Heeding Soil and Sap Tests[1]

Soybean farmers may easily be leaving $24 per acre of money on the table by not addressing key soil nutrient deficiencies.

The 10th Annual (2018) No-Till Farmer No-Till Practices Survey provides an illuminating big picture when compared to statewide soil test results published by A&L Great Lakes Laboratories for 5 states.

A&L labs provides 5 groupings in their statewide soil test reports: Very Low, Low, Medium, High and Very High.

The sum of the percentages of soil samples that fell in to the Very Low (VL) plus Low (L) categories are shown in the table for 2017. These can then be compared to the answers from the nutrient practices applied by farmers as reported for 2017 in the No-Till Farmer's Survey.

2018 No-Till Farmer No-Till Practices Survey				Statewide Soil Test Results from A&L Great Lakes Laboratories for 2017					
					% of samples that are Very Low (VL) plus Low (L)				
*Q61. Which of these Nutrients did you apply to Corn in 2017?				A&L's	IN	IL	MI	OH	WI
	2018	2017	2016	reference #	2017	2017	2017	2017	2017
Nutrient	% of farmers applying nutrient			VL+L	VL+L%	VL+L%	VL+L%	VL+L%	VL+L%
Sulfur	77.30%	72.00%	72.40%	<7 ppm	64.60%	69.30%	48.10%	47.00%	62.20%
Zinc	60.70%	61.80%	61.20%	<2.9 ppm	62.30%	64.60%	37.10%	57.40%	41.30%
Boron	33.40%	26.00%	34.20%	<0.5 ppm	77%	67.20%	63.80%	48.00%	74.10%
Manganese	20.40%	17.70%	22.30%	<14 ppm	7.10%	1.90%	11.10%	14.90%	6.30%
Magnesium	14.50%	15.00%	18.80%	<10% BS	5.60%	7.70%	6.90%	2.00%	4.90%
Calcium	20.80%	17.10%	24.30%	<55% BS	21.70%	31.20%	17.20%	21.20%	26.80%
Copper	10.70%	8.80%	12.30%	<0.4 ppm	0.30%	0.00%	0.40%	0.00%	0.10%
Molybdenum	6.90%	4.70%	8.20%	NA	NA	NA	NA	NA	NA
Iron	9.20%	8.30%	10.60%	<0.5 ppm	0.50%	1.00%	0.80%	0.30%	0.80%
Chloride	2.90%	2.50%	3.40%	NA	NA	NA	NA	NA	NA
*Q62. Which of these Nutrients did you apply to Soybeans in 2017?									
	2018	2017	2016	VL+L	VL+L%	VL+L%	VL+L%	VL+L%	VL+L%
Sulfur	38.60%	32.10%	36.20%	<7 ppm	64.60%	69.30%	48.10%	47.00%	62.20%
Zinc	24.30%	23.00%	27.10%	<2.9 ppm	62.30%	64.60%	37.10%	57.40%	41.30%
Boron	21.00%	17.70%	17.40%	<0.5 ppm	77%	67.20%	63.80%	48.00%	74.10%
Manganese	20.80%	20.50%	22.20%	<14 ppm	7.10%	1.90%	11.10%	14.90%	6.30%
Magnesium	10.30%	9.00%	9.40%	<10% BS	5.60%	7.70%	6.90%	2.00%	4.90%
Calcium	14.60%	11.50%	13.70%	<55% BS	21.70%	31.20%	17.20%	21.20%	26.80%
Copper	8.60%	5.70%	5.70%	<0.4 ppm	0.30%	0.00%	0.40%	0.00%	0.10%
Molybdenum	6.70%	5.60%	6.00%	NA	NA	NA	NA	NA	NA
Iron	5.40%	5.00%	7.10%	<0.5 ppm	0.50%	1.00%	0.80%	0.30%	0.80%
Chloride	1.10%	1.60%	0.90%	NA	NA	NA	NA	NA	NA

TABLE 1. Yellow cells show percent of soil test nutrients that are VL+L while a considerably smaller percentage of farmers are doing anything to address the potential deficiencies.

Green cells show percent of VL+L soil test nutrients that are much lower than the percent of farmers who are applying them.

[1] By Jim Porterfield, CCA, Watershed/Water Quality Specialist, Ideal Soil Consultant, Martinsville IL.

