What's Cropping Up?

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Evaluation of Reclamation Efforts from Pipeline Right of Way Construction Using the Cornell Soil Health Test

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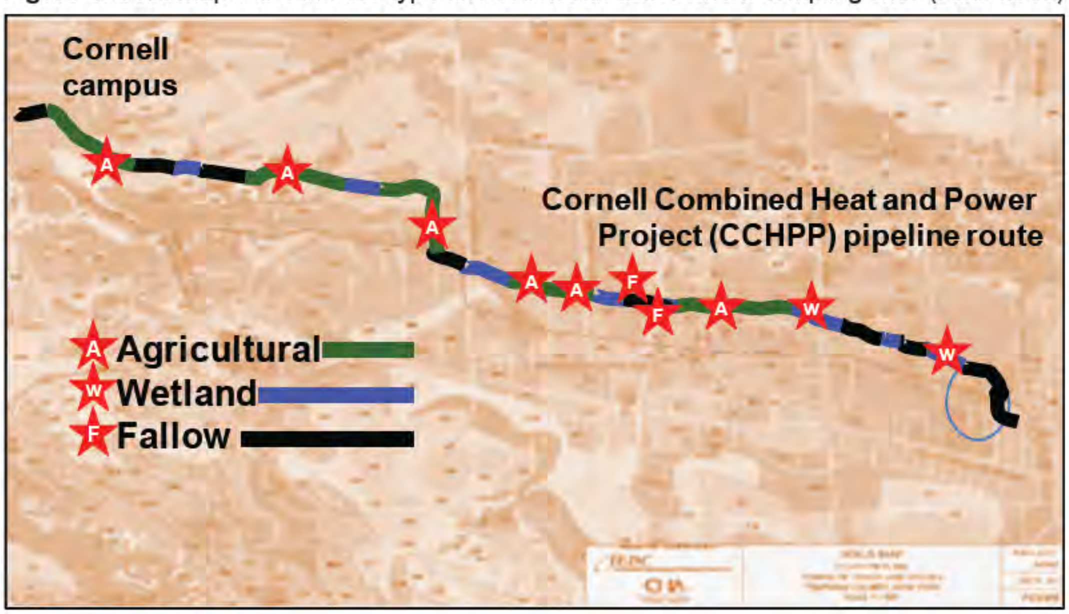
Background

Pipeline construction projects are expected to greatly expand in parts of New York as a result of the exploration of the Marcellus Shale natural gas field. Right-of-way (ROW) construction efforts can result in damage to soil quality along its course from construction activities like soil removal, compaction by heavy equipment, mixing of topsoil and subsoil materials, etc., thereby affecting the ability of the disturbed soils to sustain soil functions like plant growth, water infiltration and retention, support of soil life, etc. Soil quality sampling to monitor and assess the impact of construction can ensure that applied construction standards are adequate and/ or suggest a focus for remediation efforts.

The newly-developed Cornell Soil Health Test (CSHT) (*How to Interpret and Use the Cornell Soil Health Test Report, What's Cropping Up?, Vol. 18, No. 1, 2008*) provides a standard for assessment of soil quality relative to important soil physical, chemical and biological processes and functions. The CSHT was evaluated as a tool for assessment of right-of-way (ROW) construction impacts using a test case of the Cornell Combined Heat and PowerPproject, which included the construction of an eight-inch gas delivery line over a three mile length from the interstate transmission line to the Cornell campus during 2008 and 2009. Site-specific information is needed to provide meaningful quantitative assessment of the effects of construction activities on soil quality. Soil samples were collected from areas crossed by the pipeline (Figure 1) including Wetlands, Agricultural lands and Fallow areas, each having different construction guidelines, in a paired sampling scheme (on- and off- right of way).

Right-of-Way Construction Projects must conform to standards and practices that minimize adverse effects on agricultural and other land use types. These standards and practices that apply to each project from planning, through construction, restoration and post-construction monitoring and rehabilitation are documented in the Environmental Management and Construction Standards and Practices (EM&CS&P) plan. Land areas crossed that are designated as Fallow land use areas, require the basic soil restoration efforts. Where the pipeline crosses Agricultural land, the developed EM&CS&P plan has provision for additional site-specific soil management standards.

Figure 1. Soils map with land use type and soil health assessment sampling sites (June 2009)



Soil Health

Wetland areas crossed by the project also require enhanced construction and reclamation standards, as found in Section 11 of the EM&CS&P plan. Table 1 lists the applied Soil Management for the different land use types.

Table 1. Applied pipeline ROW construction and restoration practices by land use type.

Soil Management Practice	Land Use Type		
	Wetland	Agricultural Land	Fallow Land
Install pipe. Replace subsoil from trench onto pipe. Rough grade and remove large stones. Apply lime and fertilizer. Disk harrow.	X	X	X
Rubber or wooden mats to avoid compaction. Segregate topsoil and trench spoil on top of mats. Remove mats in reverse order.	X		
Strip and stockpile topsoil. Deep rip after rough grading of subsoil. Replace topsoil. Rough grade and deep rip again.		X	
Broadcast grass seed and apply straw mulch.	X		X
Drill grass seed and apply straw mulch.		X	

Post-Construction ROW Soil Health Assessment

Fall 2008 saw most of the pipe buried and the soil surface restored. Where ephemeral streams and ditches existed, conservation measures using straw bales and silt curtains effectively prevented the washing out or silting in of waterways. Grass seed and mulch were broadcast in the Fall of 2008 across the Wetland and Fallow land use areas as the heavy equipment project work was effectively completed by this time.

Soil Health samples were collected from the pipeline construction area in June, 2009. Sampling sites were chosen to capture typical characteristics of each soil mapping unit encountered – Agricultural, Wetland, and Fallow. Composite soil samples were collected from locations directly on the ROW and just off the ROW in the adjacent undisturbed land area. Each location therefore has paired samples from within the disturbed area (directly ON the ROW) and an associated "benchmark" sample of native soil conditions collected from directly outside the construction area (OFF the ROW). Comparison of collected data from the paired locations allows for immediate quantitative evaluation of the effects of construction on native soil function and the efficacy of the varying construction practices and remediation techniques applied to the different land use types. The field constructions photos in Figure 2 show the typical construction site appearance by land use type.

