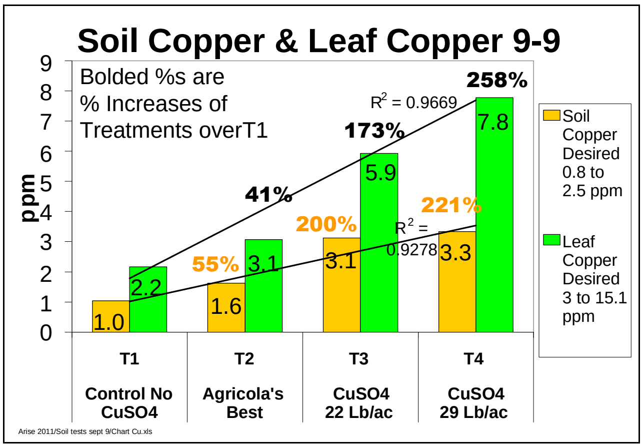

Iron (ppm)
60
50
40
30
20
10
0
23.16
24.74
21.3
22.16
28.24
26.94
24.74
20.02
T1s
T2s
T3s
T4s
Topsoil 0-6"
Subsoil 6-12"
Soil Tests sept 9.xls

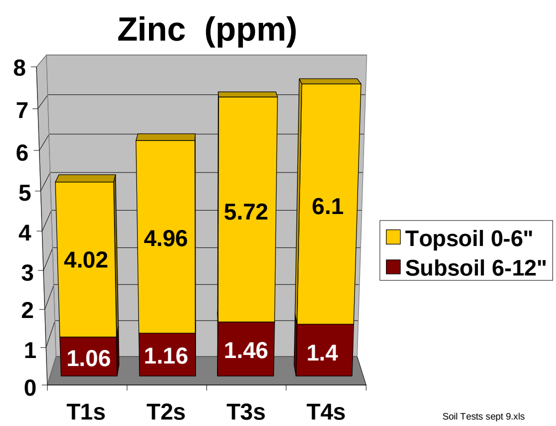

pH
14
12
10
8
6
4
2
0
6.85
6.79
7.07
7.14
6.19
6.04
6.3
6.44
T1s
T2s
T3s
T4s
Topsoil 0-6"
Subsoil 6-12"
Soil Tests sept 9.xls

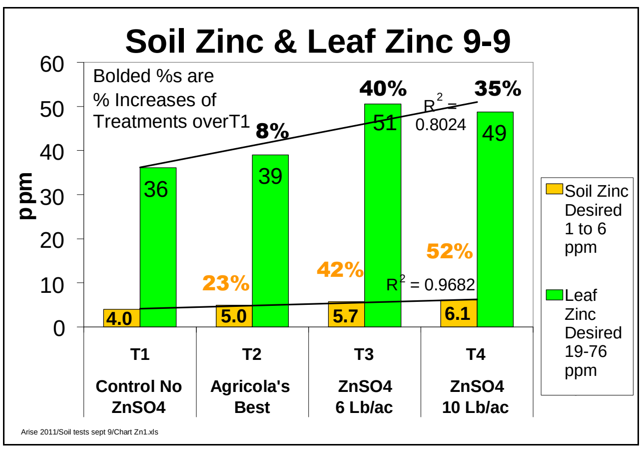

Manganese (ppm)
20
18
16
14
12
10
8
6
4
2
0
9.52
9.26
8.08
7.44
9.42
9.64
10.26
10.12
T1s
T2s
T3s
T4s
Topsoil 0-6"
Subsoil 6-12"
Soil Tests sept 9.xls


Manganese vs pH
Manganese availability seems to be pH sensitive
Manganese in topsoil ppm
12
10
8
6
4
2
0
T2
T1
T3
T4
R2 = 0.9276
6.7
6.8
6.9
7
7.1
7.2
pH


Copper (ppm)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1.04
1.62
3.12
3.34
0.48
0.62
0.72
0.68
T1s
T2s
T3s
T4s
Topsoil 0-6"
Subsoil 6-12"
Soil Tests sept 9.xls


Soil Copper & Leaf Copper 9-9
ppm
9
8
7
6
5
4
3
2
1
0
Bolded %s are
% Increases of
Treatments overT1
R2 = 0.9669
258%
173%
41%
200%
55%
221%
R2 = 0.9278
7.8
5.9
3.1
2.2
1.6
3.1
3.3
1.0
T1
Control No CuSO4
T2
Agricola's Best
T3
CuSO4 22 Lb/ac
T4
CuSO4 29 Lb/ac
Soil Copper Desired 0.8 to 2.5 ppm
Leaf Copper Desired 3 to 15.1 ppm
Arise 2011/Soil tests sept 9/Chart Cu.xls


Zinc (ppm)
8
7
6
5
4
3
2
1
0
4.02
4.96
5.72
6.1
1.06
1.16
1.46
1.4
T1s
T2s
T3s
T4s
Topsoil 0-6"
Subsoil 6-12"
Soil Tests sept 9.xls


Soil Zinc & Leaf Zinc 9-9
ppm
60
50
40
30
20
10
0
Bolded %s are
% Increases of
Treatments overT1
8%
40%
35%
R2 = 0.8024
36
39
51
49
23%
42%
52%
R2 = 0.9682
4.0
5.0
5.7
6.1
T1
Control No ZnSO4
T2
Agricola's Best
T3
ZnSO4 6 Lb/ac
T4
ZnSO4 10 Lb/ac
Soil Zinc Desired 1 to 6 ppm
Leaf Zinc Desired 19-76 ppm
Arise 2011/Soil tests sept 9/Chart Zn1.xls

Minerals in Grain vs. USDA Standard & Others

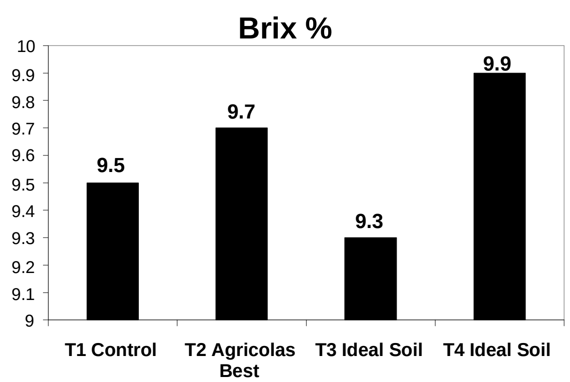
As part of the Nutrient Dense Project, composite shelled corn samples from the 4 treatments were sent to Logan Labs for a fruit test to provide numbers comparable to mineral values in USDA's Standard Nutrient Data Base **NDB No: 20014** for Yellow Corn, (red bar in following graphs). The objective of the Nutrient Dense Project is to see if addition of minerals prescribed by the *Ideal Soil Handbook* would raise the brix of the plants and correspond to increases in minerals in the fruit (corn grain in this case) and to see if those levels would be greater than USDA's standard.

There is nothing like a biological system to throw a curve at what you might expect to happen. This project was no exception. Except for T3 Ideal Soil plots, the Brix of the sap in the stalk just below the ear tended to increase as the amount of minerals added to the soil increased. However, even with no added minerals and low yields, the T1 Control's grain had greater levels of most minerals than the other three treatments; iron and calcium in T3 were notable exceptions. As evidenced by the GDV test that found the kernels to have lower entropy (less chaos), it suggests the three treatments complexed more of the minerals into organic forms which the fruit test's nitric acid could not extract.

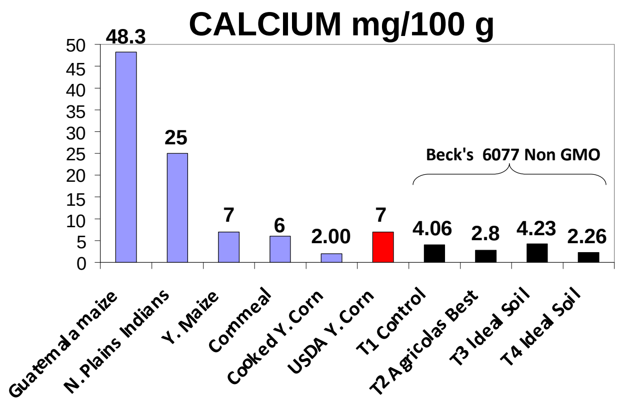
Brix levels followed the pattern T4>T2>T1 and grain mineral contents of Mg, K, P, Mn, Zn and Cu, followed along as T4≥T3≥T2.

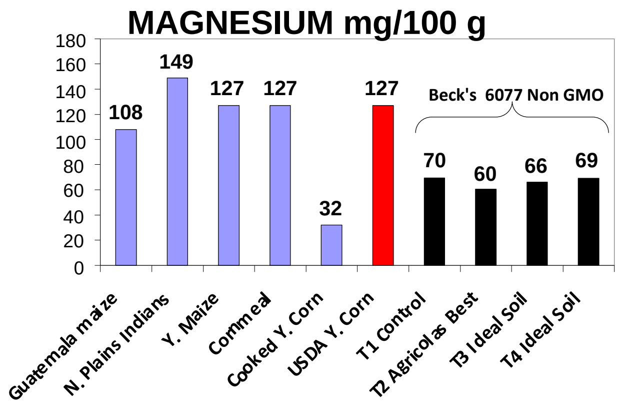
The black bars show all mineral levels of all four treatments (except Mn in T1) were below USDA's reference levels for yellow corn (red bars).

