What's Cropping Up?

A NEWSLETTER FOR NEW YORK FIELD CROPS & SOILS   VOLUME 18, NUMBER 1, JAN. - FEB., 2008

How to Interpret and Use the Cornell Soil Health Test (CSHT) Report

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Since 2003, the Cornell Soil Health Team has been working to develop an integrative approach to soil management by measuring soil physical, biological and chemical properties. This strategy was previously discussed in 2006 in What's Cropping Up?, Vol. 16 No. 2 & No. 3. We introduced the new Cornell Soil Health Test (CSHT) in early 2007 (What's Cropping Up?, Vol. 17 No. 1) to the public as a fee-for-service analysis. Here, we discuss the interpretation of the Cornell Soil Health Test Report to facilitate better soil management. For many, much of this information is new, and we will discuss approaches to maximizing its utility.

CORNELL SOIL HEALTH TEST REPORT					
FARM NAME/FARMER: Gates Farm			SAMPLE ID: e906	DATE:	5/6/2007
ADDRESS: Geneva Experimental Station			E-MAIL:	PHONE:	
FIELD/TREAMENT: PLOW TILL, VEGETABLE ROTATION			AGENT: George Abawi	SLOPE:	
TILLAGE: MOLDBOARD, DISK 2X			DRAINAGE: Adequate	SOIL SERIES:	
CROPS: SOY/ BEET/ SWEETCORN			SOIL TEXTURE: SILT LOAM	LIMA	

	INDICATORS	VALUE	RATING	CONSTRAINT	PERCENTILE RATING*
PHYSICAL	Aggregate Stability (%)	17.1	1.0	aeration, infiltration, rooting	
PHYSICAL	Available Water Capacity (m/m)	0.13	1.0	water retention	
PHYSICAL	Surface Hardness (psi)	114	10.0		
PHYSICAL	Subsurface Hardness (psi)	304	1.0	Subsurface Pan/Deep Compaction	
BIOLOGICAL	Organic Matter (%)	2.5	2.0	energy storage, C sequestration, water retention	
BIOLOGICAL	Active Carbon (ppm)	566	2.0	soil biological activity	
BIOLOGICAL	Potentially Mineralizable Nitrogen (µgN/ gdwsoil/week)	5.1	3.0		
BIOLOGICAL	Root Health Rating (1-9)	2.9	8.0		
CHEMICAL	pH (see CNAL Report)	7.3	10.0		
CHEMICAL	Extractable Phosphorus (see CNAL Report)	11.0	10.0		
CHEMICAL	Extractable Potassium (see CNAL Report)	51	7.5		
CHEMICAL	Minor Elements (see CNAL Report)		10.0		50th Percentile →BETTER
	OVERALL QUALITY SCORE (OUT OF 100)		LOW		54.6

Ratings on this report are based on generalized crop production standards for New York. For crop specific nutrient interpretation and recommendation, see the attached chemical test report.

Figure 1. A typical Cornell Soil Health Test Report.

The Report (Figure 1) has been optimized towards improved soil management practices. For each, color-coded results shown on the report include the measured value, a 1-10 rating (<3 red, 3-<8yellow and > 8 green) scaled according to soil texture, a listing of constraints when a rating is less than 3 (low), and a percentile rating that relates the measured values to others in our database. An overall soil quality score at the bottom integrates the suite of indicators. It is important to recognize that the information presented in the report is not intended as a measure of a grower's management skills. Instead, the report is really a tool that allows growers to target their management efforts to address

Soil Health Data and Scoring

The CSHT Report shown in Figure 1 is from an intensively managed silt loam soil. Low values of three physical and two biological indicators return red ratings and the soil functional constraints are listed. This soil would be susceptible to crusting and hard-setting with low water storage capacity. A deep restrictive layer or 'pan' is present. The low amount of organic matter is coupled with low activity of soil organisms.

Soil Health

specific soil constraints. Complex soil interactions prohibit extensive judgments of results between the soil indicators except in the case of controlled studies where adequate randomization and sampling intensity can allow for such hypothesis testing.

As an entry point in our understanding of soil health, we can take any identified soil constraint as management targets. When multiple constraints are considered together we can develop a best management plan to restore full functionality to the soil. Efficient users of the information will realize that implementing a single practice can affect more than one indicator and therefore multiple soil functional properties.

Linking Soil Health Indicators to Management

LOW AGGREGATE STABILITY:
short-term: integrate shallow-rooted cover or sod-rotation crops, add manures
long-term: reduce tillage intensity

LOW AVAILABLE WATER CAPACITY:
short-term: add stable organic matter (e.g. compost)
long-term: reduce tillage intensity

HIGH SURFACE HARDNESS:
short-term: localized physical soil loosening (e.g., strip tillage); frost tillage, cover crops and organic matter additions
long-term: integrate shallow-rooted cover or rotation crops; avoid traffic on wet soils; use controlled traffic lanes

HIGH SUB-SURFACE HARDNESS:
short-term: targeted physical soil loosening at depth (e.g., zone building, ripping, strip tillage); inte deep-rooted cover crops
long-term: avoid moldboard plows and disks that generate tillage pans; reduce equipment loads; avoid heavy equipment traffic on wet soils

LOW ORGANIC MATTER and LOW ACTIVE CARBON:
short-term: integrate cover or sod rotation crops; add manure or compost
long-term: reduce tillage

LOW POTENTIALLY MINERALIZABLE NITROGEN:
short-term: add N-rich organic matter (not excessive); use legume cover / rotation crops
long-term: reduce tillage

HIGH ROOT ROT RATING:
use proper rotations, cover crops, appropriate chemical and biological control products

LIMITING LEVELS OF pH OR NUTRIENTS: see CNAL recommendations

Figure 2. Long- and short-term management strategies to address soil health indicator constraints.