The measured suite of CSHT indicators can be used to define and assess ROW construction project effects on the land it traverses. Assessing soil function through measuring a suite of indicators that represent critical soil processes allows for the quantification of the success of remediation efforts, identification of remaining soil limitations, and guidance for additional remedial practices if post-construction reclamation was inadequate. A composite soil

Figure 2. In-field construction site soil management practices by land use type.

CORNELL SOIL HEALTH TEST REPORT (COMPREHENSIVE)

ON Right of Way AGRICULTURAL

	Indicators	Value	Rating	Constraint
PHYSICAL	Aggregate Stability (%)	72	[illegible]	
	Available Water Capacity (m/m)	0.17	54	
	Surface Hardness (psi)	70	[illegible]	
	Subsurface Hardness (psi)	320	38	
BIOLOGICAL	Organic Matter (%)	6.4	[illegible]	
	Active Carbon (ppm) [Permanganate Oxidizable]	695	67	
	Potentially Mineralizable Nitrogen (μgN/ gdwsoil/week)	22.9	100	
	Root Health Rating (1-9)	6.0	38	
CHEMICAL	*pH	5.8	44	
	*Extractable Phosphorus (ppm) [Value <3.5 or >21.5 are downscored]	25.0	44	
	*Extractable Potassium (ppm)	185	100	
	*Minor Elements		100	
	OVERALL QUALITY SCORE (OUT OF 100):		72.5	High

Measured Soil Textural Class:⟹ silt loam

SAND (%): 21.8 SILT (%): 68.1 CLAY (%): 10.1

Location (GPS): Latitude⟹ 42.43539143 Longitude⟹ -76.44353276

...TH TEST REPORT (COMPREHENSIVE)

OFF Right of Way AGRICULTURAL

Value	Rating	Constraint
98	100	
0.16	50	
105	[illegible]	
350	27	Subsurface Pan/Deep Compaction
6.4	99	
691	66	
16.7	100	
4.0	63	
5.4	0	Toxicity, Nutrient Availability (for crop specific guide, see CNAL report)
8.0	100	
145	100	
	56	
...T OF 100):	70.0	Medium

silt loam

23.8 SILT (%): 67.1 CLAY (%): 9.1

...526537 Longitude⟹ -76.44351365

Figure 3. Cornell Soil Health Test Reports from ON- and OFF- pipeline Right of Way. AGRICULTURAL land use type. Pipeline construction and restoration efforts decreased subsurface compaction and also increased soil pH.

CORNELL SOIL HEALTH TEST REPORT (COMPREHENSIVE)

ON Right of Way WETLAND

	Indicators	Value	Rating	Constraint
PHYSICAL	Aggregate Stability (%)	65	94	
	Available Water Capacity (m/m)	0.18	66	
	Surface Hardness (psi)	95	83	
	Subsurface Hardness (psi)	180	84	
BIOLOGICAL	Organic Matter (%)	3.4	47	
	Active Carbon (ppm) [Permanganate Oxidizable]	439	18	Soil Biological Activity
	Potentially Mineralizable Nitrogen (μgN/ gdwsoil/week)	19.8	100	
	Root Health Rating (1-9)	3.0	75	
CHEMICAL	*pH	6.1	67	
	*Extractable Phosphorus (ppm) [Value <3.5 or >21.5 are downscored]	2.0	44	
	*Extractable Potassium (ppm)	100	100	
	*Minor Elements		56	
	OVERALL QUALITY SCORE (OUT OF 100):		69.7	Medium

Measured Soil Textural Class:⟹ silt loam

SAND (%): 35.2 SILT (%): 52.9 CLAY (%): 12.0

Location (GPS): Latitude⟹ 42.43250219 Longitude⟹ -76.4198875

...TH TEST REPORT (COMPREHENSIV...

OFF Right of Way WETLAND

Value	Rating	Constraint
83	89	
0.19	71	
140	65	
290	50	
4.1	67	
504	20	Soil Biological Activity
15.4	100	
4.0	63	
5.3	0	Toxicity, Nutrient Availabili... crop specific guide, see CNA...
2.0	44	
95	100	
	56	
...T OF 100):	62.0	Medium

silt loam

31.6 SILT (%): 61.8 CLAY (%): 6...

...242801 Longitude⟹ -76.41997509

Figure 4. Cornell Soil Health Test Reports from ON- and OFF- pipeline Right of Way. WETLAND land use type. Pipeline construction and restoration efforts increased soil pH.

Soil Health

CORNELL SOIL HEALTH TEST REPORT (COMPREHENSIVE)

ON Right of Way FALLOW

	Indicators	Value	Rating	Constraint
PHYSICAL	Aggregate Stability (%)	27	35	
PHYSICAL	Available Water Capacity (m/m)	0.13	28	water retention
PHYSICAL	Surface Hardness (psi)	375	1	rooting, water transmission
PHYSICAL	Subsurface Hardness (psi)	450	5	Subsurface Pan/Deep Compaction
BIOLOGICAL	Organic Matter (%)	2.5	22	energy storage, C sequestration, water retention
BIOLOGICAL	Active Carbon (ppm) [Permanganate Oxidizable]	509	29	Soil Biological Activity
BIOLOGICAL	Potentially Mineralizable Nitrogen (µgN/ gdwsoil/week)	5.2	0	N Supply Capacity
BIOLOGICAL	Root Health Rating (1-9)	3.0	75	
CHEMICAL	*pH	7.5	67	
CHEMICAL	*Extractable Phosphorus (ppm) [Value <3.5 or >21.5 are downscored]	2.0	44	
CHEMICAL	*Extractable Potassium (ppm)	65	100	
CHEMICAL	*Minor Elements		56	
	OVERALL QUALITY SCORE (OUT OF 100):		38.5	Very Low

