What's Cropping Up?

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Soil Health Assessment and Management: The Concepts

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Soil health has recently captured the attention of farmers as soil degradation from intensive cultivation, mechanization, limited crop rotations, and lack of organic matter additions have reduced yield potential. This has often led to increased soil compaction, erosion, greater pest problems, and reduced crop productivity. A survey conducted in 2003 (Wolfe) to assess the state of soil quality of vegetable farms in New York State showed that soil degradation is a common problem in many fields. Often-stated problems include increased disease and pest pressure, soil compaction, decreased infiltration, reduced water holding capacity, low organic matter content, drought-prone soils, and excessive runoff and erosion. Though soil degradation was visible on many farms, a systematic approach to characterize soil health, which transcends the conventional soil nutrient analysis, was not yet available.

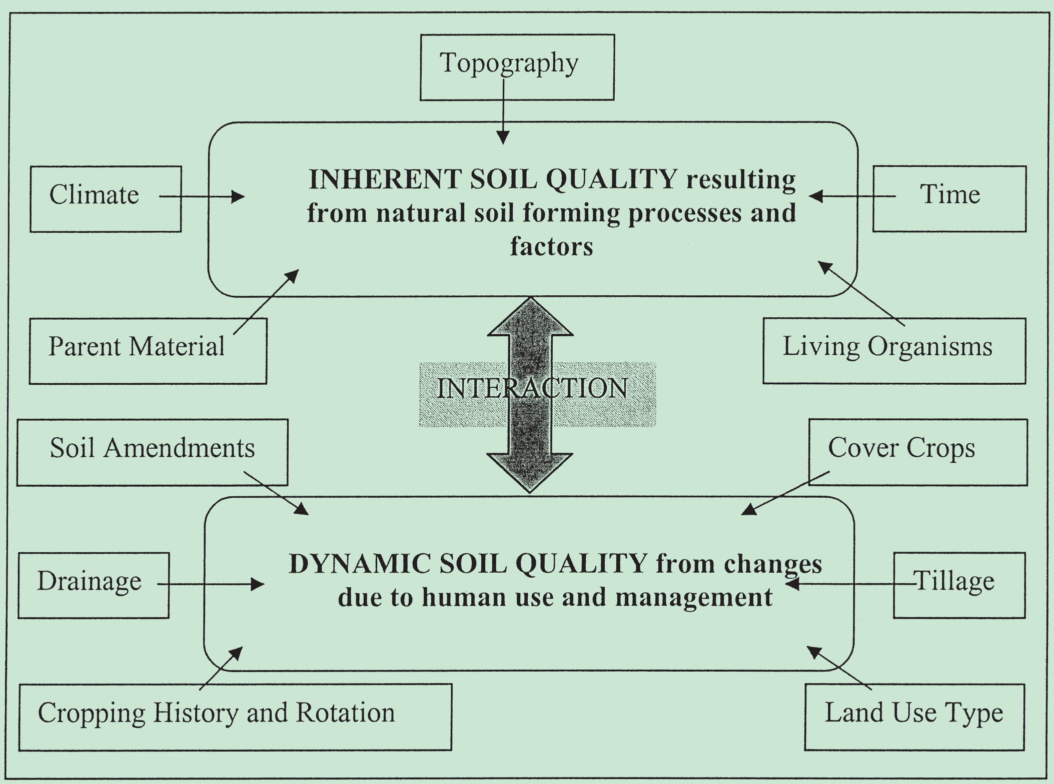


Figure 1. Inherent and dynamic soil quality and various factors affecting them.

Soil Health

Soil health deals with both inherent and dynamic soil quality (Figure 1). The former relates to the natural (genetic) characteristics of the soil (e.g., texture), which are the result of soil-forming factors. They are generally represented in soil surveys and generally cannot easily be amended. On the other hand, the dynamic soil quality component is readily affected by management practices and relates to the levels of compaction, biological functioning, root proliferation, etc. The dynamic component is of most interest to growers because good management allows the soil to come to its full potential. The inherent and dynamic soil quality components do interact, however, as some soil types are much more susceptible to degradation and unforgiving of poor management than others.