It appears that corn farmers have gotten the message that soils are testing low to very low for Sulfur and Zinc. 72% of the no-till farmers applied Sulfur and 61.8% said they applied Zinc to their corn fields in 2017. However, across the five state area, 47% to 69.3% of the soil tests are still in the low to very low range. This suggests that they may not be applying enough to move the soil tests. Or it could be they are using as little as possible but still seeing a return on their investment.

Meanwhile, it would appear that more than half of the no-till soybean farmers are not addressing Sulfur and Zinc deficient soils.

A&L Labs' soil test data in Fig 1. shows a sharp increase from 2006 to 2015 when about 65% of the tests suggested deficiencies in Sulfur over the five state region.

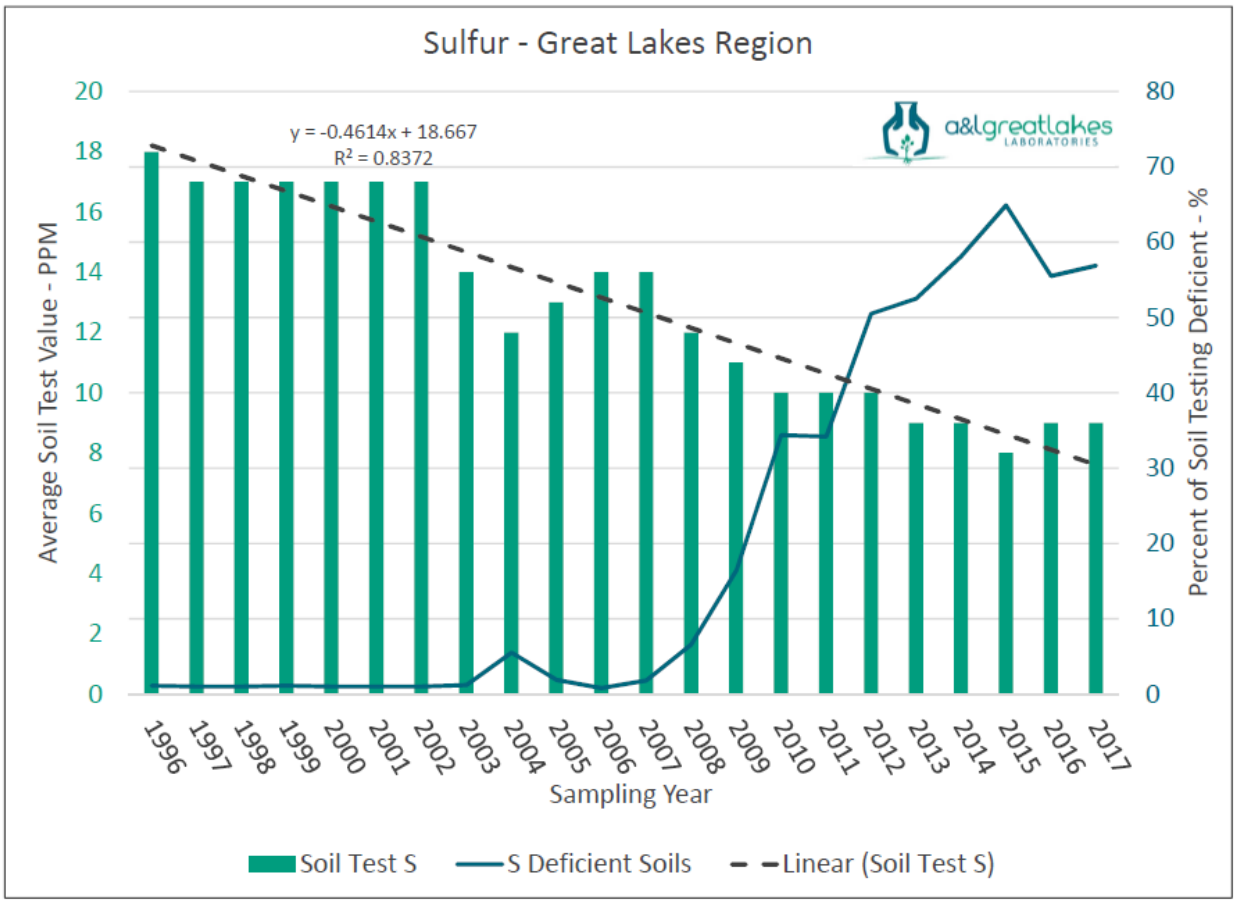


Fig 1. Trends in Sulfur content of soils tested from 1996 to 2017 in the Great Lakes Region. At an average of 8 to 9 ppm these are very low values. Much of the decline was due to Clean Air rules that limited Sulfur emissions from coal fired power plants.