Measured Soil Textural Class:==> *silt loam*

SAND (%): 37.3 *SILT (%): 54.3* *CLAY (%): 8.4*

Location (GPS): Latitude=> 42.4347705 Longitude=> -76.43774598

LTH TEST REPORT (COMPREHENSIVE)

OFF Right of Way FALLOW

Value	Rating	Constraint
90	100	
0.16	49	
263	15	rooting, water transmission
383	17	Subsurface Pan/Deep Compaction
5.0	87	
689	66	
21.6	100	
2.8	88	
5.3	0	Toxicity, Nutrient Availability (for crop specific guide, see CNAL report)
1.0	17	<3.5:Plant P Availability, >21.5: Env. Loss Potential
115	100	
	56	
UT OF 100):	57.9	Medium

silt loam

24.2 *SILT (%): 68.4* *CLAY (%): 7.4*

3469574 Longitude=> -76.43787548

Figure 5. Cornell Soil Health Test Reports from ON- and OFF- pipeline Right of Way. FALLOW land use type. Pipeline construction and restoration efforts decreased Available Water Capacity, decreased Organic Matter, lowered soil biological activity and increased soil pH and Phosphorus. Overall Soil Quality Score decreased significantly.

health score is used to document overall soil quality status at the time of sampling. Repeated sampling in time can be used to measure the effectiveness of applied project remedial practices.

Construction Effects on Soil Health

The effects of the ROW construction can be evaluated by comparing results from the on and off-ROW Soil Health Reports (Figures 3-5). Cornell Soil Health Test results indicated that (i) Wetland and Agricultural land construction and remediation methods resulted in satisfactory post-construction soil conditions, and (ii) lower construction and remediation standards in Fallow areas resulted in significantly lower soil quality levels than the other lands. In the latter case, additional remediation practices such as deep ripping and organic matter applications would address some of the measured constraints.

We conclude that the Cornell Soil Health Test is an effective tool for assessing soil quality impacts of right-of-way construction projects and should be considered as a monitoring tool in the permitting of such activities. The direct measurement of soil parameters can be used to assess compliance with construction site soil mitigation and reclamation standards. We will return to the same GPS coordinates in 2011 to sample and test on- and off- the ROW to gather information on the effects of time on soil quality.

More information on soil health testing at: http://soilhealth.cals.cornell.edu

Deciphering the GM Corn Terminology

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Pest Management

The litany of terms bantered about when talking about GM corn is confusing to the agribusiness community and a number of individuals are also using this terminology incorrectly. Perhaps, I can decipher the terminology as I understand it.

GM corn has one to several traits incorporated into its genetic material. Currently in commercially available corn varieties, there are the following events available. For Corn Borer control, there are two available toxins. One is a Dow product (Herculex-I) and the second one is a Monsanto product (YieldGard-corn borer). For Corn Rootworm, there are two available toxins. One is a Dow product (Herculex-rw) and the second one is a Monsanto product (YieldGard-Rootworm). There are also herbicide tolerances available in corn, but that discussion is beyond the scope of this article.

In years past, when a corn variety has a single toxin or herbicide tolerance incorporated into its genetic coding, we called those varieties "Single Trait " varieties. In today's market, single trait varieties are not readily available. The next offering was to incorporate 2-3 different traits into a single corn variety targeting 2-3 different pests. For example, a corn borer toxin, a rootworm toxin and a herbicide tolerance. These corn varieties are called "Stacked Trait" varieties and currently comprise most of the GM corn varieties available for planting. Now, if the plant has two toxins expressed in plant tissue targeting the same insect, we refer to these varieties as "Pyramiding Traits". So if a corn variety has two different toxins to kill corn rootworm, this variety is a "pyramid". What if the company has a stacked variety (multiple toxins for different insects) and multiple toxins for each insect? We call this variety a "Stacked Pyramid".

How does this discussion apply to the array of GM corn in the market place? OK, some examples. Roundup ready corn is a "single trait" variety. Roundup ready corn with a corn borer toxin (and/or rootworm toxin) is a stacked trait. Only in the past year, has an example of a pyramid trait variety entered the market place. When we flip through trade magazines or talk to the seed dealers, the terms of YieldGard, Herculex, SmartStax and AcreMax are tossed about. How do those terms fit into the above description?

YieldGard VT Pro: These are stacked varieties with Monsanto's corn borer toxin, Monsanto's corn rootworm toxin and herbicide tolerance. There is only a single toxin for each insect.

Herculex Xtra: These are stacked varieties with Dow's corn borer toxin, Dow's corn rootworm toxin and herbicide tolerance. There is only a single toxin for each insect.

SmartStax: These are stacked pyramid varieties with two corn borer toxins (both Dow and Monsanto), two corn rootworm toxins (both Dow and Monsanto) with herbicide tolerance. Currently, the SmartStax registration allows the required refuge to be reduced from 20% to 5%, but the refuge still needs to be planted in a block or strips in the field. Future registrations may allow SmartStax to be used in a seed mix where susceptible seeds are factory mixed in the bag and the farmer does not have to worry about planting a refuge.

AcreMax: Pioneer is trying to get permission from EPA to deploy their refuge in a seed mix where the susceptible seeds are mixed in the bag. Their varieties are stacked varieties using the Dow products contained in Herculex Xtra. The terminology of "Optimum AcreMax" is a marketing tool to promote the seed mix refuge strategy using corn containing Herculex Xtra.

Structured Refuge vs. Seed Mix Refuge:
Insects are very capable of developing resistance to toxins when the vast majority of the population are exposed to and killed by the toxin. There are many examples in the literature of insecticide resistance across numerous species of insects. Corn Rootworm and Corn Borer are no exception and when the toxin is incorporated into the host plant, the selection pressure to development resistance is severe. The concept of a refuge is to have an area where the insect population is not subjected to the toxin and have the area produce a large enough number of unexposed insects. These unexposed insects are then available to mate with the extremely low number of insects which survive the toxin and continue to dilute the genes for resistance. In this manner, the number of resistant insects remain very small and the toxin continues to provide protection from economic insect damage.