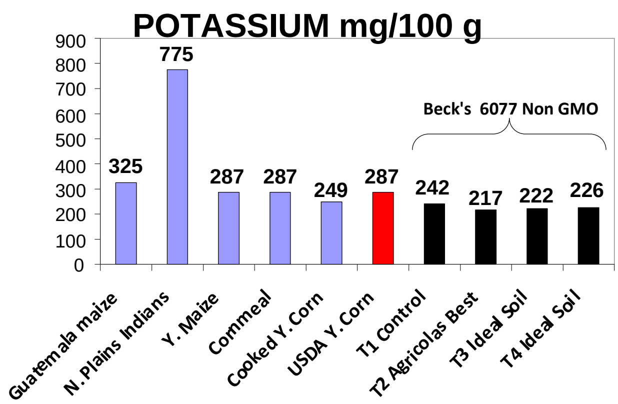
As additional reference points, Guatemala Maize and Dried Yellow Corn of the Northern Plains Indians had much higher levels of minerals than USDA's reference points and than levels in this project.
Cooked corn and cornmeal are also shown.

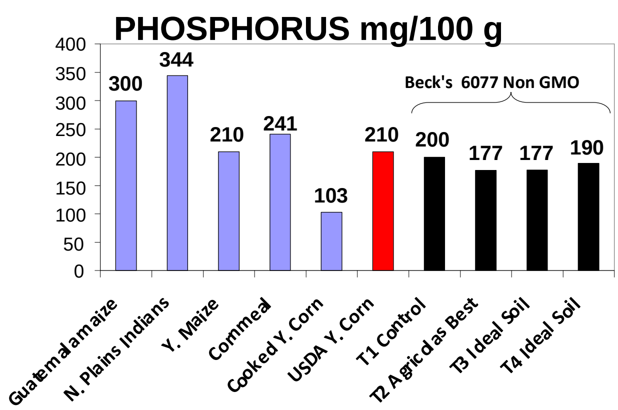


Graphs of Mineral Levels in Corn Grain









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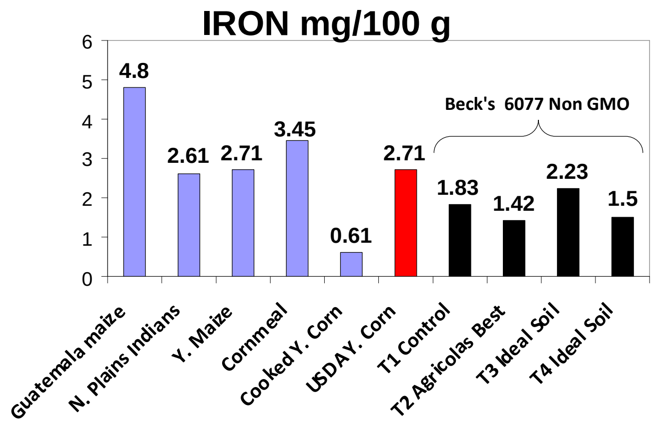
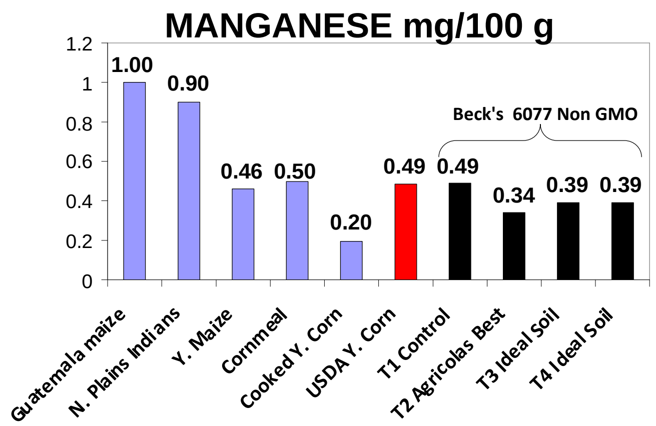
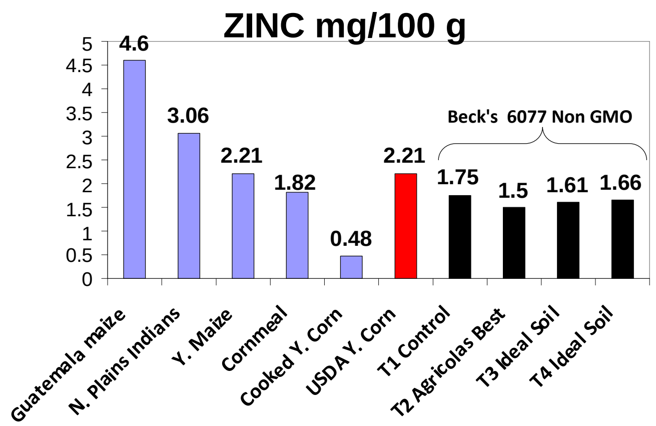
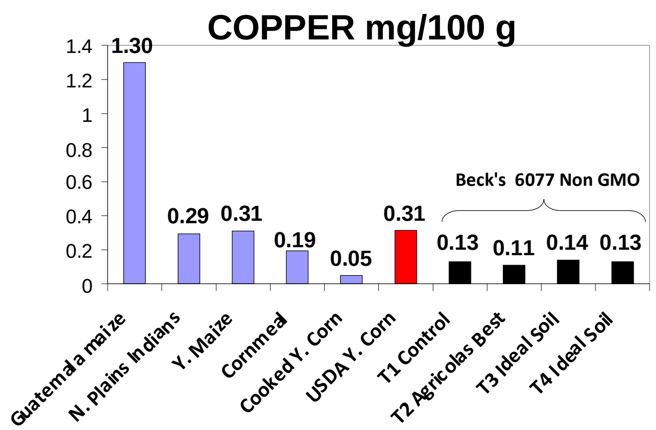


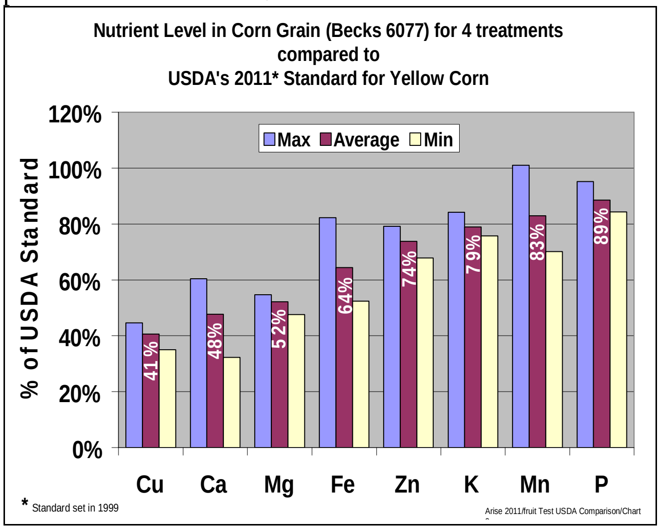






Since the corn was planted June 21 and harvested October 25, it had only 2,359 growing degree days (GDDs). That is 186 GDD less than the 2,545 normally required for this variety to go from emergence to maturity. Had it been planted 3 weeks earlier it would have gotten another 350 GDD, which should have helped increase the minerals in the grain.

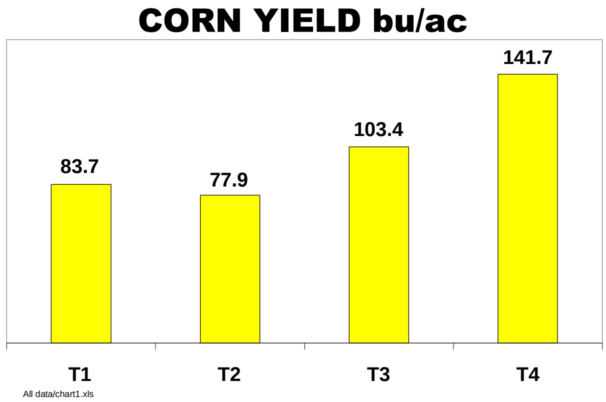
The averages for the 8 nutrients in the 4 treatments found the levels of copper, calcium and magnesium were less than 55 percent of USDA averages for yellow corn. Iron, zinc and potassium were 64, 74 and 79 percent of USDA standards.
Manganese and phosphorus were between 80 and 90 percent of the standard.

