Soil Management in Berry Crops as a Model for Management Education Project Invites Commercial Berry Growers to Participate in an On Farm Demonstration Trial

Commercial berry growers in the Northeast have traditionally made standardized fertilizer applications based on crop age. This practice continues today, some 10 years or more after commercial berry crop guidelines for analysis-based fertilization programs became widely available. Adoption of soil health improving practices has also been slow.

Research demonstrates an analysis-based approach to berry crop nutrition provides increased yields along with better fruit quality and plant health. Use of soil health management practices (i.e. cover cropping) has been shown to reduce weed, nematode and soil-borne disease pressure, along with improving soil tilth, organic matter and nutrient content. Rising costs of products and concerns about environmental impacts of fertilizers make a whole farm approach to berry crop nutrient and soil management highly desirable.

Ag educators, frequently called on to cover multiple commodities and/or information areas outside their field of expertise, often struggle to assist commercial berry growers with berry crop soil and nutrient problems. No single comprehensive resource on this topic is currently available for either educators or growers.

A 2-year NE SARE Professional Development Project, led by Dr. Marvin Pritts, Small Fruit Horticulturalist and Berry Crop Nutrition Specialist, is beginning this fall to provide in-depth berry crop nutrition and soil management training and resources for ag educators and the commercial berry growers they serve.

Year one of the project focused on helping ag educators build berry crop nutrient and soil management expertise through 1) a series of 12 in depth webinars and case study learning modules on the subject and 2) development of internet resources to be used by educators in grower training.

Year 2 of the project, beginning this spring, is focusing on assisting ag educators to 3) develop and implement grower training programs and 4) carry out one-on-one consultations with participating growers. Year 2 will also involve educators in monitoring adoption and success of analysis-based berry crop nutrient and soil health management by growers.

A whole farm soil and nutrient management decision tool for commercial berry crops will be developed from existing resources. This tool, along with accompanying ag educator and commercial grower training materials, made available via an internet web site, will provide a “one-stop-shop” resource for ag educators interested in building skills or providing training and/or commercial berry growers interested in improving berry crop soil and nutrient management.

Soil and nutrient management principles and practices gained through this project will have application to other crops currently or in the future.

We invite you to participate in the project by joining us as one of our grower collaborators.

Grower On-Farm Demonstration Trial

Growers participating in the grower training portion of this project are then eligible to be one of our grower collaborators. Grower collaborators will receive in return for their participation one complementary Cornell soil health test and one Agro-One foliar analysis, along with related resource materials and a one-on-one discussion of test results with their educator trainer. Educator trainers will also be available to advise during the on-farm demonstration trials. Participating growers will receive a copy of the final report detailing project outcomes at the conclusion of the project.

In return, grower collaborators are asked to:

1. Collect and submit a soil and leaf sample for analysis.
2. Participate in a one-on-one discussion of test results with their educator.
3. Select a soil and/or nutrient management practice suggested by the test results they wish to try on one of their commercial berry crops.
4. Identify a convenient portion of their commercial berry planting to try the treatment on; the remainder of the planting should receive their standard practice.
5. The portion of the field identified should be representative for that planting:
    a. Plants should be the same variety and plant age for both treatment and grower standard plots
    b. Planting edges may not be representative due to edge effects and should be avoided
    c. We ask the treated area cover a minimum of 3 adjacent rows in the planting.
    d. Center row(s) will be used for observation and sampling leaving at least one border row on either side.
    e. Grower standard rows used for observation and sampling should be at least 3 rows away from treated border row(s).
6. Treatment should be applied in fall 2012 or early spring 2013, with harvest in 2013
7. Growers are asked to harvest fruit as follows:
    a. Completely harvest all ripe fruit (4 pickings) from 12 ft of row in each section, recording combined yield (level pts. or quarts) or total weight for the both treatment and grower standard areas
        i. 12 ft section of strawberry row
        ii. 3 blueberry bushes (approx. 12 ft)
        iii. 12 ft section of raspberry row
    b. For each harvest date randomly select a full container (pt. for blueberries, raspberries; qtr. for strawberries) that will likely contain sound both and rotted berries.
        i. Count the total number of berries in the container
        ii. Count the number of berries with fruit rot
        iii. Determine if there are flavor differences between treatment and grower standard berries.
        iv. Record other observed differences in fruit from plots such as fruit shape, uniformity, symmetry, ripening, etc.
8. Growers are asked to record any observed growth impacts or differences between the treated and grower standard areas as follows:
    a. Make observations the spring after treatment (2013), during harvest, and the fall after harvest.
    b. Observations could include:
        i. Foliage color differences such as light green vs. dark green, leaves greening up sooner, etc.
        ii. Difference in growth indicators such as:
            1. Height of primocane growth for raspberries
            2. New shoot length for blueberry canes
            3. Number of runners per plant for strawberries
        iii. Disease and arthropod pest (insect and mite) activity such as mites, leaf spot diseases, fruit rots etc.
        iv. Other