<u>Structured Refuge:</u> A structured refuge is a block or wide strips (4-6 rows) of corn without the plant incorporated toxin (like BT) where the insect can feed without being exposed to

Pest Management

the plant incorporated toxin. As insect larvae move from plant to plant, they are not exposed to any plants with the toxin expressed in the tissue. Plant to plant movement occurs with both corn borer larvae above ground and corn root larvae below ground. Narrow strips in the field (1-2 rows) do not provide acceptable toxin free zones and too many larvae are allowed to move from non-toxic plants to toxic plants. If larvae when small, first feed on a non-toxic plant and partially develop, they are better able to survive the toxic plant when they move as larger larvae. This survival contributes to the faster development of insecticide resistance. While structured refuges provide the “perfect refuge” with no exposure to the toxin by developing larvae, the poor compliance of farmers required to plant refuges nullifies the impact of refuges in delaying resistance development to the plant incorporated toxin. This leads to the statement of “Perfect Refuge but Imperfect Compliance”.

<u>Seed Mix Refuge:</u> A seed mix refuge is where a percentage of toxin-free seeds are mixed within a bag of seeds containing the plant incorporated toxin. The seeds are mixed by the seed supplier and all the farmer has to do is plant the field. The susceptible toxin free seeds are mixed randomly throughout the field. Compliance by the farmer is perfect since the farmer has no control over planting of the refuge. However, during development, the larvae are exposed to both non-toxic plants and toxic plants which reduces the effectiveness of the refuge in delaying the development of resistance to the toxin by the insect. This leads to the statement of “Imperfect Refuge but Perfect Compliance”.

So, which is better 1) Perfect refuge but imperfect compliance or 2) Imperfect refuge but perfect compliance? The answer is unknown, but if resistance develops, we will know that we made the wrong choice.

20% Refuge vs 5% Refuge:

This topic has always been hotly debated between the public corn entomologists, the companies marketing seed and EPA. The public corn entomologists generally believe that if only a single toxin for an insect species is expressed in the plant tissue, a 20% refuge is required. However, if there two toxins expressed in the plant tissue with different modes of action, a 5% refuge may be adequate.

As Soybean Acreage Expands so do Row Spacings

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Crop Management

Soybean acreage continues to expand in New York with many first-time growers now planting the crop. Many of the new growers plant with a corn planter instead of a grain drill, which has been the almost exclusive planter for soybeans in NY over the last 20 years. Also, some experienced soybean growers, who no longer plant wheat, have switched to a corn planter to save on equipment costs. With that in mind, we conducted a variety (Pioneer 91Y90 and Asgrow 2002) by row spacing (7.5, 15, and 30 inch) by seeding rate (130,000, 150,000, 170,000, and 190,000 seeds/acre) study at the Aurora Research Farm in 2008 and 2009. We planted the 7.5 inch row spacing with an IH Case 5400 Drill and the 15 and 30-inch row spacing with a White Air Seeder. In both years, the experimental sites, which followed corn, were chiseled the day before planting and then worked the day of planting, May 13 in 2008 and May 11 in 2009. The first objective of the study was to determine if the wider row spacing reduces soybean yield in New York. The second objective was to see if the optimum seeding rate for soybeans at 15 and 30-inch row spacing in New York differs from the currently recommended 180,000 seeds/acre for drilled soybeans.

The 2008 and 2009 growing seasons had close to normal total growing degree days (GDD) in both years with 25 GDD above normal in 2008 and 70 GDD below normal in 2009 (Table 1). Total precipitation averaged 1 to 3 inches below normal, mostly because of the dry September in both growing seasons. In fact, May through August precipitation totaled 13.67 inches in 2008 and 14.39 inches in 2009 compared with the 30-year average of 14.18 inches. Consequently, growing conditions for soybeans at the Aurora Research Farm in 2008 and 2009 were probably as close to normal as possible for two consecutive growing seasons.

When averaged across varieties and seeding rates, emergence counts taken in mid-June indicated similar emergence rates with all row spacings averaging from 67 to 71% (Table 2). This was somewhat surprising because we expected lower emergence rates when planting with the drill. When averaged across varieties and seeding rates, seed yield showed a linear response to row spacings with the 7.5 inch row spacing yielding 6% higher than the 15-inch row spacing and 14% higher than the 30-inch row spacing (Table 2). Both varieties responded similarly to row spacing in this study. We conducted a similar study in 1997 and 1998 with three varieties and reported that 7 and 15-inch row spacing yielded the same (43.5 bu/acre), which was 9% higher than yields (40 bu/acre) at 30-inch row spacing (What's Cropping Up?, Vol.8, No.5, p.6-7). Consequently, the results from the study in 2008-2009 were fairly consistent with the 1997-1998 study. There was no row spacing by seeding rate interaction with all three row spacing showing a

Table 1. Average temperature and monthly precipitation at the Aurora Research Farm during the 2008 and 2009 soybean growing seasons.

	GROWING DEGREE DAYS			PRECIPITATION		
Month	2008	2009	30-yr mean	2008	2009	30-yr mean
		°F			in.	
May	236	330	315	1.39	3.77	3.17
June	586	454	498	3.76	4.75	4.09
July	677	555	632	5.44	2.43	3.31
August	547	642	591	3.03	3.64	3.61
September	414	364	389	1.81	2.81	4.21
Total	2460	2365	2435	15.48	17.20	18.39

Crop Management

Table 2. Row spacing and seeding rate effects on final stands and yield of a Pioneer and Asgrow soybean variety, averaged across the 2008 and 2009 growing seasons, at the Aurora Research Farm.							
	ROW SPACING (in.)						
	7.5	15	30	7.5	15	30	Avg.
SEEDING RATE	FINAL STAND			YIELD			
Seeds/acre	--------plants/acre----------			---------bu/acre---------			
130,000	100,000	91,100	88,805	51	46	40	46
150,000	105,260	87,860	99,190	48	44	44	46
170,000	127,935	119,840	117,005	53	49	45	**49**
190,000	122,265	113,605	126,725	49	48	44	47
Avg.	113,865	107,813	107,181	**50**	47	43	

quadratic response to seeding rates with maximum yields at a seeding rate of 170,000 seeds/acre.