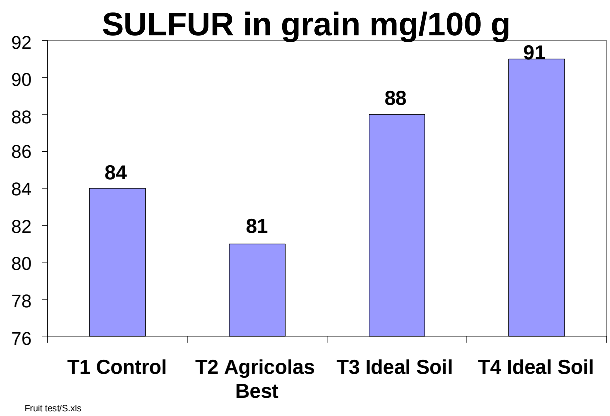


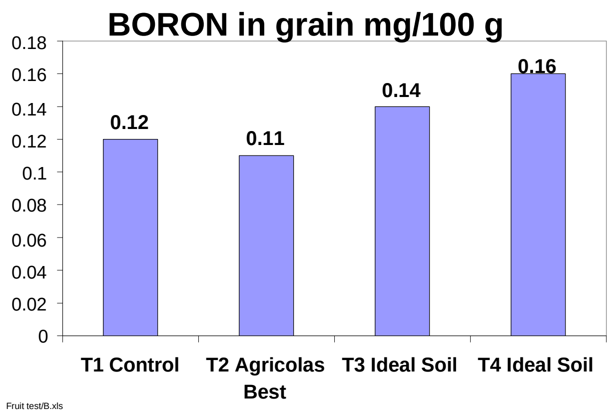
Even though this systems approach shows the grain from the control had higher mineral levels, the T4 Ideal Soil treatments increased yields by 69 to 82 percent over T1 & T2 and had better plant and soil health as measured by tissue tests, energy levels, biological activity in the soil and GDV analysis.

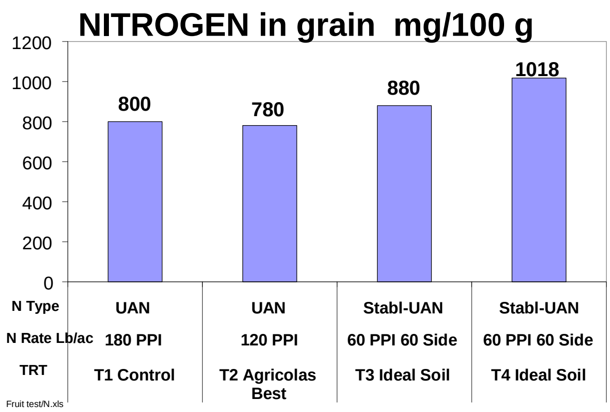
It appears that USDA is using the data generated in 1999 by Loren Cordain as its standard for minerals in yellow corn. If the information generated from Beck's hybrid 6077 for this project is representative of today's hybrids, and soil mineral balances are not improved, then we are guaranteed to see further degradation of plant health and debasement of the mineral value of livestock feed and human food, further encouraging insects and disease. This will cause increased expenditures for herbicides, fungicides, insecticides, mineral additives for livestock feed, and animal and human drugs. It will also cause lower yields and/or retard the rate of yield increase that is needed to support a growing population.

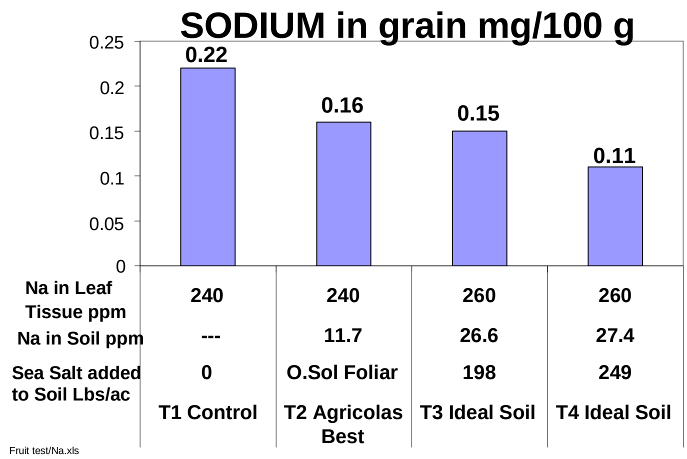
Sulfur, boron and nitrogen in the grain followed the same pattern as yields. However, sodium did the exact opposite.



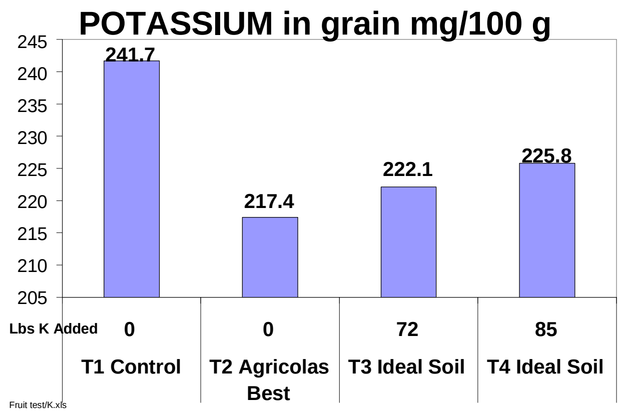


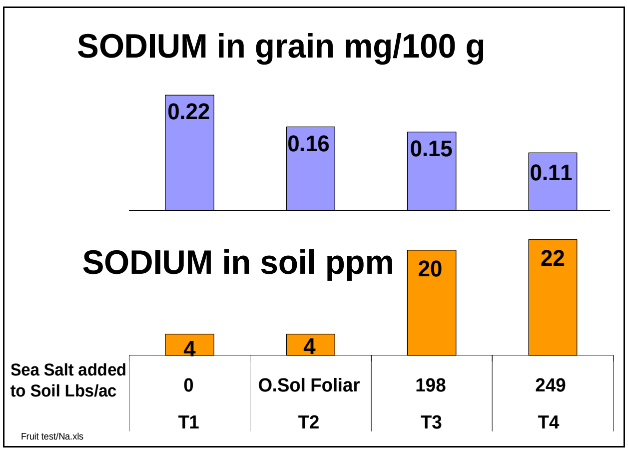






How could 249 Lb/ac of Sea Salt be added to the soil in T4, produce a 134% increase in the sodium in the soil, an 8% increase in the leaf tissue and still have a 31% to 50% decrease of sodium in the corn grain compared to plots T2 and T1 that had no Sea Salt added to the soil? And get a 69 to 82 percent increase in yield (142 bu/ac for T4 vs. 84 and 78 bu/ac for T1 and T2.) Biological processes can transmute sodium into potassium, and K did increase, but some of that could be due to the 72 and 85 Lbs K/ac of potassium sulfate that was added to T3 and T4, or it could be that sodium was incorporated into organic complexes.





Grain Fruit Tests done at Logan Labs

Grain Harvested Oct 25	T1		T2		T3		T4		T4 Increase or Decrease	
	Grain mg per 100 gr	% of Total	Grain mg per 100 gr	% of Total	Grain mg per 100 gr	% of Total	Grain mg per 100 gr	% of Total	vs T1 mg per 100 gr	vs T1 % of Total
Na	0.22	0.016%	0.16	0.012%	0.15	0.010%	0.11	0.007%	-50.0%	-56.1%
Ca	4.06	0.289%	2.8	0.212%	4.23	0.293%	2.26	0.141%	-44.3%	-51.1%
Mn	0.49	0.035%	0.34	0.026%	0.39	0.027%	0.39	0.024%	-20.4%	-30.1%
Fe	1.83	0.130%	1.42	0.107%	2.23	0.155%	1.5	0.094%	-18.0%	-28.0%
K	241.7	17.218%	217.4	16.441%	222.1	15.398%	225.8	14.120%	-6.6%	-18.0%
P	200	14.247%	177	13.386%	177.4	12.299%	189.5	11.850%	-5.3%	-16.8%
Zn	1.75	0.125%	1.5	0.113%	1.61	0.112%	1.66	0.104%	-5.1%	-16.7%
Mg	69.5	4.952%	60.5	4.573%	66.0	4.576%	69.2	4.328%	-0.4%	-12.6%
Cu	0.13	0.009%	0.11	0.008%	0.14	0.010%	0.13	0.008%	0.0%	-12.2%
Sulfur	84	5.984%	81	6.126%	88	6.101%	91	5.690%	8.3%	-4.9%
N	800	56.988%	780	58.988%	880	61.009%	1,018	63.626%	27.2%	11.6%
Boron	0.12	0.009%	0.11	0.008%	0.14	0.010%	0.16	0.010%	33.3%	17.0%
Tot Minerals mg/100 gr	1403.81	100.0%	1322.31	100.0%	1442.4	100.0%	1599.2	100.0%	13.9%	
Weight per Kernel gr	0.37		0.37		0.38		0.45		21.6%	
Ca Mg K Na in grain	315.49		280.83		292.48		297.38			
Anions S B N in grain	884.12		861.11		968.14		1108.7			
Total other in grain	204.2		180.37		181.77		193.18			
Total Nutrients in Grain	1403.8		1322.3		1442.4		1599.2			

Absolute values for Ca, Mg, Fe and Mn in the grain were less for T4 than T1, but Na, K, P and Zn also were lower in the T4 grain compared to T1 Control. While the total decrease of 29.4 mg/100 grams for Ca Mg K Na plus “others” was rather small, the percentage decreases were large (Na down 50%, Ca down 44%, Mn down 20% and Fe down 18%). Only sulfur, nitrogen and boron increased in the grain for T4 over T1. Of the 195 mg/100 grams net increase in nutrients in the grain, nitrogen accounted for 217.5 mg/100 grams or 112 percent of the net increase. Boron increased by 33% which is a huge move considering its low starting value for T1.