Figure 2 is taken from the Cornell Soil Health Assessment Training Manual (Gugino et al. 2007), which provides more extensive information on the CSHT and management practices. The Cornell Soil Health Training Manual can be downloaded at soilhealth.cals.cornell.edu. Figure 2 shows linkages between measured soil constraints and soil management practices for both the short- and long-term. Combining these with growers' needs and abilities provides for active scenario-testing and discussion. This facilitates knowledge sharing between regional extension educators, consultants, and growers. Local 'success stories' of specific management practices that effectively address targeted soil constraints also provide for a regional knowledge base of soil management consequences. There are no specific 'prescriptions' for what management regimen must be followed to address the highlighted soil health constraint, yet we can recommend a number of effective practices to address specific constraints.

The Soil Health Management Toolbox

⇒ Reducing or modifying Tillage

⇒ Crop Rotation

⇒ Growing cover crops

⇒ Adding organic amendments

Figure 3. Strategies for soil health management.

The Soil Health Management Toolbox (Figure 3) lists the main categories of action for soil management. These techniques can be used singly or in combination. The same constraint can be overcome through a variety

Grain Crop Grower Issues

Fields managed for top grain crop production are well suited to reduced tillage/ planting systems. No-till drilling of grain crops reduces soil disturbance and saves operator time. Heavy harvesting equipment in the field can compact surface and subsurface soil layers. Choosing shorter-season crop varieties may open planting windows for short season cover crop (green manure) establishment. Identify windows for application of off-farm sources of manure and composts.

of management options. The option a grower chooses may depend on farm-specific conditions such as soil type, cropping, equipment and labor availability etc. Therefore, each grower is faced with a unique situation in the choice of management options to address soil health constraints. Different land use systems afford their own sets of opportunities or limitations to soil management.

The principles outlined below can assist in interpreting the Cornell Soil Health Test Reports. **1. The report is a management guide and not a prescription:** The report basically shows the aspects of the soil needing attention in order to enhance productivity and sustainability. Growers should see this report as a tool in planning the best soil management strategies for their fields. The new information provided by the test on the physical and biological aspects of the soil, together with the nutrient analysis results gives a better picture on the state of soil health.

Choose management approach from information and ability

When soil constraints are identified, it is important to implement soil management strategies that specifically address the issue(s) without negatively affecting the soil.

Choice of the most appropriate techniques will vary with grower expertise. If multiple constraints are identified, adoption of efficient or innovative management practices can address target issues simultaneously.

2. Different management approaches can be used to mitigate the same problem: As previously mentioned, the choice and details of management efforts to be used in overcoming soil health constrains are dependent on resources available to the farmer. For example, growers seeking to increase the soil organic matter of their fields might approach this either by using reduced tillage practices or by adding organic manure or by combining both methods, the latter generally yielding the best results.

3. In addressing some soil constraints, management practices can affect multiple indicators: Many of the soil health indicator measurements can benefit from a single management practice. For example, adding manure to the soil improves soil aggregation; increases organic matter and active carbon content; and improves soil nutrient status. However, the magnitudes of these effects are dependent on the specific management practices and soil types.

4. While certain indicators are generally related, a direct explanation of indicator relationships may lead to misleading interpretations: While the soil health indicators are generally inter-related, the degrees of interrelationships vary with soil type and previous management history. For example, a general linear relationship exists between organic matter and active carbon contents in many of our samples. However, there are some cases where this relationship is not true. Active carbon deals with relatively fresh organic carbon available for easy microbial decomposition. A soil may be high in organic matter but be lacking the fresh decomposable component, which leads to a low active carbon content.

5. Direct comparison of two fields that have been managed differently may lead to confounded interpretations: Comparing two test reports of fields from different areas or that have been managed differently are not valid ways to use the CSHT report. The absence of baseline data from such comparisons makes it impossible to judge the direction of change of the soil health indicators. However, if a field was managed the same way and then divided up into sections with different management practices, the CSHT can be used to compare these management alternatives.