At the heart of soil health is the integration of the soil physical, chemical and biological processes and functions (Figure 2). A healthy soil will be balanced for all three components. In order to make interpretations of the health of a soil, the various processes and function in Figure 2 need to be assessed through meaningful indicators. For years we have relied on inexpensive soil testing procedures to assess the chemical (fertility) properties, but methods for rapid assessment of the physical and biological status of the soil are not generally offered. The Cornell Soil Health Initiative, through funding by USDA-SARE, the Northern New York Agricultural Development Program, and USDA-Hatch, sought to find indicators that can be used to evaluate and integrate these different processes and functions for the purpose of improving soil health. Our approach was to:

- identify the vital processes and functions of the soil needed for soil health assessment in relation to agronomic land use
- test different soil properties that can serve as potential soil quality indicators
- develop appropriate sampling and measurement protocols for soil health which can complement

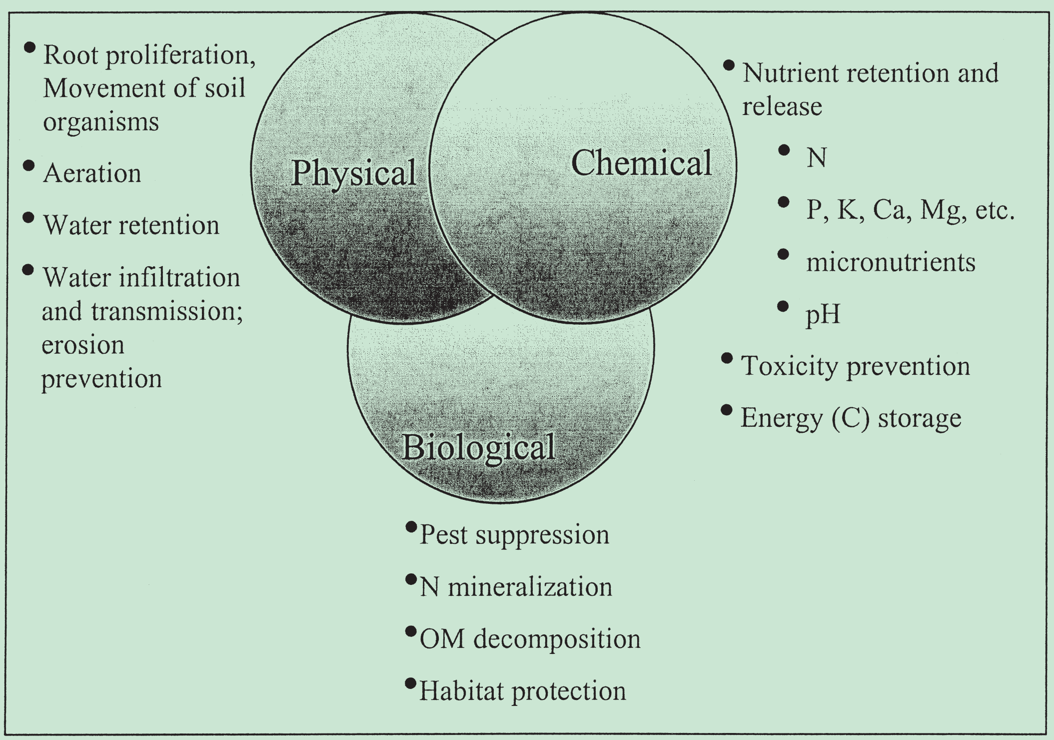


Figure 2: Soil physical, chemical and biological processes and functions

existing chemical laboratory and can be offered on fee for service basis

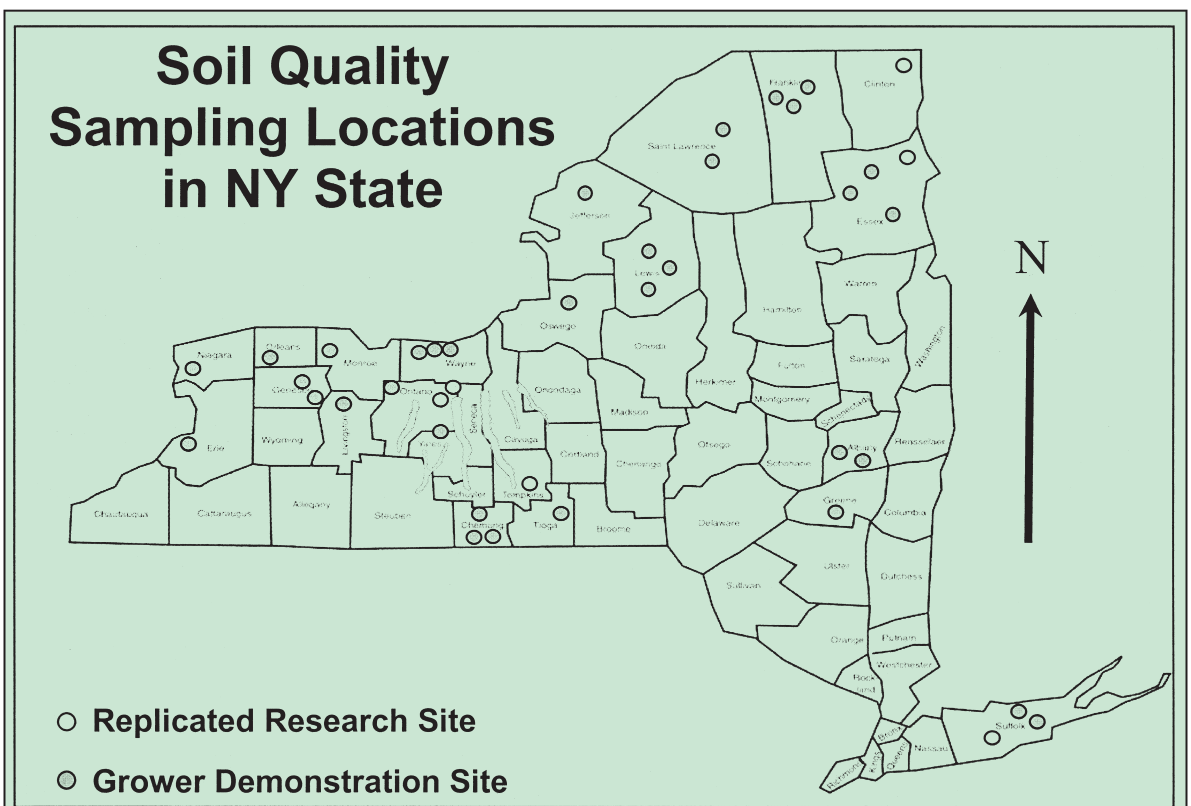
- develop criteria for interpreting soil health indicators in an agronomically meaningful way
- develop and evaluate accessible databases as repositories for high quality, reliable soils information; and
- recommend improved soil management practices based on soil health assessment that will ensure economic viability, environmental safety and social acceptability.

To achieve this goal, soil samples were collected from selected sites scattered over New York State (Figure 3). In this, we took a two-pronged approach: Some of the samples came from long-term controlled research sites (e.g., 30+-years of plow vs. no-till), which enabled us to assess the usefulness of different measurements to serve as soil quality indicators. Other samples came from commercial growers' fields, which enabled us to test the sensitivity of our indicators under real-world field conditions.

The field samples collected were passed through different soil analyses in multiple Cornell laboratories. Soil physical properties measured were texture, bulk density, macro-porosity, meso-porosity, available water capacity, residual porosity, penetration resistance, saturated permeability, aggregate size distribution, and wet aggregate stability. Biological measurements taken were root rot rating using bean bioassay technique, root lesion, root knot and saprophytic nematodes, potentially-mineralizable nitrogen, decomposition rate, particulate organic matter and active carbon. Standard chemical tests were also performed on the samples through the Cornell Nutrient Analysis Laboratory. In addition, we assessed in-field penetration resistance and infiltration tests as potential soil health indicators. In a next article, we will discuss results of these tests, the development of a new protocol for routine soil health assessment, and the availability of new laboratory analyses.