Harvest Data

Grower name:_____Extension Contact:_____

Berry Crop: _____Crop Age (yrs):_____Variety:_____

Field ID:_____Total Berry Crop Acres:_____Price/Unit (ex. $/pint)_____

Treated Area	**Total Yield (# units)**	**Total # Berries/level unit**	**# Rotted berries/level unit**	**Observations** (Differences in flavor, fruit shape i.e. uniformity, symmetry, ripening, other with grower standard)
Picking 1 (Date:)				
Picking 2 (Date:)				
Picking 3 (Date:)				
Picking 4 (Date:)				

Grower Standard Area	**Total Yield (units)**	**Total # Berries/level unit**	**# Rotted berries/level unit**	**Observations**
Picking 1 (Date:)				
Picking 2 (Date:)				
Picking 3 (Date:)				
Picking 4 (Date:)				

Growth and Pest Observations

Grower name:_____Extension Contact:_____

Berry Crop: _____Crop Age (yrs):_____Variety:_____

Field ID:_____Total Berry Crop Acres:_____Price/Unit (ex. $/pint)_____

Make observations the spring after treatment, the following season just before harvest, and the fall after harvest. Record any observed differences between the treatment and Grower standard plants.

Growth Observations

Observation Dates	Treatment[1]	Grower Standard[1]
Spring2013 (Date:)		
Harvest 2013 (Date:)		
Fall 2013 (Date:)		

[1]Observations could include: Foliage color differences such as light green vs. dark green, leaves greening up sooner, etc. Difference in growth indicators such as: height of primocane growth for raspberries, new shoot length for blueberry canes, number of runners per plant for strawberries, other.

Pest Observations

Observation Dates	Treatment[1]	Grower Standard[1]
Spring 2013 (Date:)		
Harvest 2013 (Date:)		
Fall 2013 (Date:)		

[1]Observations could include differences in disease and arthropod pest (insect and mite) activity such as tarnished plant bugs, sap beetles, mites, leaf spot diseases, powdery mildew, rusts, cankers, cane diseases, other.

Grower Expense Survey

Grower name:_____Extension Contact:_____

Berry Crop: _____Crop Age (yrs):_____Variety:_____

Field ID:_____Total Berry Crop Acres:_____Price/Unit (ex. $/pint)_____

Fertilizer	Treatment (lbs. actual /A)	Grower Standard (lbs. actual/A)	Price/Unit
Nitrogen			
Phosphorus			
Potassium			
Micro-nutrient(s) List:			
Sulfur			
Lime			
Other List:			

Utility of Soil and Tissue Testing…

- Pre-plant
  - Maximize soil health ⇒ maximize plant establishment and longevity
    - Identification and remedy of soil constraints
    - Soil pH adjustment
    - Addition and incorporation of required nutrient inputs
- Post-plant
  - Optimize profitability
    - Avoid costly over or under fertilization
    - Optimize crop yield and quality
    - Protect the environment

Types of Soil and Tissue Testing

- Standard Soil Test
  - Used in established plantings in concert with tissue analysis to determine nutrient status of plants
  - Used in established plantings for diagnostic testing when nutrient imbalances are suspected
- Cornell Soil Health Test
  - Used pre-plant to identify soil health constraints
    - Includes standard soil test
  - Used in established plantings for diagnostic testing when soil health issues are suspected
- Tissue Analysis
  - Used in established plantings in concert with standard soil test or soil health test to determine nutrient status of plants.