Conclusion:

New and experienced growers in NY are planting more soybeans with a corn planter, which reduces crop damage with a postemergence herbicide application in June and the occasional applications for aphid or disease control in July or August. Also, wider row spacing reduces white mold potential. In our study, however, soybeans planted with a grain drill at 7.5 inch row spacing yielded higher, especially when compared with 30-inch row spacing. We realize that in our small plot study, we do not run over the soybeans with postemergence applications of Roundup in June or other pesticide applications in July or August. Consequently, our study indicates the potential yield and not the actual yield increase because we do not experience yield losses via mechanical damage to soybeans at 7.5 inch row spacing. Nevertheless, we believe that there is a distinct yield advantage for soybeans in New York at 7 or 7.5 inch row spacing and growers should think twice before planting beans with a corn planter, especially without inter-units. Regardless of row spacing, yields were maximized at seeding rates of 170,000 seeds/acre in this study.

Effect of Sampling Height and Length on Corn Stalk Nitrate Test Results

Nutrient Management

Eun Hong, Quirine Ketterings, Greg Godwin, Sanjay Gami, Sarah Wharton, Karl Czymmek, Dept. of Animal Science, Cornell University

Introduction

The end-of-season corn stalk nitrate test (CSNT) measures nitrate concentrations in the lower portion of corn (*Zea mays* L.) stalks at silage harvest time. This test is a useful tool as it helps fine-tune nitrogen (N) management over time and on a field by field basis.

The recommended sampling protocol for the CSNT is to collect an 8-inch portion of each stalk, between 6 and 14 inches above the ground. Leaf sheaths should be removed from stalk samples and stalks handled to avoid contact with the soil. While sampling, it is also recommended to avoid taking stalk samples from corn damaged by disease or insects, such as corn borers.

In the fall of 2009, the Cornell Nutrient Management Spear Program (NMSP) occasionally received samples that were shorter or longer than 8-inches. It was also frequently remarked by farm advisors that it was easier to take the samples after the chopper had passed through the field, but that this was only possible if fields were chopped at 14 inches or higher, compromising dry matter yield. This raised questions about the impact of sampling 8-inch stalks closer to the ground, and/or taking shorter stalks than the recommended 8 inches to reduce sample volume and accommodate lower chopper heights. Work by Wilhelm et al. (2005) showed that stalks taken between 4 and 12 inches and those taken between 8 and 16 inches above the ground showed minor deviations from stalks taken 6 to 14 inches above the ground. This implies that samples can be taken closer to the ground to enable sampling after harvest. However, little is known about the impact of taking shorter stalks.

Our objective was to evaluate the impact of taking shorter stalk samples (6-7 inches length) on CSNT results using stalks varying in CSNT values from low to excess.

Methods

Ten corn fields were selected from two farms: the Musgrave Research Farm in Aurora (2 fields) and the Teaching and Research Center in Harford (8 fields). At each

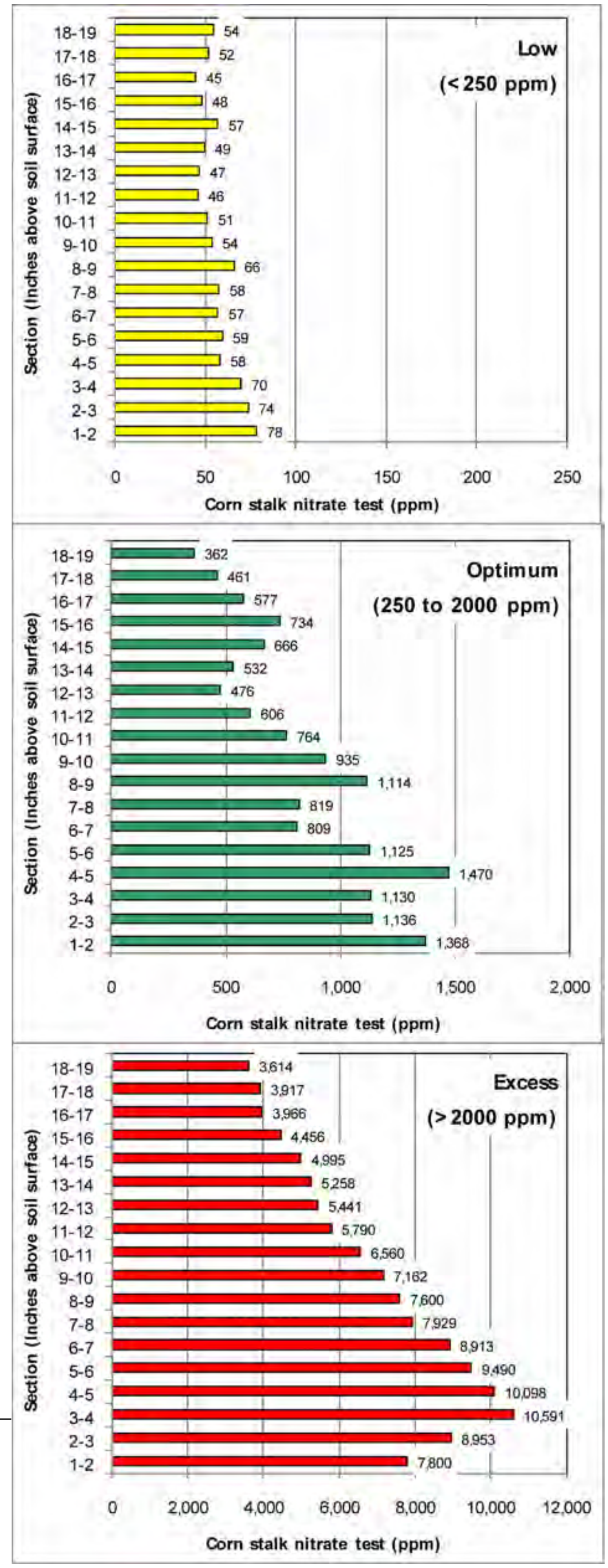

Figure 1. Average corn stalk nitrate test results as impacted by the position of the 1-inch piece in the stalk for average of 10 fields, low fields (2 locations), optimal fields (2 locations) and fields with excessive CSNT (6 fields).