Sodium was most interesting as it steadily declined across all three treatments compared to T1 even though each of the three treatments added successively more sea salt to the soil.

The anions sulfur, boron and nitrogen apparently replaced some of the four major cations, as well as some of the other minerals.

One theory of why the control (T1) had higher concentration of minerals in the grain was that it produced smaller ears and less yield, so the minerals would be more concentrated, while the minerals in the higher yielding treatments would be more dilute. That theory was shattered when sulfur, boron and nitrogen all increased in concentration as yield increased.

An increase of 13.9 percent in the total weight of nutrients per 100 grams of corn resulted for T4 over the Control. Apparently, this hybrid liked the balanced mineral blend created by the Ideal Soil treatment system. Again, the key word is “System”.

Fall Cornstalk N Test

1,070 N mg/Kg 38 bu/ac

While this Control plot would be in the Optimum range for the Fall Cornstalk N test, it only yielded 38 bu/ac. It was supposed to have had 180 Lbs N applied preplant incorporated (PPI). It is possible that the applicator malfunctioned or was not turned on.

768 N mg/Kg 119.5 bu/ac

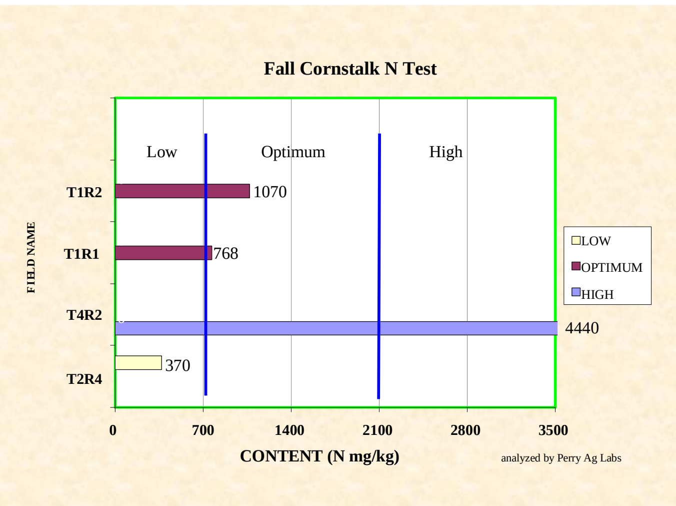
In Optimum range, but yielded only 119.5 bu/ac on its 180 LbN/ac. It yielded 3X more than T1R2, but was still 36.5 bu/ac less than theT4R2 plot.

4,440 N mg/Kg 156 bu/ac

Considered in the excessive range, i.e. the crop had more nitrogen than it needed even though it had 33 percent less total nitrogen applied with 60 Lbs Stabl-UAN PPI and 60 Lbs Stabl-UAN sidedressed than the T1 Controls at 180 LbN/ac UAN PPI. Counting the 44 LbN/ac of MAP, T3&T4 had only 9% less N than T1. T4R2 had a 9% and 28% increase in stalk diameter and a 19% and 63% increased stalk basal area compared to T1R1 and T1R2.

370 N mg/Kg 116 bu/ac

This is in the low range for cornstalk N. In other words, it could have used more nitrogen than the 120 LbN/ac UAN that was applied PPI.



According to Iowa State University, "Corn plants suffering from inadequate N availability remove N from the lower cornstalks and leaves during the grain-filling period. Corn plants that have more N than needed to attain maximum yields, however, accumulate nitrate in their lower stalks at the end of the season." Small increases in rates of fertilization that increase yield with little or no increase in stalk nitrate concentration response indicate that supplies of available N were limiting plant growth at the end of the season. An increase in stalk nitrate concentration with little or no increase in yield indicates that supplies of available N were not limiting growth during this period.

In our case, T2R4 with 120 LbN/ac of UAN PPI did not have enough N. But T4R2 had more than enough N from split applications of structured Stabl-UAN that also totaled 120 LbN/ac (along with a balanced mineral budget.) Its next door neighbor T1R1 looks like it was close to running out of nitrogen even though it had 180 LbN/ac UAN PPI. It begs the question: How could T4R2 produce 36.5 more bu/ac than T1R1 and exhibit excess stalk nitrogen on 60 Lb/ac less N? Was it due to Presto Gold, structured Stabl-UAN, WakeUP, Bio-Gold, MAP, the balanced minerals? Could less be used?

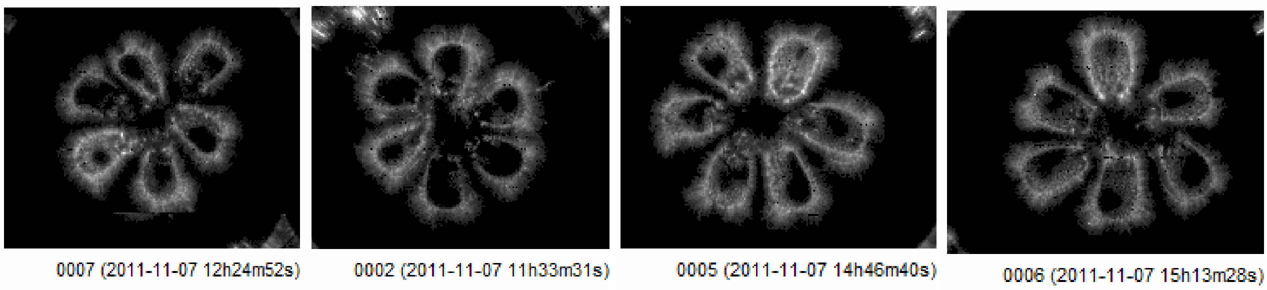
Photo Sept 9, 2011 of representative ears from all 12 plots. All 12 ears were showing some ear worm damage.

Photo Aug 23, 2011 of representative ears from all 12 plots.

Average ear weights (fresh wt)

	T1s	T2s	T3s	T4s	(T4 % Increase vs T1,T2,T3)
Aug 23	**35 gr**	**42 gr**	**77 gr**	**113 gr**	**(222%, 169%, 46%)**
Sept 9	**230 gr**	**165 gr**	**230 gr**	**275 gr**	**(20%, 67%, 20%)**
Oct 25	**221 gr**	**200 gr**	**281 gr**	**326 gr**	**(48%, 63%, 16%)**
Oct 25 Yield	**84 bpa**	**78 bpa**	**103 bpa**	**142 bpa**	**(69%, 82% 37%)**

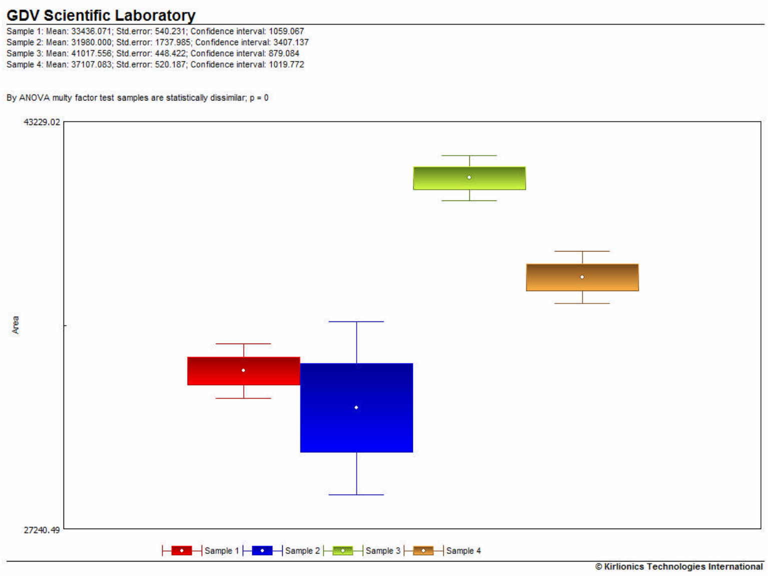
Gas Discharge Visualization (GDV) Tests Ears from which seeds were taken for the GDV tests.