Routine vs. Diagnostic Testing

Routine

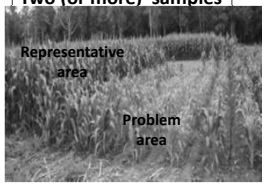
- Lime and fertilizer recommendations for plant maintenance
- No known history of fertility or soil health problems

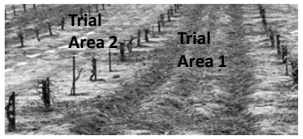
Diagnostic

- Suspected nutrient imbalance or soil health issue
  - Use paired samples, “good” and “bad” areas to confirm problem.
  - Consider adding soluble salts package if marginal leaf burning/necrosis is present
  - Use plant tissue analysis to further assist in diagnosis

Sampling Strategy

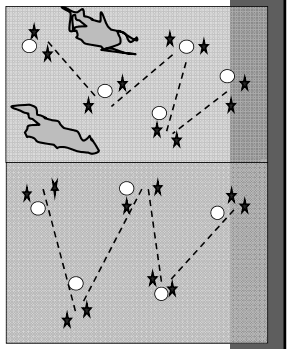
Uneven field-
Two (or more) samples





Trial area 1- "poor"

Trial area 2- "ideal"



Determine which field features will be sampled:

- **by soil type**
- **by management practice**
- **by crop growth and yield**

"benchmark area" sample (native)

About Standard Soil Tests…

- Different soil testing labs use various extractants to estimate the amount of plant-available nutrients
- Numbers can vary greatly between labs depending on which extractant is used
- Do not use values from one lab with recommendations from another lab

Agro-One Standard Soil Test

Dairy One

Agro-One Soils Laboratory
730 Warren Road, Ithaca NY 14850
Phone: 800-344-2697 • Fax: 607-257-1350
soil@dairyone.com
www.dairyone.com

- Soil test packages and nutrient guidelines for the Northeast
  - *Maryland, New Hampshire, New York, Pennsylvania, and Vermont*
- New York customers also have the option of an Agro-One analysis with Cornell recommendations*

*Cornell recommendations are based on a modified Morgan extractant and have been developed for each berry crop.

Sampling Tools

- Stainless steel probe or auger
  - Iron contamination (rust) can be an issue
  - Shovels/spades – generally not a good idea
    - Wedge-shaped samples not representative
    - Edges need to be trimmed off
    - Slower, more difficult to get good sample
- Clean plastic pail for mixing
  - Zinc contamination may be a problem when used galvanized pails or sampling tools
- Agro-One sample boxes and forms

Probe…

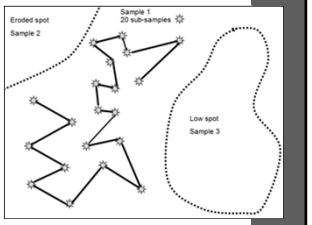
- Probes for dry soils with few rocks
  - Collect a continuous core through the entire sampling depth
  - Minimum disturbance of the soil
  - Faster in good conditions
  - Easier on your back
  - May use lubricant to prevent plugging of probe
    - WD 40, PAM, Dove dish soap, Silicone
    - Do not use if micronutrient deficiency suspected
  - Prices range from $50 to $1,000 for standard soil test probes/kits

… or Auger?

- Auger for rocky or wet soils
  - Wet soil sticks to auger flights but still works
  - Power drill may be used if doing a lot of samples
  - DIY plastic container with hole in center collects soil as auger pulls it out.