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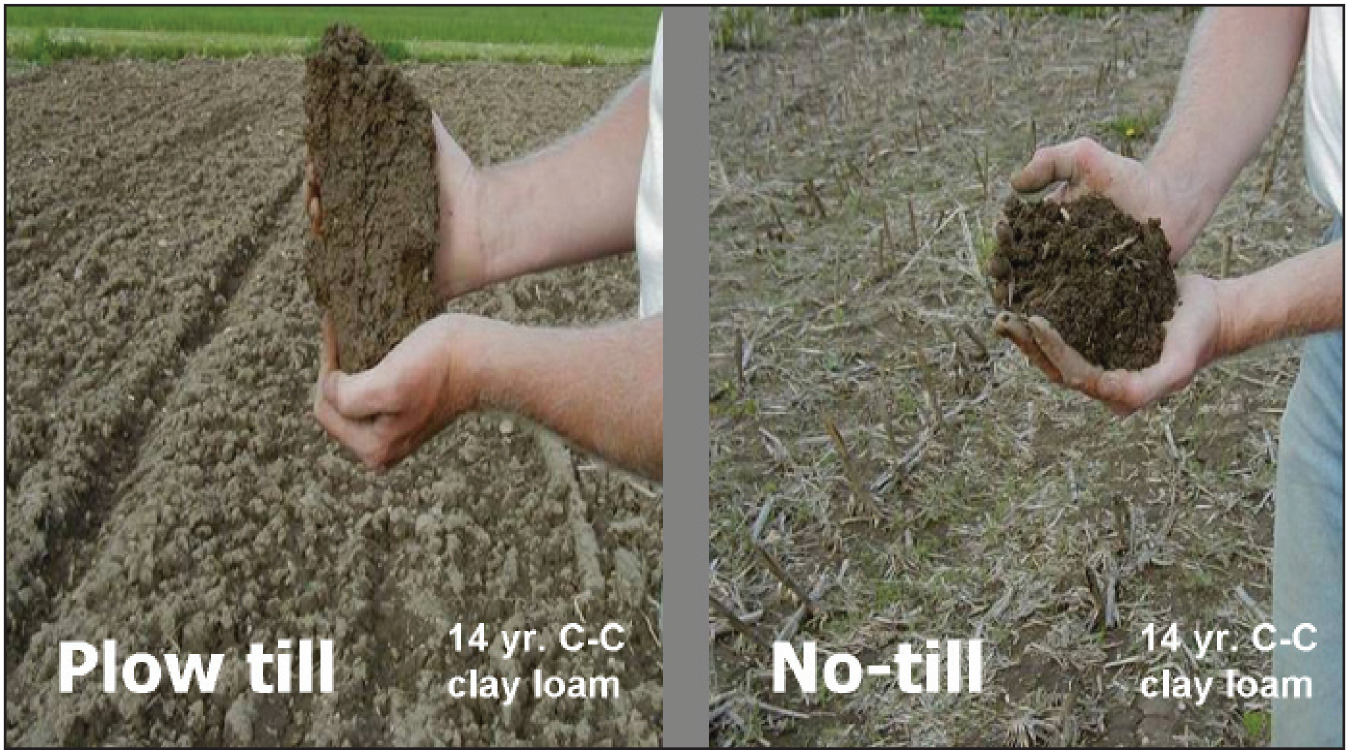

6. Soil health changes slowly over time: Generally, management recommendations to address soil health constraints take time for desired effects to be shown. This is unlike what happens with chemical amendments such as fertilizers. Some changes can be seen in the short term while other management options take a longer period to effect change. For example, deep tillage to address subsurface compaction can produce an immediate effect within a season. However, planting of deep rooted cover crops or conversion to no-tillage may take up to 3-5 years before changes can become noticeable. Remember, soil health management is a long-term strategy!

Organic Management Improves Soil Health: Results from the Organic Grain Cropping Systems Experiment

Soil Health

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The Organic Cropping Systems Project (OCS) has developed long-term experiments comparing organic vegetable and grain production systems. In addition to providing important research results, field days at the experiments serve as practical "living laboratories" for farmers to learn about natural processes at work on organic farms and how these can be affected by management. This past summer, soil health was the focus of field days at both the grain and vegetable experiments. Farmers were treated to hands-on demonstrations of how to measure aspects of soil health by members of the Cornell Soil Health Program Work Team.

Cash grains management systems

The ongoing organic grain systems trial started in 2005 through a grant from the USDA Integrated Organic Program. This experiment is located at the Musgrave Research Farm in Aurora, New York and compares five different systems using two rotation entry points and four replications. The first three years of the trial focused on the organic transition process. Research has included intensive sampling to assess the effectiveness of different management practices on soil quality, yield, weed control, pest damage, nutrient balance, and economic viability. We report the highlights of our soil health findings here.

The organic systems compare different tillage, weed management and nutrient regimens. System 1 simulates an organic farm where the goals are to maximize income using high fertility inputs. Compost is a major nutrient and organic matter input, while cover crops are used to retain N over the winter. System 2 represents a typical organic cash grain farm with limited nutrient inputs. Minimal fertilizer is used and the only cover crop is clover before corn. In both systems 1 and 2 standard tillage practices and cultivation tools are used. System 3 simulates an organic cash grain farm with heavier emphasis on weed management. Nutrient management is similar to System 2. Winter cover crops are used to help suppress weeds. Enhanced cultivation tools coupled with the use of short fallows, high winter grain seeding rates and other approaches are used to minimize weed problems. System 4 employs ridge tillage to reduce energy use and potential soil damage from deep tillage. Ridges are scraped off by a planter attachment and rebuilt during cultivation. This system also allows controlled wheel traffic so that the crop rows are not compacted by traffic. System 5 is a control under conventional management. It uses standard tillage, fertilizers, herbicides, and no winter cover crops. This system uses the same varieties and organically grown seeds as the others. The management systems are summarized in Table 1.