Nutirnet Management

location, five 20-inch stalks were collected (in one row) from 0 to 20 inches above the ground. Each stalk was separated into eighteen 1-inch segments (the top segment (18-20 inches) was discarded). Corresponding sections of five plants per field were combined to obtain sufficient material to conduct the study. In total, 180 stalk segments were dried, ground, and measured for stalk nitrate concentration in the NMSP laboratory using the $Al_2(SO_4)_3$ extracting solution and a nitrate combination ion selective electrode.

Table 1. Impact of length of stalk and position above the ground on corn stalk nitrate test (CSNT) averaged over ten fields. The standard protocol is an 8-inch sample taken 6 inches above the ground (in blue). In red are listed the sampling protocols for samples that resulted in means no more than 5% different from the standard protocol.

Position from ground	Length of stalk (inches)								Effect of cutting height on 8-inch samples ↓	
(inches)	6	7	8	9	10	11	12		8	P value
Average	-------------------- % nitrate concentration --------------------									
1	154	150	146	141	135	131	127		146	<0.0001
2	146	141	136	131	126	122	119		136	<0.0001
3	138	133	127	123	118	115	112		127	<0.0001
4	127	121	117	113	109	107	**104**		117	0.0791
5	116	112	108	**105**	**103**	**100**	**97**		108	0.9564
6	106	**103**	**100**	**98**	**95**	93	90		**100**	.
7	**99**	**96**	**95**	92	90	87			95	0.9658
8	92	90	88	86	83				88	0.1005
9	87	84	82	80					82	0.0017
10	81	79	77						77	<0.0001
11	78	76								
12	74									
6	106	103	**100**	98	95	93	90	← Effect of stalk length on 6 inch cutting height		
P value	0.0365	0.8962	.	0.7798	0.0002	0.002	<0.001			

Results

Distribution of CSNT

Stalk nitrate decreased with distance from the soil with the exception of the first section 0 to 1 inch above ground. Fields that were low in CSNT (two fields at the Musgrave Research Farm) showed no differences among stalk sections (Figure 1, top chart). However, for fields that were optimal in N (two fields) and those that showed excessive N levels (six fields), nitrate accumulated at the bottom 10-12 inches of the stalks (Figure 1, middle and bottom charts).

Effect of sampling height (distance from ground) on 8-inch samples for CSNT

For corn that was low in stalk nitrate (CSNT less than 250 ppm; two fields), sampling height above the ground did not impact the CSNT of 8-inch samples as long as samples were taken 3 or more inches above the ground (Figure 1, top chart). For corn optimal in CSNT (250-2000 ppm), 8-inch samples could be taken from 5 to 9 inches above the ground without significant differences in CSNT. Taking samples 4 inches or closer to the ground did result in higher CSNT values than the standard 8-inch samples taken at 6 inches above the ground (Figure 1, middle chart).

Where stalks were excessive in CSNT (2000 ppm or higher), samples taken 1 or 2 inch above the recommended height of 6 inches were not significantly different, whereas samples taken closer to the ground showed higher CSNT levels and those taken higher above the ground were lower in CSNT (Figure 1, bottom chart).

The 8-inch stalk samples taken at 5 and 7 inches above the ground resulted in CSNT values than were less than 5% higher or lower than those obtained with the standard protocol of 8-inch stalks taken 6 inches above the ground. The 8-inch stalk samples taken 4 inches (or lower) or 8 inches (or higher) above the ground had CNST means that were more than 10% higher or lower than the CSNT obtained with the standard protocol (Table 1).

Nutrient Mangaement

Effect of stalk length on CSNT

Six-inch samples resulted in CSNT values within 5% of the standard protocol only when samples were taken 7 inches above the ground (Table 1). The CSNT of 7-inch stalks was within 5% when samples were taken 6 inches above the ground. Seven-inch samples taken 7 inches above the ground showed less than 5% deviation in CSNT as well, but this alternative requires a 14-inch chopping height (i.e. no different from the standard protocol). Samples taken 5 inches above the ground needed to be 9 inches or longer to be within 5% of the value obtained with the recommended 8-inch stalks, a disadvantage compared to the standard protocol (greater sample volume to handle).

Conclusions

The standard protocol for CSNT sampling is to take an 8-inch sample between 6 and 14 inches above the ground. Results within 5% of this value can be obtained with sampling of (1) 7-inch stalks taken between 6 and 13 inches above the ground, or (2) 6-inch stalks taken between 7 and 13 inches above the ground. Both alternatives reduce sample volume (by 1 and 2 inches, respectively) and allow for sampling after harvest for fields chopped at 13 inches or higher.

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Crop Management

Corn Silage Hybrids and Plant Populations

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We evaluated the grain and silage yield response of nine hybrids from 1991 to 1993 and reported maximum yields at 36,000 kernels/acre for silage and 31,000 kernels/acre for grain (What's Cropping Up, 1993 Vol.3, No.6, p.1-3). Silage quality, especially neutral detergent fiber (NDF), and crude protein (CP), decreases as plant populations increase (What's Cropping Up?, 1997, Vol.7, No.1, p. 2-3), so we currently recommended seeding rates at about 34,000 kernels/acre to offset the silage quality decline as populations increase. We also demonstrated in the late 1990s that leafy and brown midrib hybrids have similar yield and quality responses as other hybrids to plant populations so we also recommend dropping at about 34,000 kernels/acre for leafy and brown midrib hybrids (What's Cropping Up, 2000,Vol.10, No.1, p.4-6). Nevertheless, some still question whether leafy and brown midrib hybrids should be planted at 34,000 kernels/acre. Consequently, we initiated a 2-year study at the Aurora Research Farm in 2008 and 2009 to evaluate two Pioneer (34T55 and 34A89), two DeKalb (DKC61-69 and DKC63-42), two leafy (TMF2Q716 and 2W587, Mycogen), and two brown midrib (F2F566 and F2F610, Mycogen) hybrids at planting rates of 25,000, 30,000, 35,000, and 40,000 kernels/acre to determine if different corn silage hybrid types have different yield and quality responses to plant populations. We planted the study during the last week of April and harvested during the first week of September in both growing seasons.