Soil Sampling Guidelines

- Sample each “management area” separately
- Remove top 1 inch or organic matter/debris
- Take sub-samples in zigzag pattern in each management area
  - 8-10 subsamples if < 2 acres
  - 10-20 subsamples if > 2 acres
- Pre-plant Berries
  - Surface 0 – 8” (rooting depth for most berry crops)
- Established plantings
  - Sample to 8” depth
  - Use in conjunction with tissue analysis

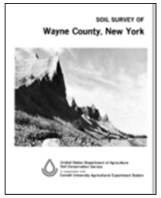


Soil Sampling Guidelines

- Subsamples
  - Discard organic “matt” on top and soil below 8 inches
  - Mix subsamples completely in clean plastic pail
    - Remove large stones, break up clods before mixing
    - If muddy, dry then mix
  - Air dry wet samples in thin layer on clean surface
    - No heater, fan OK
    - Plastic or stainless steel tray or box…
  - Ship in container provided
    - Include all necessary forms with requested information completed

How to Find Soil Series Names

- Soil Series Name is required for Agro-One nutrient guidelines in NY
  - Use mapping tools to identify soil series
    - http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm
  - iPhone app!
    - http://itunes.apple.com/us/app/soil-web-for-the-iphone/id354911787?mt=8
  - County soil map
    - No longer in print
    - Local CCE offices often have copies on hand…



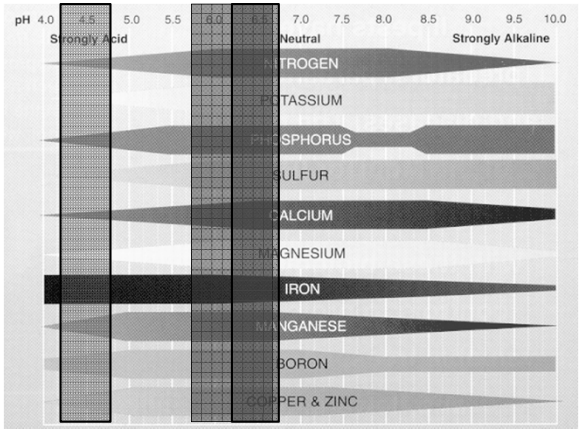
Interpreting Soil Test Results

- Check your soil pH – is it right for the berry crop you're growing?
  - Strawberries and Raspberries – 6.2 to 6.5
  - Blueberries - 4.2 to 4.5
- Do your macro-nutrient levels (N, P and K) fall in medium range or above?
- What's your soil organic matter content? (3% or higher best for berry crops)
- Soil calcium
  - Should be 2,000 lb/A or less for blueberries
- Soil aluminum
  - high levels (> than 300 lb/A) of this nutrient are toxic to berries
  - The problem is greater in acid soils
  - Do not use aluminum based fertilizers i.e. aluminum sulfate

If pH is not within a desired range, then the ability of the plant to take up nutrients will be compromised.

A WORD ABOUT SOIL pH

Soil pH and Nutrient Availability



Modifying Soil pH

- Sulfur can be used to lower pH and lime can be used to raise pH Soil pH modification is best accomplished pre-plant
  - Changing soil pH after planting is extremely slow and difficult
- **Significant time is required for lime or sulfur to affect the pH (6 months or longer)**
- For more information on modifying pH see the NRAES Production Guide for the Berry Crop in question.

Component	Mod. Morgan ppm	Mod. Morgan lbs/acre	Morgan Equiv. lbs/acre	Soil Test Levels
				Very Low / Low / Medium / High / Very High
Phosphorus (P)	4	8	9	**********
Potassium (K)	88	176	175	**********
Calcium (Ca)	1,802	3,605		**********
Magnesium (Mg)	302	603		**********

Water pH	Water Buffer pH	Calcium Chloride pH	Calcium Chloride Buffer pH	No Till pH	No Till Buffer pH	Organic Matter (%)	Nitrate-N (ppm)	HWS Boron (lbs/acre)	Soluble Salts (mmhos/cm)	Total N (%)
6.1	5.9					4.6		0.9		

Other Nutrients, Mod. Morgan, lbs/acre

Sodium (Na)	Aluminum (Al)	Sulfur (S)	Zinc (Zn)	Manganese (Mn)	Iron (Fe)	Copper (Cu)	Boron (B)	Molybdenum (Mo)
	62.6		0.5	14.6	5.6			