Table 1. Organic Grain Cropping Systems

System	
1	High nutrient input
2	Typical cash grain/ limited inputs
3	Intensive weed management
4	Ridge tillage
5	Conventional

The crop rotation in all systems follows that used by Klaas and Mary-Howell Martens and other organic cash grain farmers in central New York. The 3-year rotation sequence is soybean; spelt undersown with red clover; then corn. Two entry points into this rotation are summarized in Table 2.

Table 2. Entry Points A and B

Year	Entry A	Entry B
2005	Soybean	Corn
2006	Spelt/clover	Soybean
2007	Corn	Spelt/clover
2008	Soybean	Corn

Soil Health Results

Soil quality measurements in the grain trials showed an improvement in the transitional

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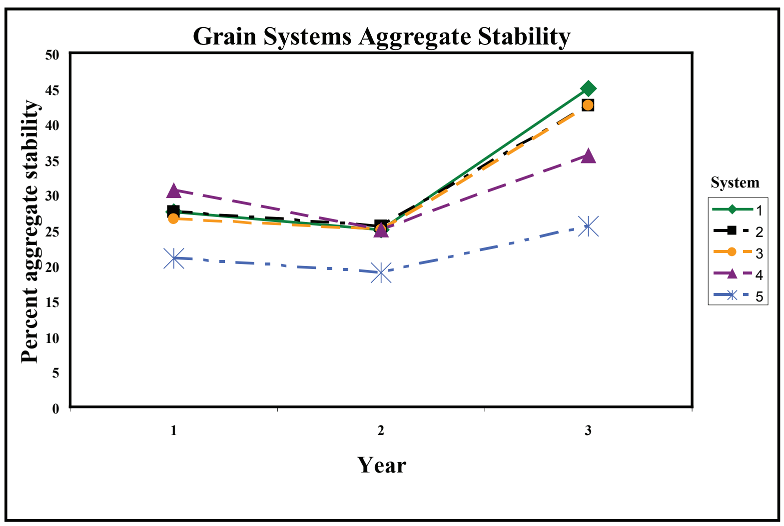
organic plots compared to the conventional system after two years of organic management. It should be noted that the measured values for soil quality parameters for all systems in this experiment are relatively low when compared to other silt soils studied by the Cornell Soil Health Team. However, positive trends were observed for aggregate stability, total organic matter, active carbon, available water capacity, and potentially mineralizable N. Aggregate stability is the percentage of soil crumbs that remain stable when subjected to 0.5 inches of rainfall in 5 minutes. Organic matter is what forms and holds these soil crumbs together. Active carbon is a measure of the amount of organic matter that is available to feed the life of the soil. Available water capacity measures the amount of water that can be held in the soil for use by plants. It decreases when soil is compacted. Potentially mineralizable N is the amount of N that the soil can release for use by crops.

The amount of fungi waiting to rot crop roots is measured by examining the roots of snap beans that have been growing in the soil for 4 weeks. Snap beans are highly susceptible to root rot diseases that attack many crops, and the degree of damage can be rated on a scale of 1 to 9 by comparison with photographs. This measure of soil rotting fungi was in the healthy range for all systems

Systems 1, 2, and 3 did not differ for any measurement except that System 1 had greater active carbon than system 2 in Entry A, probably due to more crop residue from greater crop productivity.

Aggregate stability tended to improve under organic management. Baseline values for aggregate stability taken in 2005 varied little among systems, and the systems also remained similar in 2006 (Figure 1). Only at the beginning of the third year did systems differ. Aggregate stability tended to increase in all systems in 2007, but the greatest increase occurred in Systems 1-3. This improvement occurred despite greater soil disturbance in the organic systems. Higher aggregate stability values indicate better soil aeration, water infiltration, and crop rooting. The increase in aggregate stability in the organic systems may have been due to use of cover crops or due to the absence of chemical fertilizers which tend to break down soil aggregates. More work will be needed to determine whether aggregate stability remains higher in the organic systems, and what mechanisms are creating the differences.

Figure 1. Changes in aggregate stability through time.



Aggregate stability also tended to be high in System 4 (ridge tillage), particularly in the areas between ridges. Soil in the valley bottoms has not been disturbed since the beginning of the experiment, and this may have allowed formation of highly stable aggregates. Generally aggregate stability is improved by lack of tillage.

Available water capacity is another indicator of physical soil health. Available water measures the ability of the soil to store water in pores and then release it to crop roots. The main variation across systems was that the valleys between ridges in System 4 tended to have lower available water capacity. This may be due to compaction in the wheel tracks. Comparing the low available water capacity of the valleys with their relatively high aggregate stability values shows that various measures of soil health do not necessarily vary together. The conventional system showed lower available water capacity in Entry B.

Active carbon measures the amount of organic matter in the soil that is available to support biological activity. It is generally low across all the systems in this experiment, though levels in the organic systems were higher than those in the conventional system in 2007. The clover in Systems 1-3 in Entry Point A at the time of sampling probably contributed to higher values in those plots. All of the organic systems (Systems 1-4) in Entry Point B received a heavy application of dairy manure compost before corn in the first year of the experiment, and this could contribute to higher values in the organic treatments in that entry point.