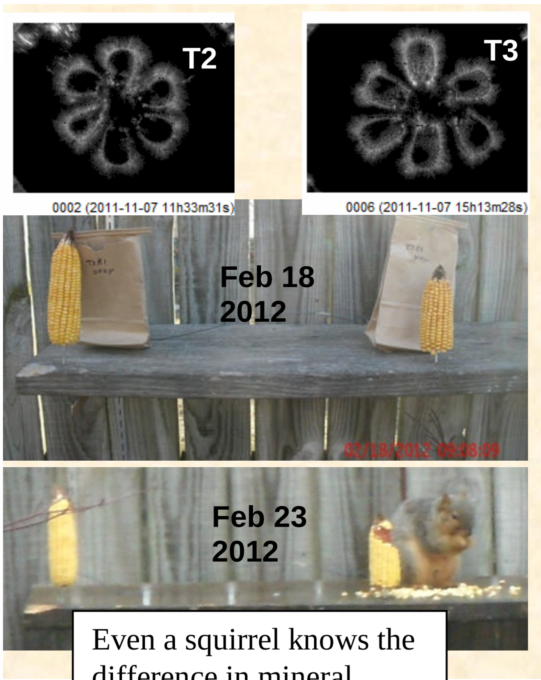


	T1	T2	T3	T4	
Area Pixels	33,436	31,980	41,017	37,107	(higher is better)
Avg Intensity	63.8	68.2	74.6	68.4	(higher is better)
Entropy	4.6	4.6	4.3	4.5	(lower is better)
Kernel wt. grams	0.37	0.37	0.38	0.45	
Avg. Yield bu/ac	83.7	77.9	103.4	141.7	

Gas Discharge Visualization (GDV) Images Energy emitted from these 6 kernels from one ear from each plot pictured above was dissimilar at p=0, indicating that T3 and T4 samples were better quality grain as they showed more pixels (bigger seeds), higher average intensity (biophotons) and lower entropy (less chaos).
GDV images by Krishna Madappa, Taos, NM.[1]

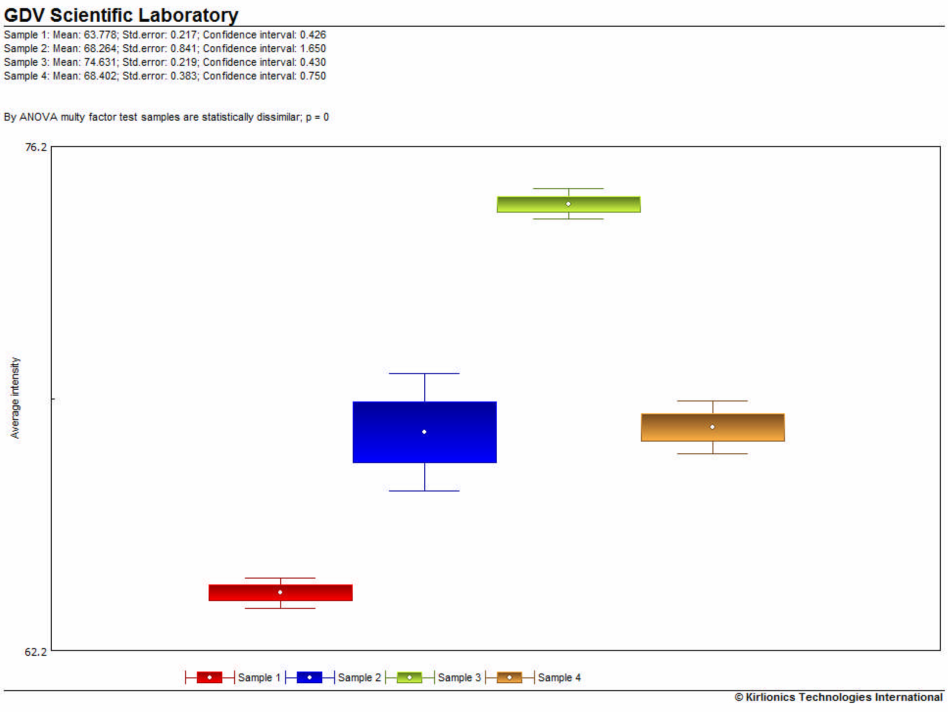
GDV Area Pixels.



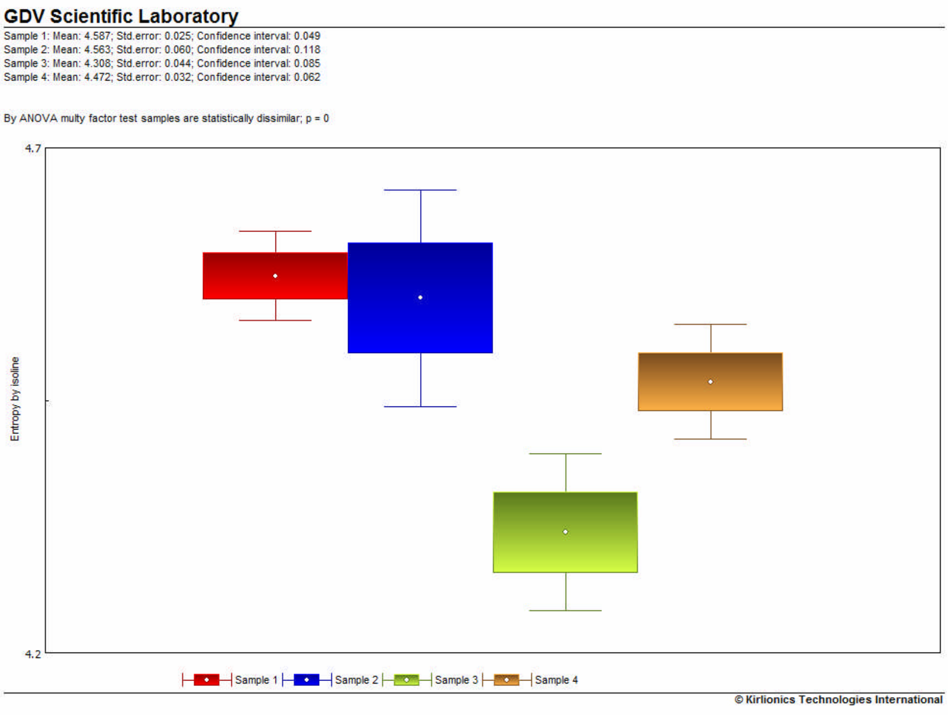


Even a squirrel knows the difference in mineral density between T2 & T3

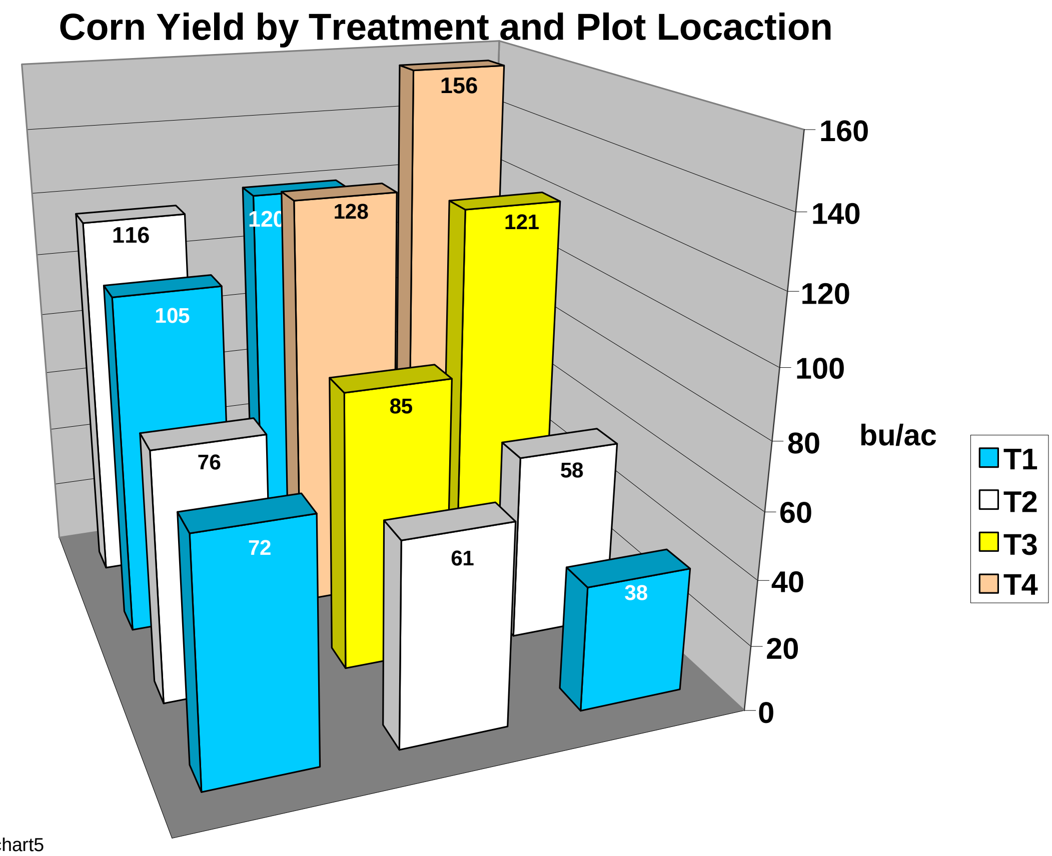
GDV Average Intensity (Biophotons)



GDV Entropy by Isoline (Chaos)



Entropy (chaos) is a measure of organization within a living system. Lower the numbers indicate that the cells are more organized and therefore have more life in them



All Data/chart5

The striping in the leaves of the young plants represents either a manganese and/or sulfur deficiency. We did not measure sulfur in the tissue, but Manganese was measured on July 6.

T1	T2	T3/T4
41.8	19.6	34.6 ppm Mn

The sufficiency range for manganese in tissue was 19 to 75 ppm and the T2 sample was at the very low end of the range. T2 yielded consistently low. Also, Midwest Labs' cut off point is 80 ppm Mn, which it uses as the point below which the samples are considered deficient at this growth stage.