Soil Fertilizer Recommendations

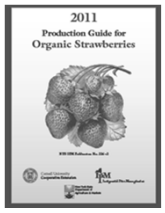
Year	Crop	tons / acre Lime	lbs / acre N	lbs / acre P_2O_5	lbs / acre K_2O	lbs / 1000 sqft Lime	lbs / 1000 sqft N	lbs / 1000 sqft P_2O_5	lbs / 1000 sqft K
1	Strawberries, Spring	0.0	100	25	0	0.0	2.3	0.6	0

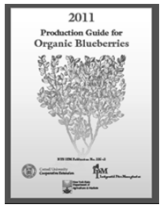
Comments

Nutrient recommendations provided by Cornell University.
These are general comments. Always consult with your crop advisor for recommendations specific to your farm.
For assistance interpreting your report, contact your local Cooperative Extension office at 607-272-2292.
Yr1 Apply 80 lbs/acre of N in July, and another 20 lbs/acre the first of September. Do not apply N in early spring except on sandy soils.
Yr1 Apply fertilizer uniformly around the plants or through drip irrigation. Do not allow granules to remain on leaves. Do not fertilize when leaves are wet.
Yr1 The best time to apply potassium and phosphorus fertilizers is in the fall before mulch is applied.
Yr1 Use both a soil test and leaf analysis to adjust nutrient levels.

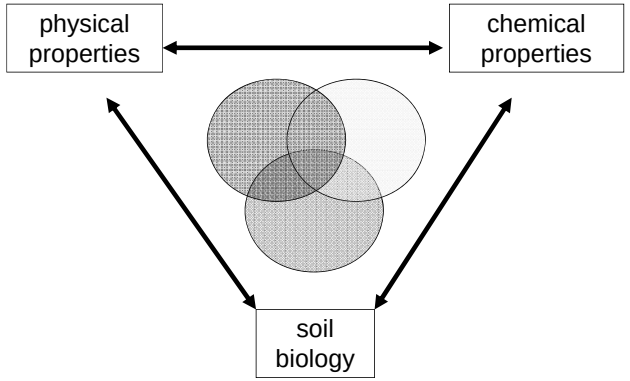
Organic vs. Conventional

- Recommendations are mostly <u>THE SAME</u> whether one is organic or conventional
- The difference is in the source of the fertilizer/amendment to be applied – not the recommended amount
  - a few exceptions depending on release rate
- <u>http://www.nysipm.cornell.edu/organic_guide/</u>



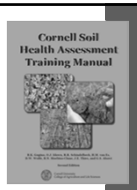


INTERACTION



These soil properties also interact with the growth of plants creating a complex ***soil ecology***

Cornell Soil Health Test



Cornell Nutrient Analysis Lab (CNAL),
G01 Bradfield Hall, Ithaca, NY 14853
(607) 255-4540
Soil Health Coordinator: Bob Schindelbeck (607) 227-6055, rrs3@cornell.edu
E-mail: soilhealth@cornell.edu
Website: http://soilhealth.cals.cornell.edu

- Basic Package ($45)
  - Recommended for :
    - conventional grain and forage crops
    - non-agricultural applications (landscaping, site remediation, etc.)
- Standard Package ($75)
  - Recommended for:
    - vegetable production
    - organic production
    - problem diagnosis in landscaping and other urban applications
    - ***first-time soil health assessment***

Soil Health is…

"the capacity of the soil to function…."

(Doran and Parkin, 1993)

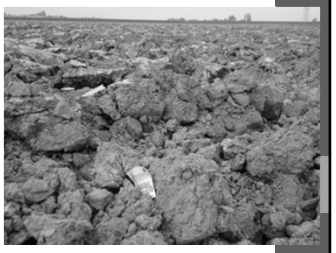
… chemically, biologically and physically.