Potentially mineralizable N is an indicator of the N supplying capacity of the soil. It was significantly higher in Systems 1-3 in Entry Point A, probably due to the presence of a good stand of clover at the time the samples were taken (Table 1). Values also tended to be higher, however, in the organic systems in Entry Point B, but the data were too variable to show statistical significance.

Conclusion

The data clearly show changes in the soil quality entering the third year of the experiment. In general, organic management appears to be improving soil health, though the performance of the organic ridge tillage plots is variable. Although these are preliminary results, emerging differences between the systems show the potential for organic systems to rapidly improve some measures of soil health. Further research on these systems will determine if these trends persist.

Table 3. 2007 Soil health measurements in grain systems

System	Aggregate Stability %	Available Water Capacity (ft3/ft3)	Active Carbon (ppm)	Potentially Mineralizable N (µg N/ g soil/week)
Entry A (clover at sampling, then corn)				
System 1, 2 & 3, organic	48.3 a	0.147 a	526 a	12.4 a
System 4, organic, between ridges	51.1 a	0.127 b	458 bc	9.1 ab
System 4, organic, ridges	42.8 a	0.152 a	470 ab	6.0 bc
System 5, conventional	25.6 b	0.147 a	369 c	4.0 c
Entry B (spelt at sampling, then clover)				
System 1, 2 & 3, organic	37.9 a	0.138 ab	518 a	6.4 a
System 4, organic, between ridges	43.2 a	0.135 ab	498 a	7.3 a
System 4, organic, ridges	27.3 b	0.149 a	522 a	7.3 a
System 5, conventional	24.4 b	0.130 b	385 b	4.6 a

Systems 1, 2, and 3 did not differ for any measurement except that System 1 had greater active carbon than system 2 in Entry A.

Values followed by the same letter do not differ significantly at $P < 0.05$

Pest Management

Corn Rootworm Choices: Which one is best for you?

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The predicted increase in the price of corn for the next several years has producers seriously considering a significant increase in their corn acreage for 2008 and beyond. These increasing acreages will cause producers to alter their rotations and may contribute to new production problems not previously observed on the farm. Increased corn rootworm (CRW) damage may be one of these issues. With the BT-CRW corn varieties competitively priced with the chemical control options, the choice of rootworm control can be a more difficult one.

Since adult corn rootworm lay their eggs in existing corn fields during August of the previous year, the risk of an economically damaging rootworm larval population increases with the number of years of continuous corn in the field. For example, first year corn has a very low risk for rootworm damage unless there was volunteer corn in the field the previous year. The risk of economic rootworm damage increases in second year corn to 25-35%. Third year corn has an increased risk of 50-70% while fourth year and longer continuous corn has a risk of 80-100%.

Cash grain production vs. Corn silage production:

Many cash grain operations grow corn on an annual rotated basis with another crop (wheat or soybeans). In this situation, the rotation eliminates corn rootworm as a significant economic problem. However as these annual rotations become continuous corn fields due to the attractive corn price, corn rootworm will become an increasing problem and will require a higher level of management. In contrast, the corn silage producer is usually rotating corn production with a longer term perennial crop like alfalfa or alfalfa-grass mixture. The multi-year nature of the forage crop usually means that the corn silage crop is grown on a continuous basis for 4 or more years in the same field. Many corn silage producers are in the habit of employing corn rootworm management tools in their continuous corn fields.

Seed treatments:

There are two rates of seed treatments (Poncho, Cruiser) available on your corn seed purchases. The lighter rate (0.25mg/kernel) works only on the seed emergence insect pests (seed corn maggot, wireworm) and will not give adequate control of corn rootworm. The heavier rate (1.25 mg/kernel) is the effective corn rootworm rate. The heavier rate has performed well in NY university trials since they were first tested in 2000. Corn rootworm pressure is manipulated to be much higher in the university trials than is commonly present in commercial corn production fields. During the past 2 years, a number of fields have been suspected as seed treatment failures but upon closer inspection, the lodged plants were a result of soil compaction, wet fall soil conditions or herbicide injury to the roots. Seed treatments remain effective on moderate to heavy rootworm pressure and logically fit into the second and third year of continuous corn.

Strategies to prevent resistance to seed treatments:

The use of the Corn Rootworm rate of Poncho™/Cruiser™ should not be the only CRW management tool used on the entire farm. It is suggested that no more than 50% of the corn acreage on a farm should be exposed to the CRW rate of Poncho™/Cruiser™ to prevent the entire CRW population from being exposed to lethal doses of these materials and accelerate insecticide resistance development. Good stewardship and smart IPM practices early in the life of an insecticide reduces the probability of resistance development and the premature loss of the insecticide from the market place.