The tables on the next two pages show the amount of element added and the results of nutrient tests in soil, tissue and grain averaged for the four treatments. Availability of the soil nutrients to the roots was measured with the LaMotte test using the Morgan Extract from soil samples taken weekly for the first 5 weeks after planting. Soil nutrient reserves were measured once with the Mehlich 3 method from soil samples taken immediately after harvest. T4 Ideal Soil results were compared against T2 Agricola's Best Minerals plots and against T3's results because all three treatments had a total of 120 LbN/ac applied and because the Control T1 did not have soil samples pulled from it during the first 5 weeks.

Numbers for the amount of element added in the spring of 2011 were based on the percentage of that element contained in the product that was used to amend the soil, (for example, 1,000 Lbs/ac of gypsum was applied, but only 220 Lbs/ac of calcium is reported to be added since gypsum is only 22 percent calcium.)

Soil Tests Averaged from June 20 thru July 28 plus Sept 8. Tissue Sept 9 at R1-R2. Grain Oct 25							**T4 Increase**		
	T1	**T2**	**T3**	**T4**	**Units**	**Measured**	**vs T1,**	**vs T2,**	**vs T3**
Ammonia-N	-NA-	4.0	4.0	4.3	Lbs/ac	Soil		7.1%	7.1%
Calcium as Gypsum		---	220	220	Lbs/ac	Element Added			
Calcium Band as Hi Cal Lime		---	88	88	Lbs/ac	Element Added			
Calcium Broadcast in Hi Cal Lime			350	350	Lbs/ac	Element Added			
Ca	---	1208	1374	1549	Lbs/ac	Soil Availability		28.2%	12.7%
Ca	1792	1862	1803	2072	Lbs/ac	Soil Reserve	15.6%	11.3%	14.9%
Ca %	0.59	0.53	0.60	0.49	%	Tissue	-17.6%	-7.7%	-18.1%
Ca	4.06	2.8	4.23	2.26	mg/100 gr	Grain	-44.3%	-19.3%	-46.6%
Magnesium in MgO	---	---	82	143	Lb/ac	Element Added			74.4%
Mg	-NA-	70	71	76	Lbs/ac	Soil Availability		8.1%	6.8%
Mg	181	175	187	178	Lbs/ac	Soil Reserve	-1.8%	1.7%	-5.1%
Mg%	0.25	0.25	0.17	0.17	%	Tissue	-34.2%	-33.0%	-3.6%
Mg	69.5	60.5	66.0	69.2	mg/100 gr	Grain	-0.4%	14.5%	4.9%
Potassium in K2SO4	---	---	72	85	Lbs/ac	Element Added			18.1%
K	-NA-	169	207	224	Lbs/ac	Soil Availability		32.8%	8.0%
K	275	255	289	273	Lbs/ac	Soil Reserve	-0.8%	7.0%	-5.5%
K %	1.98	2.44	2.39	2.29	%	Tissue	15.6%	-6.0%	-4.1%
K	241.7	217.4	222.1	225.8	mg/100 gr	Grain	-6.6%	3.9%	1.7%
Sodium in Sea Salt	---	---	69	87	Lb/ac	Element Added			26.1%
Na	-NA-	11.7	26.6	27.4	ppm	Soil Availability		134.1%	3.2%
Na	29	26.5	33.0	31.5	Lb/ac	Soil Reserve	8.6%	18.9%	-4.5%
Na	240	240	260	260	ppm	Tissue	8.3%	8.3%	0.0%
Na	0.22	0.16	0.15	0.11	mg/100 gr	Grain	-50.0%	-31.3%	-26.7%
P as MAP	---	---	91	91	Lb/ac P	Element Added			0.0%
P	-NA-	64	63	97	Lbs/ac	Soil Availability		51.3%	55.2%
P	162	152	141	147	Lbs/ac	Soil Reserve	-9.4%	-3.4%	4.3%
P %	0.19	0.19	0.25	0.25	%	Tissue	35.9%	36.3%	0.1%
P	200	177	177.4	189.5	mg/100 gr	Grain	-5.3%	7.1%	6.8%
Iron in FeSO4	---	30	0	0		Element Added			
Fe	-NA-	37	38	37	ppm	Soil Availability		1.8%	-1.0%
Fe	222	217	204	220	ppm	Soil Reserve	-1.0%	1.4%	7.6%
Fe	97	84	113	91	ppm	Tissue	-6.4%	8.9%	-19.7%
Fe	1.83	1.42	2.23	1.5	mg/100 gr	Grain	-18.0%	5.6%	-32.7%
Manganese in MnSO4	---	15	22	29	Lbs/ac	Element Added		93.3%	31.8%
Mn	-NA-	7.3	6.6	6.1	ppm	Soil Availability		-16.2%	-8.1%
Mn	76	79	85	83	ppm	Soil Reserve	8.2%	4.1%	-2.4%
Mn	59	54	52	46	ppm	Tissue	-21.6%	-15.1%	-10.7%
Mn	0.49	0.34	0.39	0.39	mg/100 gr	Grain	-20.4%	14.7%	0.0%
Copper in CuSO4	---	3	5.5	7.5	Lbs/ac	Element Added		150.0%	36.4%
Cu	-NA-	2.8	5.0	5.6	ppm	Soil Availability		100.0%	11.5%
Cu	1.8	2.6	4.7	4.1	ppm	Soil Reserve	132.5%	59.3%	-11.9%
Cu	2.2	3.1	5.9	7.8	ppm	Tissue	258.8%	153.3%	31.2%
Cu	0.13	0.11	0.14	0.13	mg/100 gr	Grain	0.0%	18.2%	-7.1%
Zinc in ZnSO4	---	5.3	2.1	3.5	Lbs/ac	Element Added		-33.3%	66.7%
Zn	-NA-	6.3	8.1	10.8	ppm	Soil Availability		71.8%	33.2%
Zn	7.5	8.0	8.9	9.1	ppm	Soil Reserve	20.6%	12.9%	2.0%
Zn	36.1	39.0	50.6	48.7	ppm	Tissue	34.9%	24.9%	-3.7%
Zn	1.75	1.5	1.61	1.66	mg/100 gr	Grain	-5.1%	10.7%	3.1%
pH	-NA-	7.1	7.0	7.1		Soil		0.7%	1.3%
pH	6.3	6.3	6.3	6.2		Tissue	-1.4%	-2.7%	-2.4%
pH	7.1	7.2	7.2	7.0		Soil Reserve	-1.8%	-2.4%	-2.8%
Boron	---	2.25	2.4	3.1	Lbs/ac	Element Added		37.8%	29.2%
Boron	0.12	0.11	0.14	0.16	mg/100 gr	Grain	33.3%	45.5%	14.3%
Boron	0.54	0.58	0.70	0.82	ppm	Soil Reserve	53.3%	42.6%	17.1%
Ag Sulfur	---	---	57.6	67.5	Lbs/ac	Element Added			17.2%
Sulfur	84	81	88	91	mg/100 gr	Grain	8.3%	12.3%	3.4%
Sulfur	14.5	14	28	31	ppm	Soil Reserve	113.8%	121.4%	10.7%

Soil Tests Averaged from June 20 thru July 28 plus Sept 8. Tissue Sept 9 at R1-R2. Grain Oct 25	**T1**	**T2**	**T3**	**T4**	**Units**	**Measured**	**T4 Increase vs T1,**	**vs T2,**	**vs T3**
Formazan	-NA-	778	631	813	ppm	Soil		4.6%	28.9%
ERGS	-NA-	267	469	528	*u* S/cm	Soil		97.9%	12.4%
SUGAR	26.0	24.0	30.0	32		Tissue	23.1%	33.3%	6.7%
Chlorophyll July 6	32.6	31.3	33.2	36.0	%	Leaf	10.4%	15.0%	8.6%
Chlorophyll Aug 18	47	43.1	57.2	56.2	%	Leaf	19.6%	30.4%	-1.7%
Chlorophyll Sept 9	31.8	31.6	50.3	50.8	%	Leaf	59.7%	60.8%	1.0%
Stalk Brix	9.5	9.7	9.3	9.9	%	Stalk	4.2%	2.1%	6.5%
NO3-N	-NA-	22.9	32.9	37.1	Lbs/ac	Soil		62.5%	13.0%
N %	1.12	1.23	2.16	2.00	%	Tissue	79.4%	62.5%	-7.5%
# of Leaves Fired 9-9	4.6	4.6	3.3	2.0	#	Leaves on Stalk	-56.8%	-56.8%	-38.5%
N	800	780	880	1,018	mg/100 gr	Grain	27.2%	30.4%	15.6%
Fall Cornstalk N	919	370	---	4,440	N mg/kg	Stalk	383.1%	1100.0%	
GDV Area	33,436	31,980	41,017	37,107	Area Pixels on 6 corn seeds		11.0%	16.0%	-9.5%
GDV Light Intensity	63.8	68.3	74.6	68.4	BioPhotons on 6 corn seeds		7.2%	0.1%	-8.3%
GDV Entropy	4.59	4.56	4.30	4.49	Chaos on 6 corn seeds		-2.2%	-1.5%	4.4%
Population (K)	25.5	22.75	25.5	26.5	1,000 plants/ac		3.9%	16.5%	3.9%
Weeds (Fresh Wt)	3.3	2.0	3.2	1.3	Tons/ac		-62.1%	-36.4%	-60.1%
Compaction									
Non Wheel Track	1.33	-NA-	-NA-	2.47	Depth to compaction, Inches		85.7%		
MC%	35.7	36.6	39.1	37.5	%MC at Harvest Oct 25		5.2%	2.5%	-4.1%
MC%	31.3	28.4	34	30.7	%MC Nov 2 at Lab		-1.9%	8.1%	-9.7%
Weight per Kernel	0.37	0.37	0.38	0.45	grams	Grain	21.6%	21.6%	18.4%
Yield rep 1	120	61	85	128	bu/ac		6.7%	109.8%	50.6%
Yield rep 2	38	58	121	156	bu/ac		310.5%	169.0%	28.9%
Yield rep 3	72	76	---	---	bu/ac				
Yield rep 4	105	116	---	---	bu/ac				
Avg Yield Bu/ac at 15% MC	**83.7**	**77.9**	**103.4**	**141.7**	**bu/ac**		69.3%	81.9%	37.0%