Table 2. Planting rate effects on moisture and yield (tons/acre@65% moisture) of two Pioneer, two DeKalb, two leafy, and two brown midrib (BMR) corn silage hybrids, averaged across the 2008 and 2009 growing seasons, at the Aurora Research Farm.

	HYBRIDS							
	Pioneer	**DeKalb**	**Leafy**	**BMR**	**Pioneer**	**DeKalb**	**Leafy**	**BMR**
PLANTING RATE	**MOISTURE**				**YIELD**			
Kernels/acre	--------------------%---------------				----------------tons/acre (65% H20)---------			
25,000	67.1	67.9	66.3	69.0	25.3	25.5	23.2	22.2
30,000	66.7	67.9	66.6	68.9	26.0	25.6	24.3	24.0
35,000	66.5	68.1	66.1	68.7	26.6	**26.0**	**25.7**	**24.8**
40,000	67.3	67.9	66.4	69.2	**27.6**	25.8	25.8	24.8
Avg.	66.9	67.9	66.3	69.0	26.4	25.7	24.8	23.9

The 2008 and 2009 growing seasons had close to normal total growing degree days (GDD) from May through August with 10 GDD above normal in 2008 and 55 GDD below normal in 2009 (Table 1). Likewise, total precipitation from May through August averaged close to normal compared with the 30-year average of 14.18 inches. Consequently, growing conditions for corn silage production at the Aurora Research Farm in 2008 and 2009 were probably as close to normal as possible for two consecutive growing seasons.

When averaged across growing seasons, there was indeed a hybrid by planting rate interaction but that was because the Pioneer hybrids yielded best at 40,000 kernels/acre, whereas the DeKalb, leafy, and brown midrib hybrids did best at 35,000 kernels/acre (Table 2). Planting rates did not affect moisture at harvest (Table 2). As expected NDF showed a linear increase and CP showed a linear decrease as planting rates increased (Table 3). The CP decreased presumably because the increased yield at higher plant populations resulted in a dilution effect on the N or CP. The NDF usually increases as plant populations increase because there is less grain in the crop at the higher plant densities but plant populations had

Table 1. Average growing degree days (GDD) and monthly precipitation at the Aurora Research Farm during the 2008 and 2009 corn silage growing seasons.

	GROWING DEGREE DAYS			PRECIPITATION		
Month	2008	2009	30-yr mean	2008	2009	30-yr mean
		°F			in.	
May	236	330	315	1.39	3.77	3.17
June	586	454	498	3.76	4.75	4.09
July	677	555	632	5.44	2.43	3.31
August	547	642	591	3.03	3.64	3.61
Total	2046	1981	2036	13.62	14.59	14.18

Crop Mangaement

no effect on starch concentrations in this study. Consequently, we are not sure why NDF increased as plant populations increased. As shown previously, plant populations did not affect NDFD (What's Cropping Up?,1997 Vol.7, No.1, p.2-3).

Table 3. Planting rate effects on silage quality, including neutral detergent fiber (NDF), 30-hr NDF digestibility (NDFD), crude protein (CP), and starch of two Pioneer, two DeKalb, two leafy, and two brown midrib (BMR) corn silage hybrids, averaged across the 2008 and 2009 growing seasons, at the Aurora Research Farm.

	HYBRIDS							
	Pioneer	DeKalb	Leafy	BMR	Pioneer	DeKalb	Leafy	BMR
PLANTING RATE	**NDF**				**NDFD (30 hr)**			
Kernels/acre	------------------------%------------------				------------------------%----------------------			
25,000	39.8	39.5	40.1	41.3	58.7	58.3	58.7	71.2
30,000	40.8	39.9	41.4	41.1	59.3	57.7	59.1	72.3
35,000	40.9	39.9	40.4	41.1	57.9	57.2	59.6	72.2
40,000	**41.4**	**40.6**	**42.0**	**42.5**	59.3	57.4	59.5	73.0
Avg.	40.7	39.9	40.9	41.5	58.8	57.6	59.2	72.2
	CP				**STARCH**			
25,000	**8.9**	**8.6**	**8.8**	**8.8**	33.3	34.6	34.6	33.3
30,000	8.5	8.3	8.6	8.6	34.2	34.6	34.5	32.1
35,000	8.3	8.3	8.4	8.5	33.9	34.9	34.8	32.6
40,000	8.2	8.1	8.2	8.4	33.8	34.7	34.0	31.5
Avg.	8.5	8.3	8.5	8.6	33.8	34.7	34.5	

Conclusion:

Based on the results of this study, we will continue to recommend planting rates of about 35,000 kernels/acre for all hybrids, regardless of the hybrid type. The DeKalb, leafy, and brown midrib hybrids had their highest yield at 35,000 kernels/acre with no real detrimental effect on NDFD and starch concentrations, the major determinants of silage quality. The Pioneer hybrids however yielded best at 40,000 kernels/acre with just a slight increase in NDF and a decrease in CP in the 2 years of this study when drought stress did not occur. Consequently, corn silage producers may wish to experiment with higher seeding rates for Pioneer hybrids, especially with these two hybrids on soils or in regions where drought does not occur often. The results of this study indicate that leafy and BMR hybrids yield best at 35,000 kernels/acre under NY growing conditions when drought stress does not occur.