Characteristics of Healthy Soils

- Good tilth
- Sufficient (but not excess) nutrients
- Sufficient depth
- Good water storage and drainage
- Free of chemicals that might harm plants
- Low populations of plant disease and parasitic organisms
- High populations of beneficial organisms
- Low weed pressure
- Resistance to being degraded
- Resilience (quick recovery from adverse events)

General Signs of Poor Soil Health

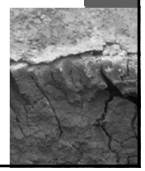
- Plowing up cloddy soil and poor seedbeds
- Hard soil (at planting, etc.)
- Rapid onset of stress or stunted growth during dry or wet periods
- Poor growth of plants
- Declining yields
- High disease pressure
- Signs of runoff and erosion

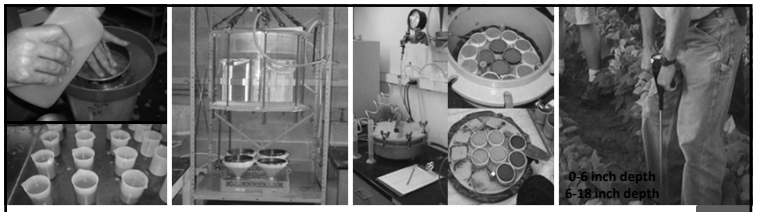


An Example of Interaction

Hard soil reduces rooting:

- **Compacted, dense soil layers restrict rooting volume to exploit water and nutrients**
- **Compacted soil suppresses beneficial biological processes**
- **Poor drainage reduces rooting and aerobic biological processes**
- **Compaction increases root diseases and denitrification losses**

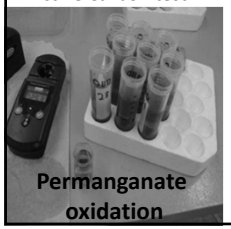




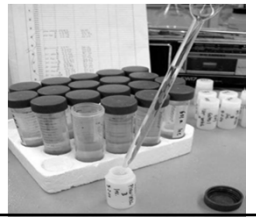
Rapid Soil Texture Wet Aggregate Stability Available Water Capacity Field Penetration

Cornell Soil Health Test Analyses (plus Chemical tests)

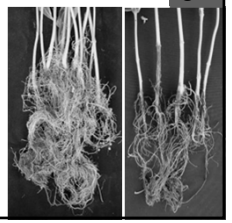
Active Carbon test



Potentially Mineralizable N



Root Health rating



Cornell Soil Health Test Guidelines

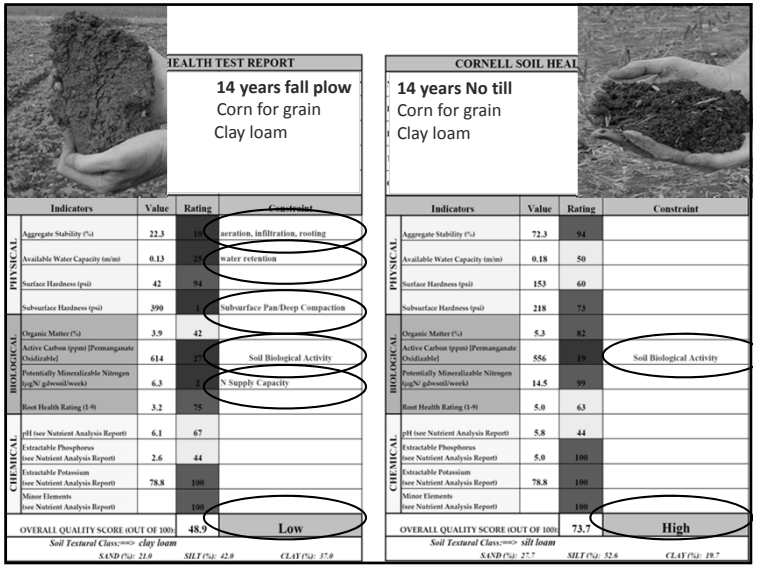
- You will need:
  - 2 5-gallon buckets/containers (one for soil, one for supplies)
  - 1 zip-loc bag (large 1-gallon)
  - 1 600 ml plastic beaker (3 cup capacity)
  - Permanent marker and pen
  - Trowel or spade
  - Penetrometer
  - Grower and field information sheet
  - Clipboard (if desired)