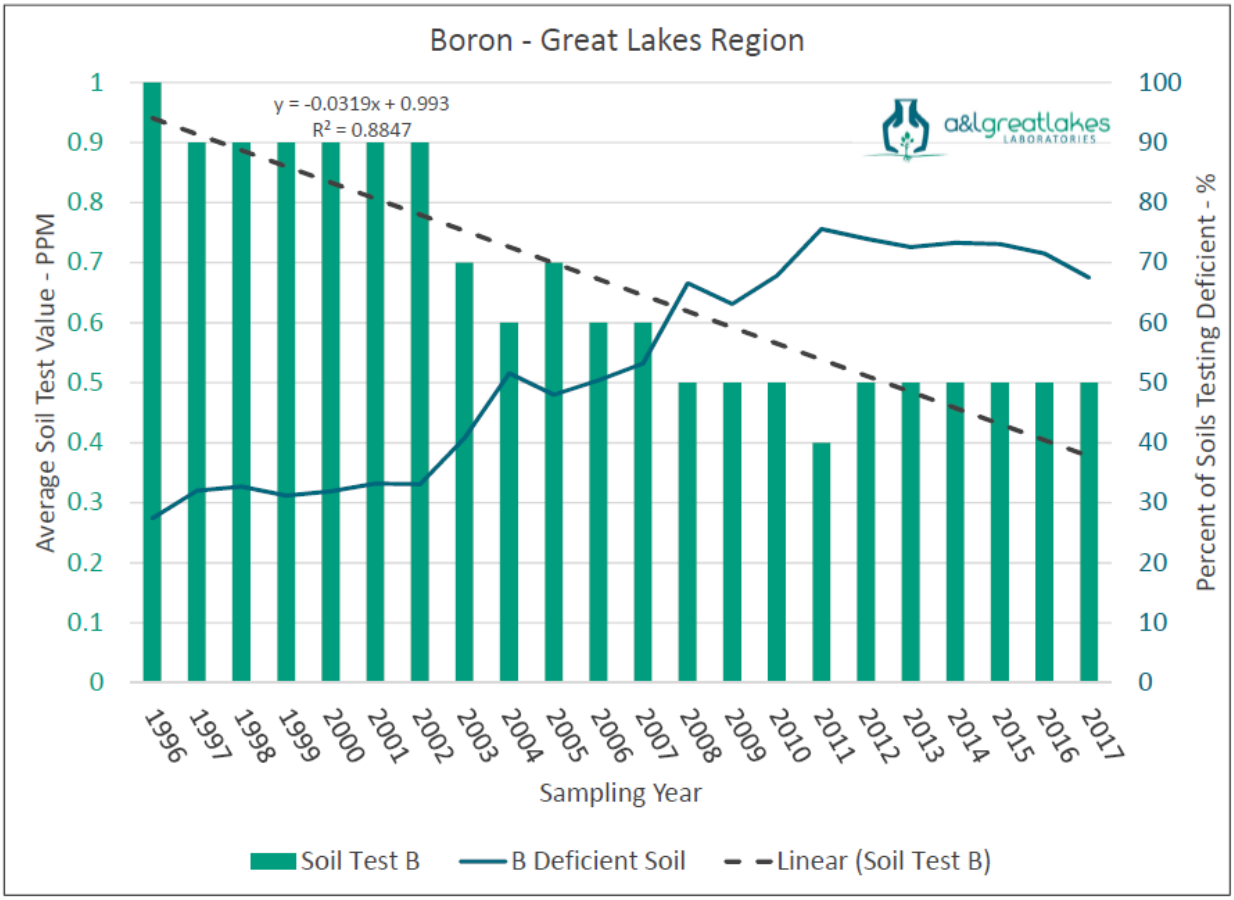


Fig 2. Boron deficiencies in soil tests have more than doubled since 1996.