T4R2

T3R2

T2R2

T1R2

Weeds: Weeds were hand hoed from all 12 plots on September 8, 2011. Weeds from between rows two and three from six of the plots were weighed. Plots are 40 feet long. Three out of four of the Ideal Soil plots (T4-T3) had less weed pressure than Treatments T2 &T1. Fresh weight of the weeds outweighed the harvested dry grain weight in treatments T1, T2 and in one of the two T3 plots. Only in three of the four Ideal Soil plots did the grain outweigh the weeds. Early corn growth helped shade out weeds in T3R2. Most of the weeds were Wild Proso Millet, which likes to grow in calcium deficient soils. The extra calcium in the lime and gypsum we applied in T3 & T4 undoubtedly had an effect in reducing the amount of these weeds.[2]

Soil Tests after Harvest: Soil samples were collected after harvest and analyzed with the Mehlich 3 test. The average nutrient values for Fe, Mn, K, Ca, and Mg appear to be more than adequate for satisfying the nutrient balance given that the Total Cation Exchange Capacity of the 12 plots averaged a very low 6.11 M.E. and OM averaged 1.78%. Of the four main cations (Ca, Mg, K & Na), potassium appears to be quite a bit higher than desired. Meanwhile, as a percent of the desired level, six other nutrients were found to be well below the amount required to be in balance according to the *Ideal Soil Handbook*. Those six ranged from 87 percent of the desired level for Zn down to 35 percent of the desired level for Phosphorus, as seen in the table below.

Mehlich 3 soil test averages on October 25th for the 12 plots.

	Avg	Min	Max	Comments
TCEC	**6.11**	**5.43**	**7.01**	Quite Low, would ideally like it above 15
pH	**7.13**	**6.9**	**7.4**	A little high, would like it close to 6.5 to 6.8
OM%	**1.78**	**1.05**	**2.11**	Quite Low, would ideally like 4 to 5% OM.

Average Found Value as % of Average Desired Level

Fe	**216%**	May interfere with Mn availability
Mn	**159%**	
K	**144%**	Higher than would be preferred
Ca	**112%**	Close to the desired level, given the TCEC
Mg	**103%**	Close to the desired level given the TCEC
Zn	**87%**	Needs some additional amendments
B	**67%**	Needs considerable amount of amendments
Cu	**61%**	Needs considerable amount of amendments
Na	**52%**	Needs considerable amount of amendments
S	**41%**	Needs considerable amount of amendments
P	**35%**	Needs considerable amount of amendments

Worksheet Oct 25/sheet1

Amount of products needed to balance soil minerals in 2012.
Looking ahead to the spring of 2012, soil samples taken immediately after harvest were analyzed with the Mehlich 3 procedure and results run through the *Ideal Soil Handbook* calculations which generated the results shown below for the amount of product needed to balance the nutrients in each plot.

Product	T1R1 Product Needed Lb/ac	T1R2 Product Needed Lb/ac	T1R3 Product Needed Lb/ac	T1R4 Product Needed Lb/ac	T2R1 Product Needed Lb/ac	T2R2 Product Needed Lb/ac	T2R3 Product Needed Lb/ac	T2R4 Product Needed Lb/ac	T3R1 Product Needed Lb/ac	T3R2 Product Needed Lb/ac	T4R1 Product Needed Lb/ac	T4R2 Product Needed Lb/ac
MAP 11-52-0	449	470	638	415	645	563	475	429	499	589	671	587
Supercal 98G	0	0	0	0	0	0	0	0	0	0	0	0
MgO 50% Mg	0	0	51	0	9	0	0	28	0	12	60	0
Potassium 51% K2OSulfate 17.5%	0	0	0	0	0	0	0	0	0	0	0	0
Sea Salt 35% Na	65	46	117	60	108	64	66	92	56	70	107	64
Borax 9%	5	5	14	7	11	6	7	8	4	5	5	5
Iron 30% Sulfate18%	0	0	0	0	0	0	0	0	0	0	0	0
Manganese 32% Sulfate 19%	0	0	0	0	0	0	0	0	0	0	0	0
Copper25% Sulfate 12.5%	23	18	30	19	22	10	17	20	0	4	19	0
Zinc 35% Sulfate 17%	11	5	22	0	15	2	12	2	0	8	23	0
Ag Sulfur	65	58	77	60	77	68	61	72	36	44	35	52

For 2012, Plots T3&T4 are generally calling for less boron, copper, zinc, sulfur and sea salt as a result or of mineral treatments that were applied in the spring of 2011.

Coefficients of determination (*r* squares) were calculated for the averages of 79 nutrients and other factors as they related to average corn yield per/acre. They were calculated for:

- Element Added--the poundage of elements added to the soil from the various nutrients and products in April, May and June
- Soil Availability-- the average availability of soil nutrients found in the first five weeks plus the soil test in September as measured with the LaMotte tests for composite samples from each treatment.
- Soil Reserve--soil test results from after harvest with the Mehlich 3 test (one sample tested from each plot and then averaged for the treatment).
- Tissue-- tests of leaf tissue at growth stage R2 from composite samples from each treatment
- Grain-- nutrient concentrations in grain from composite samples from each treatment.

Results ranged from no correlation to an *r* squared of 1.0000 and fell into three basic groups. At the low end, 30 parameters had *r* squares from 0 to 0.4900. Twenty parameters had *r* squares of between 0.5000 to 0.7400. Twenty-nine parameters had *r* squares of > 0.7500.

Eight of the twelve nutrients measured in the grain had very weak correlations with yield. Sodium was in the middle group. However, concentrations of boron, sulfur and nitrogen in the grain were highly correlated with yield with r squares of r^2 = 0.8882, r^2 = 0.9542, r^2 = 0.9993, respectively.

It seemed more likely that an individual nutrient would actually have an effect on yield if several of its parameters were highly correlated with yield. Boron, copper, manganese, nitrogen, and sulfur all had 3 parameters that were highly correlated with yield, as shown in the table below.

While manganese was highly correlated, only the Element Added was positively correlated with yield, in other words, yield increased as the amount of Mn added to the soil increased. However, Soil Availability of Mn and Tissue testing were negatively correlated, so that as concentrations of these decreased, yield actually increased.

High Coefficients of Determination (*r* squares) for Boron, Copper, Manganese, Nitrogen and Sulfur

	T1	T2	T3	T4	r^2 vs. yield	Units	Measured
Boron in Borax	---	2.25	2.4	3.1	r^2 = 0.9425	Lbs/ac	Element Added
Boron	0.12	0.11	0.14	0.16	r^2 = 0.9542	mg/100 gr	Grain
Boron	0.54	0.58	0.70	0.82	r^2 = 0.9249	ppm	Soil Reserve
Copper in CuSO4	---	3	5.5	7.5	r^2 = 0.9682	Lbs/ac	Element Added
Cu	---	2.8	5.0	5.6	r^2 = 0.8165	ppm	Soil Availability
Cu	2.2	3.1	5.9	7.8	r^2 = 0.8786	ppm	Tissue
Manganese in MnSO4	---	15	22	29	r^2 = 0.9868	Lbs/ac	Element Added
Mn	---	7.3	6.6	6.1	r^2 = 0.9723	ppm	Soil Availability
Mn	59	54	52	46	r^2 = 0.8126	ppm	Tissue
N	800	780	880	1,018	r^2 = 0.9993	mg/100 gr	Grain
N # of Leaves Fired 9-9	4.6	4.6	3.3	2.0	r^2 = 0.9683	number	Leaves on Stalk
N NO3-N	---	22.9	32.9	37.1	r^2 = 0.8873	Lbs/ac	Soil Availability
Ag Sulfur	---	0	57.6	67.5	r^2 = 0.7943	Lbs/ac	Element Added
Sulfur	84	81	88	91	r^2 = 0.8882	mg/100 gr	Grain
Sulfur	14.5	14	28	31	r^2 = 0.8180	ppm	Soil Reserve
Avg Yield Bu/ac at 15% MC	**83.7**	**77.9**	**103.4**	**141.7**		**bu/ac**	

Note: where T1 was not tested for Soil Availability of the nutrient or where no product was applied in T1 (Element Added) it was not included in the r^2 calculation.