BT-CRW resistant varieties:

Two new GM-Rootworm resistant families of corn varieties are available for 2008 (Herculex-RW™, Yieldgard-VT™) and an older family of GM-resistant corn varieties are still available in the market place (Yieldgard-RW™). All three BT-Toxin types work well under NY growing conditions. However, if corn producers choose to plant one of the GM-rootworm resistant varieties, a 20% non BT-CRW refuge is required to be planted by EPA. The location of the refuge is required to be either within the BT-CRW field or immediately adjacent to the BT-CRW field. The refuge must be planted in a field with the same field history as the BT-CRW field using a variety with similar maturity dates. In addition, the refuge must be planted on the same day as the BT-CRW field. Either a CRW seed treatment or soil insecticide can be used in the refuge to minimize damage from corn rootworm present.

With the attractive pricing of the BT-CRW option, the "cost" of the refuge should also be evaluated when considering the economics of planting one of these varieties. Under NY rootworm pressure, the logical place for the BT-CRW varieties is in fields planted to corn for 3 or more years.

Soil insecticide:
The soil insecticide option has fallen out of favor due to producers' dislike of handing the materials. However, this option remains very effective against corn rootworm under NY growing conditions. In addition, pricing of soil insecticide has remained very competitive with the other control options. Should a producer consider this option, a 75% label rate remains very effective in the lower risk fields (2nd and 3rd year continuous corn) and these less than label rates may be significantly cheaper than the rootworm seed treatment rate and the BT-CRW option. The full label rate is not necessary in most situations until the rootworm risk rises to the level found in the typical 4th year or longer of continuous corn. When using a granular soil insecticide, remember that the soil insecticide applicators need to be calibrated.

Suggested deployment of Corn Rootworm management options:
<u>1st year corn:</u>
Planter box seed treatment <u>OR</u> the low rate of Poncho or Cruiser on the seed. This treatment is necessary for stand protection against seed corn maggot and wireworm.

<u>2nd year corn:</u>
High rate of seed treatment (Poncho or Cruiser) <u>OR</u> soil insecticide at 75% of label rate.

<u>3rd year corn:</u>
High rate of seed treatment (Poncho or Cruiser) <u>OR</u> soil insecticide at 75%-full label rate OR plant a BT-CRW corn variety.

<u>4th year and longer continuous corn:</u>
Soil insecticide at the full label rate <u>OR</u> plant a BT-CRW corn variety.

Crop Management

Pardee Birdsfoot Trefoil: A Variety with Early Maturity and Good Persistence

Margaret Smith[1], Don Viands[1], Julie Hansen[1], Gary Bergstrom[2], and Bruce Tillapaugh[3], Department of Plant Breeding[1], Department of Plant Pathology[2], Wyoming County Cooperative Extension[3], Cornell University

Birdsfoot trefoil in mixture with cool season perennial grass is a good forage option for New York growers, especially on poorly-drained soils where much of our hay and pasture production occurs and where alfalfa does not do well. The most serious disease of birdsfoot trefoil is Fusarium wilt, which can kill trefoil even as early as the seeding year. A few years ago, Cornell's forage breeding project released a new Fusarium wilt resistant variety of trefoil named Pardee. Seed has been available for Pardee trefoil since spring 2003, but supplies remained limited. For the first time this year, seed supplies of Pardee are much more ample and it would be a great time to give this variety a try.

Pardee birdsfoot trefoil offers multiple advantages to growers compared to other commercially-available trefoil varieties. Pardee is a high yielding and persistent trefoil variety, whether Fusarium wilt is present or not. Table 1 shows results from a trefoil and timothy trial sown in Cobleskill in 2002, where Fusarium wilt was not observed. In the first production year, when three cuts were taken, there was no significant difference in season yield among the varieties. However, in the second and third production years, when four cuts per year were taken, Pardee plots yielded significantly more forage than the other varieties evaluated and the three year total forage yield for plots with Pardee was 10% higher than that of plots with the next best variety, Norcen.

There is more to the story than what is shown by these yield data alone. Whether grown in the presence of Fusarium wilt or not, Pardee is more persistent than other trefoil varieties. In Cornell trials sown with birdsfoot trefoil alone, Pardee was the only variety that had more than 50% stand of trefoil plants after the first production year. Table 2 shows data after three production years from Fusarium-inoculated trials and trials where no inoculation was done, to illustrate the advantage in persistence that Pardee has. When not inoculated with Fusarium wilt, Pardee had over 60% plant stand of trefoil after three production years, while the next highest stand was 33% for Norcen. This difference was even more dramatic in the presence of Fusarium wilt, where Pardee still had 52% plant stand after three production years and Norcen was next best at 18%. Due to these persistence differences, even though forage yields for other varieties may come close to those of Pardee, the Pardee forage will have much more trefoil in it, while the forage from other varieties will include a higher percentage of grass and/or weeds.

Like some other varieties, Pardee is an upright (hay-type) trefoil, but it matures earlier than other current

Table 1. Total season forage yields for three production years and three-year total yields of birdsfoot trefoil varieties sown with Chazy timothy in Cobleskill, NY in 2002.

	Total Season Yield, tons/A			Three-year Total	
Trefoil Variety	2003 (3 cuts)	2004 (4 cuts)	2005 (4 cuts)	Yield, tons/A	% of Norcen
Pardees	5.29	4.83	3.27	13.39	110
Norcen	5.47	4.21	2.52	12.20	-
Leo	5.13	4.14	2.60	11.88	97
Exact	5.40	3.93	2.55	11.88	97
LSD (.05)	0.50	0.39	0.30		

trefoil varieties. Pardee's early maturity can increase a grower's options for producing high quality forage over a wider range of harvest dates.