State by state, Boron soil test levels show 48% to 77% of soil samples being deficient. The overall average seems to have leveled off in the last decade as noted in Fig. 2. However, only 26% of the corn farmers and 17.7% of soybean farmers are saying they are doing anything about it (yellow colored row in both corn and soybeans in Table 1). Among other things, Boron is important to prevent pod abortion in soybeans. Entomologist Dr. Tom Dykstra calls Boron a "sugar elevator" in corn. If there is not enough Boron the sugars do not reach high enough brix levels. Brix should be higher than 14 to make the plant disease and insect resistant.

In 2017, I noticed our own Non-GMO corn had 12% to 40% of the ears with no earworm damage. Tissue testing of the outside 4 leaves of the ear husk suggested that if Boron concentration was above 7 ppm the earworm moth decided it did not need to lay an egg on that ear. While more study is needed, it begs the question of what plant growth stage to test for Boron to predict if there will be earworm damage and be early enough to take remedial action.

Meanwhile, even though the actual percentages are rather small, more farmers are applying Manganese (2.1X), Magnesium (2.8X), Copper (55X) and Iron (12.2X) to their corn than would be suggested by the averages of soil test results. Since most no-till farmers are using Roundup Ready traited corn,

apparently some are seeing benefits from trying to overcome the tie up of these minerals by glyphosate (Green colored cells).

Soybean growers apparently are also seeing a similar need for Manganese, Copper and Iron. An average of 2.4X, 35X and 7X more farmers, respectively, are applying these three nutrients than would be suggested by the soil tests. Iron is often in unusable oxidized form in the soil, so even though the soil tests indicate 97% to 98% of the samples are in the high to very high range, soybean plants can benefit from a foliar of available iron. Nova Crop Control in the Netherlands suggests 2.34 to 4.65 ppm of iron is the optimum range for iron measured in the soybean leaf sap. Almost three quarters of the samples that I looked at this year were below the lower end of that optimum range.

A&L's soil test results do not include Molybdenum. It is important for nodule production in soybeans and utilization of nitrate nitrogen in corn. I include Moly in the soil tests I run and most of the time it is deficient. It is also deficient in the leaf sap analyses. Only a few of the no-till farmers said they use Molybdenum, but all should look at it.

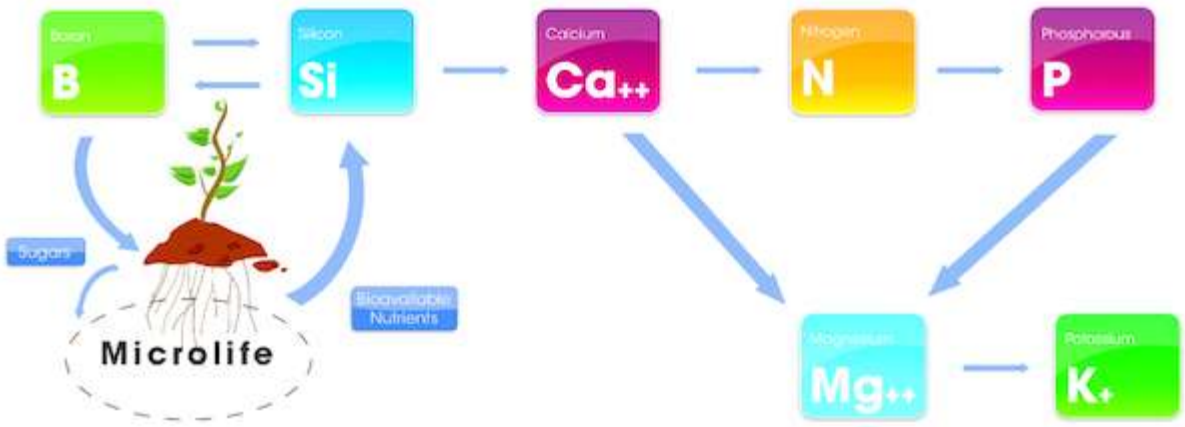
Soybean farmers also do not seem to be paying as much attention as they should to Calcium, Sulfur, Zinc and Boron as 51%, 45%, 55% and 73% of the 5-state average soil test deficiencies are not being addressed for those nutrients. This is a big mistake, especially for Boron as it is the beginning of the biochemical sequence of plant nutrient uptake.