Reference

Wolfe, D. (2003). Summary Report of the Soil Health Grower Survey. Cornell University, Ithaca, NY.



Disease Management

Asian Soybean Rust in 2006

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North America's Brief History with Soybean Rust

Asian soybean rust, a windborne fungal pathogen, first arrived in nine southern U.S. states in the fall of 2004, presumably transported by hurricanes that picked up spores from South America. The fungus survived the winter of 2004/05 in stands of non-frosted kudzu in central Florida, and, from this region, the fungus multiplied and began its northward trek in air currents. U.S. soybean producers made plans to deal with a potentially massive invasion of their crop in 2005 (see my article in *What's Cropping Up?*, Volume 15, No. 2, February 2005). The anticipated continental invasion didn't happen and soybean rust was restricted to nine southeastern states (some different from those in 2004) at the end of the 2005 production season. The reasons for limited development and spread of disease in 2005 were a combination of a small initial source of over-wintered spores and unusually dry conditions in the southeastern states. Yet soybean rust did cause significant yield losses on the order of 20 bushels per acre in commercial soybean fields where it occurred in Georgia and Alabama.

Lessons Learned in 2005

We learned several lessons from agriculturalists that observed soybean rust epidemics in late summer and fall 2005 in Alabama, Georgia, and northern Florida. The first and most important lesson is that soybean rust can be effectively managed through timely detection and application of fungicides. Each of the fully labeled (section 3) and emergency labeled (section 18) fungicides provided some protection against rust and increased yield in the presence of rust, though researchers often began their spray programs before disease was detected. Two applications were often superior to one, but the timing of the first application was found to be most critical to successful control. In general, the emergency section 18 fungicides (triazoles with or without companion strobilurins) achieved better control, due to the post-infection activities of the triazoles, than did the purely protectant, section 3 fungicides.

Even in the vicinity of rusted kudzu vines, rust was not observed on soybean plants until they reached at least the flowering stage of development. The pattern of disease development differed from field to field in a local area and wasn't always uniform in a field. Most rust was first observed at later stages of pod development. Rust was observed first on leaflets in the lower canopy. Even under intensive scouting it was difficult to see the first signs of rust on lower leaves in the field until about 10% of the plants had at least one rust pustule. It was more efficient to collect soybean leaves in the field, incubate them in a humidity chamber for a day, and then examine them under a microscope in a laboratory for the presence of rust. This is the approach that will be taken in sentinel plot scouting for most of the U.S., including New York, in 2006. The national network of sentinel soybean plots was highly effective in detecting soybean rust prior to detection in commercial fields in the same regions. This system is being enhanced in 2006 with more intensive early scouting in southern states on kudzu and soybean.

Though soybean rust has a potentially wide host range on legume species, significant rust development was only observed on soybean and kudzu in 2005. Small amounts of soybean rust were observed on Florida beggarweed and, in one Florida location, on senescent leaves of snap bean, lima bean, and scarlet runner bean. The risk of significant damage to New York's dry bean and snap bean industries is considered to be negligible though we will continue to monitor that situation.

Prognosis for 2006

Each growing season will have its own unique dynamic for soybean rust that will depend on the starting source of over-wintered spores, conditions for increase of disease in southern states, air patterns for northern movement of spores, and conditions in northern states for infection and disease increase. Freezing conditions during the 2005/06 winter were thought to have killed off rusted kudzu leaves throughout most of the Gulf Coast of the U.S. including the panhandle of Florida. Yet infected kudzu leaves were identified in March in protected pockets as far north as Montgomery, AL. There is a significant chance that soybean rust could develop earlier in the southern states in 2006 than it did in 2005. Scouting for rust in southern kudzu stands during April should give us the first indication of how large a source of spores

Table 1. 2006 New York Fungicide Decision Guidelines for Soybean Rust (SBR)[1]

Soybean Growth Stage	SBR Risk	1st Spray	2nd Spray
Early-mid vegetative	NA	Do not spray	Do not spray
Late vegetative through R5	Low[2]	Do not spray	Do not spray
	High[3]	Section 18 fungicide	Section 18 fungicide[4]
R6 or later	NA	Do not spray	Do not spray

[1] Adapted from Kentucky Spray Decision Matrix by D.E. Hershman of University of Kentucky.