	T1 $/ac	T2 $/ac	T3 $/ac	T4 $/ac
Total $/ac	$160	$2,426	$1,262	$1,420
Minerals		$2,286	$833	$983
Other	$145	$115	$354	$362
# Trips	3	5	15	15
$/trip/ac	$5	$5	$5	$5
Trips Cost	$15	$25	$75	$75
Avg Yield	83.7	77.9	103.4	141.7
Value @ $6.00/bu	$502	$467	$620	$850
Value - all costs	$342	($1,958)	($642)	($570)
Lb N/bu	2.15	1.54	1.16	0.85

Nitrogen Use Efficiency and Economics

N Use Efficiency: The Ideal Soil treatments (T3&T4) at 1.59 and 1.16 LbN/bu used nitrogen 35 to 152 percent more efficiently than the control T1 (2.15 LbN/bu). Clearly, balancing the minerals produced big advantages in yield and in plant health and grain quality.

Several Cost Caveats: While the three mineral treatments produced a negative $/ac return, there are several caveats: **First,** costs for the minerals were based on small quantities. Bulk quantities are likely to be 15 to 30% less expensive. **Second,** timely planting and more favorable growing conditions would have likely pushed yields much higher. At $6.00/bu, yields of 210 and 237 bu/ac would have broken even for T3 and T4. **Third,** using a machine like the Soil Warrior[3] to homogenously place the minerals in a 10-inch wide by 8 to 12 inch deep zone and planting in the middle of that zone would have reduced the mineral costs by at least 50%. **Fourth**, at 1,000 per acre, the Summa Mineral dust is a capital investment that should be good for at least 10 years since it supplies 70+ micronutrients that are most likely to be used by soil microbes as enzyme co-factors in very small amounts and recycled within the soil or from the plant residues.

Conclusions

It appears that the grain and plants were definitely short of copper and zinc since levels increased when these minerals were added to the soil. While not measured in the tissue, boron and sulfur levels also increased in the grain when those nutrients were added to the Ideal Soil plots.

The concentrations of anions sulfur, boron and nitrogen in the grain were directly correlated to yield. Out of the 12 nutrients measured in the grain, these were the only three that were higher in both of the Ideal Soil treatments T3/T4 than in the Control T1.

The importance of balancing the minerals shows up in various measurements of increased energy, whether it be ERGS in the soil; chlorophyll, nitrogen and sugar in the tissue; or as nitrogen and yield in the grain.

<u>% Increase in Avg. of (T3+T4) over Avg. of (T2+T1)</u>

- **ERGS +111% soil (Sept 9)**
- **Chlorophyll +59% leaf (Sept 9)**
- **Nitrogen +77% tissue (Sept 9)**
- **Sugar +24% tissue (Sept 9)**
- **Sulfur +8% grain (Oct 25)**
- **Boron +30% grain (Oct 25)**
- **Nitrogen +20% grain (Oct 25)**
- **Corn Yield +51% grain (Oct 25)**

The project met and surpassed most of its Objectives

The two Ideal Soil treatments did show promise for remineralizing the soil and increasing plant health, brix, mineral content of the grain and yield. While it is impossible to fully separate out which factor/s caused the improvements, the systems approach with starter fertilizer and foliars did suggest that the Presto Gold starter and foliars were a better combination than the Agyzme and GMS as a starter with followup GMS and Azotobacter+ liquid fish foliar. In side by side comparisons, the Presto Gold combination in T4 out yielded T3 by 35 bu/ac in Rep 2 and by 43 bu/ac in Rep 1.

Even with hot dry growing conditions and a CCC rotation, the average of the best Ideal Soil treatment T4 out yielded the T1 control by 58 bu/ac (a 69 percent increase) and out yielded the T2 prepackaged mineral mix by 63.5 bu/ac (82 percent increase). T4 also out yielded T3 by 39 bu/ac (37% increase).

The systems approach with the split application totaling 120 Lbs N/ac of structured Stabl-UAN™ did use 33 percent less nitrogen than the Control T1 at 180 Lbs N/ac. The fall cornstalk N test suggested that the 120 Lbs N/ac of structured Stabl-UAN in T4 was too much and the 180 Lbs N/ac of UAN in the Control was probably not enough, at least under the stressful growing conditions that occurred. The T3 &T4 treatments also had the Bio-Gold biological product soil applied which may have produced some nitrogen for the plants.

The Formazan analysis done during the first five weeks was useful to show changes in soil biological activity, especially as they related to weather conditions.

The Gas Discharge Visualization (GDV) technology provided another confirmation of grain quality differences. It also appears useful for detecting energy in the grain via its measurement of biophotons (7.2% increase for T4 over T1) and entropy showing the grain from T4 had more organization (less chaos) than T1.

Using the Mehlich 3 soil test after harvest and running the results through the *Ideal Soil Handbook* calculations indicates sodium, sulfur, and boron (which are water soluble) need to be added to all 12 plots for next year's crops, although less so in the T3 and T4 plots. Some plots will also need some copper and zinc. Phosphorus is the big gorilla hiding in the closet. It is deficient in all 12 plots and represents about 70 to 80 percent of the poundage of products that need to be added. The other options are to find a biological product that can make existing phosphorus more available, or find a form of phosphorus that is more readily available. The subsoil at 6-12 inch depths is also markedly deficient in phosphorus availability.

While not producing economically viable results under these stressful growing conditions, the project does demonstrate that balancing soil minerals and putting the right system together is important. Mixing the minerals in a narrow 10" wide zone where most of the roots are growing would seem like a logical way to reduce the initial sticker shock of replenishing the needed minerals. Costs/year could be cut by 50 to 70 percent as opposed to broadcasting the minerals all at once. In 30-inch wide rows with GPS and RTK positioning, the zone could be moved over 10 inches each year and the cost could be spread over 3 years. The mineral dust with 70+ elements in it should probably be viewed as a capital investment that could be spread over 10 to 15 years.

If the grain nutrient information generated from the hybrid used for this project is representative of today's hybrids and soil mineral balances are not improved, then we are guaranteed to see further degradation of plant health and debasement of the mineral value of livestock feed and human food, further encouraging insects and disease. This will require increased expenditures for herbicides, fungicides, insecticides, mineral additives for livestock feed, and animal and human drugs. It will also cause lower yields and/or retard the rate of yield increase that is needed to support a growing population.

Appendix

Agricola's Best Soil Minerals

Ingredients

Azomite Volcanic Rock Powder: An ancient deposit of volcanic ash that later became a sea bed, Azomite is a superb source of 67 naturally chelated minerals. Azomite stands for "A to Z of Minerals Including Trace Elements." From the pink hills of Utah, the Beehive State.

Vashon Glacial Rock Powder: Freshly ground glacial rock powder from the Vashon glacial deposit on Puget Sound in Washington State, the southern tip of the last ice age. Freshly ground rock powder increases the paramagnetic force in the soil, allowing greater interaction with the Earth's magnetic field. Contains more than 60 mineral elements.

Colloidal Clay Phosphate: A soft, powdery phosphate, Calcium, and trace element source from Florida. High exchange capacity and readily available. Agronomist Carey Reams used it extensively.

Jersey Greensand: The famous slow release potassium and iron source from an ancient seabed in New Jersey. J. I. Rodale recommended it highly. Also a source of Calcium, Magnesium, and phosphoric acid along with 30 or more trace elements.

Ocean Kelp Meal: Cold water ocean kelp contains ALL of the naturally occurring elements in seawater. It is a good source of Potassium and probably the best source of natural Iodine.

Humate Ore (Leonardite/Lignite): Humic and fulvic acids are extremely complex organic molecules that promote life in the soil. They dissolve in water and penetrate soil deeply, increase exchange capacity, and greatly assist in making minerals available. Humates also improve tilth and increase water holding ability. The chelated trace elements in Humate ore are immediately available to soil life.

Boron: Boron is essential for Calcium utilization and movement in living organisms. When used as directed, Agricola's Best supplies 1.5 ppm Boron from mines in the Mojave desert of California.

Iron, Manganese, Copper, and Zinc sulfates: Purified from natural mined sources, these important nutrient minerals are needed by all living things. When applied to 1000 sqft (100 mt) Agricola's best supplies approx. 2ppm Copper, 3.5ppm Zinc, 10ppm Manganese and 20ppm Iron in easily available sulfate form.

Plus these Beneficial Soil Organisms in Each 20 lb Bag of Agricola's Best Minerals

4 oz (250g) Biozome® Archaeobacteria: The life's work of Dr. Carl Oppenheimer of the U of Texas, Biozome is a collection of primitive bacteria from harsh environments around the world. Biozome can break down toxic pesticides and even oil spills into plant food and water. Decomposes fresh organic matter quickly and releases nutrient minerals from soil rocks.

1 oz (28g) MycoApply® Endo/Ecto : Beneficial fungi can increase nutrient uptake and water efficiency by ten times. MycoApply MAXX is a blend of 4 Species Endo mycorrhizae and 7 Species Ecto mycorrizae. The various fungi in MycoApply Endo/Ecto will adapt to your soil, with the ones that are best suited to your climate and garden becoming established.

All of the ingredients in Agricola's Best Soil Mineral Supplement are allowed by USDA NOP Final Rule for Organic crop production

References for Grain Mineral Levels
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