In managing trefoil, it is important to remember several important differences between trefoil and alfalfa. Trefoil plants regrow after cutting from the remaining green plant matter, not from the crown like alfalfa does. Thus, if cutting height is too low, trefoil regrowth on any variety will be set back considerably. This is especially true of Pardee, which does not have many leaves on the lower portion of the stems. Another difference between trefoil and alfalfa is that the nodules on trefoil roots die when it is cut (alfalfa does not lose its nodules when cut). Again, this sets trefoil back in terms of regrowth, so growers should expect a bit of lag time for the trefoil plants to re-establish nodules after cutting. Growers should leave at least 5" to 6" of stubble when cutting trefoil, in order to minimize the time it will take trefoil plants to establish good regrowth. For more information about birdsfoot trefoil and mixtures for New York, consult Jerry Cherney's Forage Species Selector Web site (http://www.forages.org/tools/fsst/fsst.asp) or contact your area field crops extension educator.

Pardee would be an excellent birdsfoot trefoil variety choice for New York growers. Although seed supplies in past years have been limiting, the seed supply for spring 2008 planting is good. It's definitely worth trying this new early maturing, high yielding, and Fusarium wilt resistant variety of birdsfoot trefoil.

Table 2. Total yield from three production years and percent stand after the third production year for both Fusarium-inoculated and non-inoculated plnts of birdsfoot trefoil varieties sown in pure stand.

	Fusarium-inoculated Trial [1]			Non-inoculated Trial [2]		
Trefoil Variety	3-year Total Yield, tons/A	Yield as % of Norcen	% Trefoil Plants in Stand	3-year Total Yield, tons/A	Yield as % of Norcen	% Trefoil Plants in Stand
Pardee	10.76	114	52	11.65	112	61
Norcen	9.42	-	18	10.37	-	33
Leo	8.33	88	12	(--- Leo was not in this trial ---)		
Exact	7.53	80	8	10.01	97	28

[1] Fusarium-inoculated trial was established in Ithaca in 2002; production years were 2003 throught 2005.
[2] Non-inoculated trial was established in Ithaca in 2004; production years were 2005 through 2007.

Crop Management

Spring N Management on Winter Wheat in New York?

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The price of wheat is at record highs and many growers have locked in prices above $6/bu for the 2008 crop. Unfortunately, the price of N is also at record highs with estimates that exceed $0.65/lb. Optimum spring N fertilization requires topdressing N at the correct time and rate and with the correct source to achieve maximum grain and straw yields without inducing lodging. An optimum spring N fertilization program is always one of the most important management practices on winter wheat, but especially so in 2008 because wheat and N prices are at record highs.

Some studies from the 1980s at the Musgrave Research Farm near Aurora can provide some guidance for topdressing N in 2008. A timing study in 1984-1985, in which a 60-lb N rate was applied at 2-week intervals from 1 March through 1 June, indicates that April is the optimum time to apply N to winter wheat (Table 1). Winter wheat usually breaks dormancy by mid-March, and green-up typically occurs during the last couple of weeks of March. At that time, there is sufficient N within the plant for the green-up period to proceed so no N is needed. Nitrogen applied from early to mid-March tends to be more vulnerable to N loss via denitrification or eventual leaching, explaining the low N fertilizer efficiency and high yield losses seen in Table 1.

Table 1. Grain yield of Geneva soft white winter wheat at a 60 lb actual N rate (ammonium nitrate), applied at two week intervals from March 1 until June 1 of the 1984 and 1985 growing seasons at the Musgrave Research Farm at Aurora.

Timing of N	1984	1985	Avg.
lbs/acre	Grain Yield (bu/acre)		
March 1	62	70	66
March 15	70	75	73
April 1	72	80	76
April 15	73	81	77
May 1	72	80	76
May 15	62	68	65
June 1	58	62	60
LSD 0.05	5	5	3

Winter wheat is in the tillering stage during the month of April and has a relatively low N requirement at this time. Nevertheless, an N application anytime from April 1-May 1 typically results in optimum yield, mainly because the N application occurs before but not too early before the stem elongation period in May, when wheat has a high N requirement. An N application in April also promotes tillering. An N application in mid-May, the middle of the stem elongation period, resulted in a 15% yield loss at the Aurora Research Farm probably because the N was not readily available for the entire peak N demand period of the crop. Winter wheat is a valuable crop this year and every effort should be made to topdress in April, if soil conditions permit. If conditions are too wet in April, topdressing should occur as soon as the soil dries in May.