[2] SBR not detected in New York or adjacent areas of nearby states.

[3] SBR detected in lower canopy of field to be sprayed, or SBR confirmed in other fields in the same region of New York.

[4] Do not follow a solo triazole with a solo triazole.

Disease Management

there is and over what geographic area the 2006 epidemic will begin. In any event, New York soybean producers have a significantly greater chance of avoiding losses from soybean rust than their counterparts in the South. To take full advantage of our geographic edge, I urge New York growers to plant their soybeans as early as is recommended for their area and specific variety. Fungicide sprays for soybean rust are not warranted before flowering or after plants reach the R6 stage of pod development. So by planting early, many fields may pass the R6 stage before rust showers arrive in New York.

Fine-tuning Soybean Rust Management for 2006

The key to successful management of soybean rust is to make timely fungicide application(s) if and when the risk of infection is high between flowering (R1) and the R5 stage of development in your local soybean field. Risk can be assessed from following the national, regional, and statewide detection of soybean rust in sentinel plots. We will issue risk advisories in New York through cooperative extension offices and local media outlets. Scouting of fields by producers and consultants, while encouraged, is inefficient in detecting rust before it reaches 10% incidence, a point at which it may be too late to apply protectant (section 3) fungicides to full advantage. Guidelines for deciding on the application of section 18 rust fungicides are presented in Table 1.

It is very likely that a regional advisory for high risk of infection will be triggered by confirmation of soybean rust in sentinel plots in a region of New York or an adjacent region of a nearby state like Pennsylvania, New Jersey, or Ohio. Your field may already have received a shower of rust spores at this point making protectant fungicides a less than ideal option. However, a regional risk advisory still allows a reasonable period of time (about a week or so) to apply a section 18 curative product containing a triazole. Finding of rust in the lower canopy of your field should also trigger your decision to apply a triazole material if your soybeans are between R1 and R5 stages.

Information Sources

For the latest information on the risk of soybean rust, consult the USDA Soybean Rust Website (www.sbrusa.net) and The New York State Soybean Rust Information Center (www.plantpath.cornell.edu/soybeanrustny). The latter site includes specific information on management of the disease in New York, including soybean rust fungicides registered in New York.

If you observe symptoms you think may be soybean rust in New York, please contact your Cornell Cooperative Extension fields crops educator or the Plant Disease Diagnostic Clinic at Cornell University (607- 255-7850) as soon as possible.

Downward Revision to Soybean Seeding Rate

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Crop Management

The price of soybean seed has increased significantly in recent years and seed costs now approximate $40/acre. Coupled with the current low price in New York for soybeans ($5.25-5.50/bu range), growers are wondering whether they can reduce soybean seeding rates to save on input costs. Based on research from 1996 to 1998 on Roundup Ready varieties, Cornell has recommended seeding rates of 200,000 seeds/acre for drilled (7-inch) soybeans. Research at the Aurora Research Farm from 2003 through 2005 on soybeans under conventional tillage (moldboard plow and cultimulched), however, indicates that our recommended seeding rates should be revised downward.

We planted the Group II variety, '92B38', on 20 May 2003, 20 May 2004, and 18 May 2005 at five seeding rates. Each seeding rate was replicated four to five times, depending upon the growing season. We used a John Deere 450 drill in 2003 and a John Deere 1590 No-Till Drill in 2004 and 2005. Plots measured 100 feet long by 10 feet wide and we harvested the middle four feet in late October 2003 and early October 2004 and 2005.