Boron also opens the trap door on the chloroplast cells in late afternoon. This lets the sugars move down to the microbes in the root zone. Sugar is like mother's milk to the soil microbes. If you find high levels of sugar in the leaf sap in the morning, then you know you don't have enough Boron.

Sulfur comes first in the biochemical sequence of plant nutrient uptake. It etches off minerals. Boron is number two. Although not mentioned in either A&L's soil test results or the No-Till Practices Survey, available Silicon is the third key in the biochemical sequence. You may have heard the expression Calcium is the truck and Boron is the driver and they ride on the Silicon highway.

Caitlin Blackman in a diagram & article from 2015 explains this sequence quite simply as follows:

> "It is important to understand that plants have a defined biological sequence of nutrient uptake. This starts with Boron, which stimulates the root system to leach sugars into the [soil] medium. These sugars feed the microbes, which transform silicates (Si) into silicic acid through a process called silicification. Silicic acid enhances Calcium uptake, followed by Organic Nitrogen (from L-Amino Acids), Magnesium, Phosphorus and Potassium.
>
> These elements should be present in a bioavailable form to plants. If one nutrient in this sequence is not available (or less available), the uptake of all other elements in the sequence is more difficult or missed. It is very important to respect this sequence in order to avoid mineral deficiencies and/or nutrient uptake problems."



Meanwhile, Noel Garcia of Texas Plant and Soil Lab has been looking hard at Silicon, especially from the sap of leaf petioles. Where silicon is getting into the plant leaves it thickens the leaf, making it hard for insects and disease to penetrate and get a foothold.

A quick "look see" study that I ran on four corn plots planted June 30 also showed another possible benefit of silicon. Two plots had calcium silicate foliared late one evening at the end of August. The first killing frost on October 31 had no effect on those plants. They had 48,644 ppm silicon in the ear leaves or 52% and 29% more than immediately adjacent plots that had frost damage and only 32,000 to 37,732 ppm silicon in their leaves.

Sure, NPK nutrients are important. However, you need to look deep into the forest of other nutrients. Try using both expanded 16 element soil tests (including Silicon, Selenium, Molybdenum, Cobalt and EC) and petiole or leaf sap (22 nutrients) tests to find out what's really going on.

Start small; get soil tests from one good area of the field and one bad area. Ask for a Mehlich3 soil test for 16 elements: Ca, Mg, K, Na, P, S, B, Fe, Mn, Zn, Cu, Mo, Co, Si, Se, EC. If it costs more than $30/sample, try Logan Labs in Ohio.

For corn, do not use the standard tissue test; make sure you are testing plant sap. Take whole plant samples for sap analysis at V2 to V4 and leaf sap samples at V-10 and R3 from the same two areas of the field. Look specifically at Molybdenum, Boron, and Iron as they often tend to be low. Iron may be adequate on the soil test, but is likely in the unusable oxidized form. You want available iron, which may have to be applied with an amino acid chelated foliar product.

My experience suggests Molybdenum with likely be low in both soil and leaf sap.

Adequate Boron is critical at silking. If deficient, the corn earworm moth will know and deposit an egg on the ear of every plant that is deficient. At this point in time my experience indicates that Boron level in the sap needs to be measured at V-10 so you have time to correct it.

Another surprise may be that certain nutrients will be excessive in the sap and thus causing others to be deficient, for example, high Potassium may be causing low Calcium and Magnesium.

Nova Crop Control in the Netherlands is the only lab in the world doing their particular leaf sap analysis. You will either have to send your leaf samples direct to them via overnight express or go through Crop Health Labs here in the U.S.

For soybeans, sample leaves for sap at V2, a week before first blossom and at start of pod fill. Lack of Boron means flowers get aborted, and beans may not fill each cell in a pod.

When leaf sap analysis shows a deficiency in spite of soil tests which "should" be adequate, foliars can help remediate. One product that seems to consistently amplify foliar benefits is WakeUp *Summer*.

Remember, one more pod per soybean plant translates into 2 more bushels of beans per acre. Using a 16 element soil test every year and a 22 element sap test three times per year on at least one good area and one poor area will give you actionable information worth at least several pods per plant. At 2 extra pods per plant it only takes 13 acres to recover the costs of soil and leaf sap testing. On 500 acres of beans you could afford to spend $12/ac and still get an ROI of 3X to get those 2 extra pods per plant.

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