The spring topdressing N rate depends on yield potential and lodging potential of the crop, soil type, and the residual soil N supply. If the yield potential is high and the lodging potential is low (based on past experience of the grower with respect to soil type/ variety/seeding rate/planting date/climatic factors, etc.), growers on silt loam soils may wish to consider a topdressing rate of 80-90 lbs/acre because grain yields can be increased by 5% and straw yields by 15% (Table 2). Likewise, growers on sandy or gravelly soils should consider a 70-80 lb/acre N rate because of the potential for lower N mineralization and greater leaching of N on these soils. If the field or the grower has a history of growing lodged wheat, the N rate probably should not exceed 60 lbs/acre because lodged wheat often results in reduced

Table 2. Grain yield and straw yield of Houser and Geneva soft white winter wheat varieties under different topdress N rates (ammonium nitrate) applied in April (with a second application in early May for the split-application treatments) of the 1985, 1986, and 1987 growing seasons at the Musgrave Research Farm near Aurora.

Actual N Rate	1985	1986	1987	Avg.
lbs/acre	---Grain Yield (bu/acre)---			
0	59	51	61	57
30	74	71	74	73
60	85	85	91	87
90	93	88	93	91
120	98	80	93	90
60 +30	86	80	91	86
60 +60	104	83	89	92
LSD 0.05	4	7	6	4
	--Straw Yield (Tons/Acre)--			
0	1.3	0.8	1.4	1.2
30	1.7	1.0	1.9	1.5
60	1.8	1.4	2.0	1.7
90	2.4	1.5	2.2	2.0
120	2.0	1.4	2.1	1.8
60 +30	1.9	1.4	2.1	1.8
60 +60	2.1	1.4	1.9	1.8
LSD 0.05	0.4	0.3	0.2	0.2

yields, slower dry-down, and much lower harvesting efficiency. Also, if the grower does not bale and sell the straw, the N rate should probably not exceed the 60-lb N rate on silt loam soils because the 5% grain yield increase may not offset the additional 10-15 $/acre fertilizer cost. The grower should carefully consider the expected sales price of the wheat and the actual cost of the fertilizer before deciding to fertilize above the 60 lb-N rate.

If the yield potential of the field is low, N rates should be in the 40-60 lb/acre N rate. If the field has a manure or sod history, N rates will have to be reduced further to avoid lodging problems. Wheat following soybean, however, receives no N credit and N rates should remain at 60 lbs/acre. Splitting the N rate under growing conditions at Aurora has had mixed success (Table 2) so we don't recommend two applications across the field, especially if the second application is made in May because of the probable 2% yield loss, associated with wheel track damage.

The best sources of N for topdressing winter wheat are ammonium nitrate or ammonium sulfate because of negligible volatilization losses of the N in these

Table 3. Grain yield of Geneva soft white winter wheat at a 75 lb actual N rate from different N sources during the 1984 and 1985 growing seasons at the Musgrave Research Farm near Aurora.

Source of N	1984	1985	Avg.
lbs/acre	Grain Yield (bu/acre)		
Ammonium nitrate	69	86	78
Nitrogen solution	74	----	---
Ammonium sulfate	75	87	81
Urea	72	74	73
LSD 0.05	4	6	4

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materials after application (Table 3). Unfortunately, ammonium nitrate is very hard to get and both products are extremely expensive so urea or UAN solution are often the choice. Urea and the urea portion of UAN solution, however, can volatilize under dry conditions so applications should be timed to coincide with rainfall within a day or two of application. Otherwise, some of the N will volatilize resulting in yield losses, as indicated by the 1985 data (Table 3).

Applying Nirtogen to winter wheat

Wheat field at the Musgrave Research Farm in Aurora, NY

In conclusion, winter wheat is a very valuable crop and optimum spring N management is the key to high yields with minimum lodging. Last year, we initiated a study evaluating spring topdressed N rates (ammonium nitrate) in 20 lb increments from 0-80 lbs N/acre (data not shown). Unfortunately, we topdressed the N on April 12, 4 days before a 19-inch snow storm (2.2 inches of precipitation) that remained on the soil for 4 days. We found a linear response to topdressed N last year with the 80 lb rate yielding 7 bu/acre more than the 60 lb N rate, probably in part because some of the N denitrified during the 4 day period under snow. We will continue this study for 2 more years to insure that NY wheat growers have the best information possible before making future spring N management decisions. In the meantime, based on data from the 1980s, we recommend a topdress N rate of 60 lbs/acre for most situations and soil types, but increasing to 70-80 lbs/acre for the sandier and coarser soils. If the grower has good reason to believe that an 80-90 lb rate will not induce lodging and the grower intends to harvest the wheat as straw, an 80- 90 lb rate is certainly a consideration. On the other hand, if the grower knows the field is lower yielding, an N rate of 40-60 lb/acre is sufficient. These rates can be reduced by 10 lbs/acre if sod was turned over 1-2 year prior while an application of 20 lbs/acre will be sufficient for wheat in the year following sod in the rotation. Growers should provide some N credits to fields that have a history of manure, but not for fields that are following soybeans.

Calendar of Events

Feb. 13-14, 2008	Empire State Fruit and Vegetable Expo, Syracuse
Feb. 28, 2008	Growing New York Farms in the 21st Century, Saratoga Springs
Mar. 4, 2008	Corn Congress, Miner Institute, Chazy
Mar. 18, 2008	Soil Health & Dynamic Nitrogen Modeling Workshop, Cornell
Mar. 28-29, 2008	Northeast Grasstravaganza, Binghamton

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