Table 1 shows the five seeding rates for each year and the final stand and yield for each seeding rate in each year and averaged across years. Emergence (final stand/seeding rate) averaged about 80% across the 3 years, which is the recognized average emergence rate for soybeans. In 2003 and 2005, however, emergence averaged less than 75% for most seeding rates. Nevertheless, yield varied little among the five seeding rates within individual years or averaged across years. When averaged across seeding rates of 153,333 to 273,333 seeds/acres in the 3 years, yields ranged only from 52 to 53 bu/acre. Lodging was not a significant problem in any year of the study so the lack of response to higher seeding rates can not be attributed to lodging problems. The variety, 92B38, simply did not respond to higher seeding rates in this study.

The question now is whether the lack of response to seeding rates above 150,000 is unique to 92B38 under conventional tillage system or is it true for most cropping situations. To answer that question, we have initiated field-scale seeding rate studies with a different variety under zone-till to fine-tune our seeding rate recommendations. For now, we recommend seeding rates of about 180,000 seeds/acre for drilled soybeans planted under conventional tillage practices.

Table 1. Seeding rate, final stand, and yield of 92B38 at 7" row spacing under conventional tillage in 2003, 2004, and 2005 at the Aurora Research Farm.

SEEDING RATE				FINAL STAND				YIELD			
2003	2004	2005	Avg.	2003	2004	2005	Avg.	2003	2004	2005	Avg.
seeds/acre				plants/acre				bu/acre			
160,000	150,000	150,000	153,333	108,900	146,100	119,500	124,833	37	61	57	52
200,000	175,000	175,000	183,333	138,450	174,265	128,200	146,972	39	61	57	52
240,000	200,000	200,000	213,333	178,140	199,330	147,100	174,857	39	60	59	53
280,000	225,000	225,000	243,333	219,675	208,200	163,800	197,232	38	61	61	53
320,000	250,000	250,000	273,333	248,200	239,053	172,400	219,884	38	61	60	53
LSD 0.05								2	NS	NS	NS

Calendar of Events

June 8, 2006	Small Grains Management Field Day, Aurora, NY
Jul. 6, 2006	Cornell Weed Science Field Day, Valatie, NY
Jul. 6, 2006	Seed Growers Field Day, Ithaca, NY
Jul. 12, 2006	Cornell Weed Science Field Day, Aurora, NY
Jul. 13, 2006	Cornell Weed Science Field Day, Freeville, NY
July 20, 2006	Musgrave Research Farm Field Day, Aurora, NY
Jul. 29-Aug.2, 2006	American Phytopathological Society, Quebec City, Canada
Oct. 24, 2006	Field Crop Dealer Meeting, Comfort Suites, 7 Northside Drive, Clifton Park, NY
Oct. 25, 2006	Field Crop Dealer Meeting, Holiday Inn, 1777 Burrstone Road, New Hartford, NY
Oct. 26, 2006	Field Crop Dealer Meeting, Batavia Party House, 5762 East Main Road, Batavia, NY
Oct. 27, 2006	Field Crop Dealer Meeting, Auburn Holiday Inn, 75 North Street, Auburn, NY
Nov. 7-9, 2006	NE Division of the American Phytopathological Society, Burlington, VT
Nov. 12-16, 2006	American Society of Agronomy Meetings, Indianapolis, IN
Nov. 29-Dec.1, 2006	National Soybean Rust Symposium, St. Louis, MO
Dec. 5-7, 2006	NE Region Certified Crop Advisor Conference
Dec. 10-12, 2006	National Fusarium Head Blight Forum, Raleigh, NC

What's Cropping Up? is a bimonthly newsletter distributed by the Crop and Soil Sciences Department at Cornell University. The purpose of the newsletter is to provide timely information on field crop production and environmental issues as it relates to New York agriculture. Articles are regularly contributed by the following Departments at Cornell University: Crop and Soil Sciences, Plant Breeding, Plant Pathology, and Entomology. **To get on the mailing list, send your name and address to Pam Kline, 234 Emerson Hall, Cornell University, Ithaca, NY 14853.**

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