Weed Management

Residual Herbicides Help Control Common Lambsquarters in Glyphosate-Resistant Soybeans

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Erratic common lambsquarters control in glyphosate-resistant (GR) soybeans is an ongoing problem for growers who rely on postemergence (POST) applications of glyphosate alone. While normal application rates of glyphosate alone will control small (less than 3 or 4 inches tall) lambsquarters, these rates sometimes miss larger plants. Larger lambsquarters can usually be controlled with higher than normal glyphosate rates (1.5 to 2 times normal). Tank-mixes of glyphosate with Harmony SG or with Synchrony XP can also improve lambsquarters control but these combinations can cause crop injury.

A two-pass program that includes a residual herbicide will guarantee excellent lambsquarters control in GR soybeans. Residual herbicides can be part of a preplant burndown application in no-tillage fields or can be applied preemergence (PRE) in conventionally tilled fields. These residual herbicides either control lambsquarters directly or suppress the population so that sequential glyphosate applications easily control the small lambsquarters that have not been controlled. Although this approach adds an extra application in conventionally tilled fields and in no-tillage fields that are not candidates for a burndown application, it insures excellent weed control and can play an important role in herbicide resistance management.

Preemergence Residual Applications

An experiment on a commercial farm near Moravia, NY demonstrated the relative effectiveness of several PRE residual herbicides. The experiment, established in a conventionally tilled field, was planted May 20, 2009 and PRE herbicides applied May 22. Lambsquarters control ratings were made 5 weeks after treatment (WAT) and again just prior to sequential late POST (LPOST) glyphosate applications. Lambsquarters control 5 WAT was 95% or greater for all six herbicides (Table 1). Some differences among these herbicides developed over the next several weeks. Lambsquarters control was still at or near 100% with Valor SX (flumioxazin), Canopy EX (a mixture of chlorimuron and tribenuron), and with Enlite (a mixture of chlorimuron, flumioxazin, and thifensulfuron) 8 WAT. Control with Python (flumetsulam) was 92% while control with Prefix (a mixture of fomesafen and metolachlor) and with Linex 4L (linuron) had decreased to 78 and 80% respectively by 8 WAT. LPOST glyphosate applications easily controlled small, late-emerging lambsquarters so all six treatments provided excellent control of this and other annual weeds.

Table1. Percent common lambsquarters control in glyphosate-resistant soybeans following preemergence herbicide applications near Moravia, NY in 2009.

Preemergence Herbicides	Rate Amt/A	% Lambsquarters Control	
		5 WAT	8 WAT
Prefix	2 pt	95	78
Python WDG	0.8 oz	100	92
Linex 4L	1 pt	95	80
Valor SX	2 oz	99	99
Canopy EX	1.1 oz	100	98
Enlite	2.8 oz	100	100
LSD (0.05)		2	4

Lambsquarters is easiest to control with glyphosate when less than 3 to 4 inches tall.

No-Tillage Burndown

A second experiment, at the Musgrave Research Farm near Aurora, demonstrated the residual activity of several herbicides in no-tillage soybeans. Preplant burndown herbicide treatments were applied May 30, 2009 and soybeans planted June 10. All burndown applications included 22 fl oz/A of Roundup PowerMax and 3.4 lb/A of ammonium sulfate (AMS). Weed control ratings were made 5 WAT prior to mid-POST (MPOST) glyphosate applications on July 9. Control ratings for common ragweed and giant foxtail demonstrated the residual activity of some of the burndown treatments. Ratings in Table 2 show that ragweed and foxtail control averaged about 70 and 60% 5 WAT following burndown applications of 22 fl oz/A of Roundup PowerMax alone, or in combination with 1 pt/A of 2,4-D LVE respectively. The combination of Roundup PowerMax and Valor SX provided 91 and 80% ragweed and foxtail control respectively. Finally, combinations that included Valor XLT (a mixture of flumioxazin and chlorimuron) or Canopy EX resulted in plots that were nearly weed free prior to sequential MPOST Roundup PowerMax applications. According to the label, Canopy EX should not be used north of Interstate 90 in NY State and should not be applied to fields with soil pH greater than 7.6. Although the lambsquarters' population in the plot area was not adequate for meaningful control ratings, each of these residual herbicides has good activity against this annual broadleaf weed.

Table 2. Percent common ragweed and giant foxtail control following preplant burndown applications in no-tillage soybeans near Aurora, NY in 2009.

Preplant Herbicides*	Rate Amt/A	% Control 5 WAT	
		Ragweed	Foxtail
Roundup PowerMax	22 fl oz	73	57
+ 2,4-D LVE	1 pt	70	63
+ Valor SX**	2 oz	91	80
+ Valor XLT**	2.5 oz	100	99
+ Canopy EX**	1.1 oz	100	96
LSD (0.05)		9	14

*All preplant burndown treatments included 3.4 lb/A AMS.

**Included 1% (v/v) methylated seed oil (MSO).

Resistance Management Strategy

Two-pass programs assure excellent weed control and provide the option of using herbicides with different sites-of-action than that of glyphosate products. In the long run, this herbicide resistance management strategy will go a long way in delaying or preventing development of glyphosate-resistant weed populations. Soybean growers should give this option serious consideration.

Calendar of Events

Mar. 24, 2010	**Cornell Soil Health & Adaptive Nitrogen Management Training, Ithaca, NY**
June 3, 2010	**Small Grains Management Field Day, Musgrave Research Farm, Aurora, NY**
June 27-30, 2010	**Northeast Branch Crops, Soils, and Agronomy Conference, Ithaca, NY**
July 8, 2010	**The Seed Growers Field Day, Foundation Seed Barn, Ithaca, NY**
July 14, 2010	**Weed Science Field Day, Thompson Research Farm, Freeville, NY (morning program)**
July 14, 2010	**NYSABA Summer BBQ, Musgrave Research Farm, Aurora, NY (12:00 noon)**
July 14, 2010	**Weed Science Field Day, Musgrave Research Farm, Aurora, NY (afternoon program)**
July 22, 2010	**Aurora Farm Field Day, Musgrave Research Farm, Aurora, NY**
Aug. 16-19, 2010	**International Cornell Soil Health Train-the-Trainer Workshop, Ithaca, NY**

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