Cornell Soil Health Test Guidelines

- Sampling is done roughly in the same manner as for the standard soil test with these exceptions:
  - Sample in spring when soil is at field capacity
  - Use a trowel or spade to sample soil as a larger volume of soil is required for this test.
  - Make 5 stops across the field, collecting 2 subsamples at each stop. Mix subsamples thoroughly.
  - Take 2 penetrometer readings (0-6” and 6-18” depths) at each subsample location. Record on form.
  - Place 6 full cups (1.5 quarts) mixed soil into zip-loc bag labeled with field name/ID and date.
  - Keep samples out of direct sunlight; preferably in cooler in field.
  - Store in cold room or refrigerator; ship as soon as possible.

Interpreting Soil Health Test Results

- The report is a management guide, not a prescription.
- Different management approaches can be used to mitigate the same problem.
- In addressing some soil constraints, management practices can affect multiple indicators.
- Soil health changes slowly over time.



HEALTH TEST REPORT

14 years fall plow
Corn for grain
Clay loam

	Indicators	Value	Rating	Constraint
PHYSICAL	Aggregate Stability (%)	22.3	16	aeration, infiltration, rooting
	Available Water Capacity (in/in)	0.13	25	water retention
	Surface Hardness (psi)	42	94	
	Subsurface Hardness (psi)	390	11	Subsurface Pan/Deep Compaction
BIOLOGICAL	Organic Matter (%)	3.9	42	
	Active Carbon (ppm) [Permanganate Oxidizable]	614	27	Soil Biological Activity
	Potentially Mineralizable Nitrogen (µgN/ gdwsoil/week)	6.3	2	N Supply Capacity
	Root Health Rating (1-9)	3.2	75	
CHEMICAL	pH (see Nutrient Analysis Report)	6.1	67	
	Extractable Phosphorus (see Nutrient Analysis Report)	2.6	44	
	Extractable Potassium (see Nutrient Analysis Report)	78.8	100	
	Minor Elements (see Nutrient Analysis Report)		100	
OVERALL QUALITY SCORE (OUT OF 100):		48.9		Low

Soil Textural Class:<==> clay loam
SAND (%): 21.0 SILT (%): 42.0 CLAY (%): 37.0

CORNELL SOIL HEAL

14 years No till
Corn for grain
Clay loam

	Indicators	Value	Rating	Constraint
PHYSICAL	Aggregate Stability (%)	72.3	94	
	Available Water Capacity (in/in)	0.18	50	
	Surface Hardness (psi)	153	60	
	Subsurface Hardness (psi)	218	73	
BIOLOGICAL	Organic Matter (%)	5.3	82	
	Active Carbon (ppm) [Permanganate Oxidizable]	556	19	Soil Biological Activity
	Potentially Mineralizable Nitrogen (µgN/ gdwsoil/week)	14.5	99	
	Root Health Rating (1-9)	5.0	63	
CHEMICAL	pH (see Nutrient Analysis Report)	5.8	44	
	Extractable Phosphorus (see Nutrient Analysis Report)	5.0	100	
	Extractable Potassium (see Nutrient Analysis Report)	78.8	100	
	Minor Elements (see Nutrient Analysis Report)		100	
OVERALL QUALITY SCORE (OUT OF 100):		73.7		High

Soil Textural Class:<==> silt loam
SAND (%): 27.7 SILT (%): 52.6 CLAY (%): 19.7

Approach for a Successful Soil Management Strategy

- Assess your soil's health to identify constraints
- Make changes in management strategies that work for your farm, and that address specific constraints
- Experiment on your farm to see what works in your situation… (start small)
- Adapt many resources of information to your farm
- Build healthy soils to increase resiliency to extremes

About Tissue Analysis…

- Directly measures amount of nutrients in leaves
- Sufficiency ranges known or estimated from other crops
- Alerts grower when nutrient levels are approaching sufficiency/deficiency
- Corrective action may be taken before symptoms occur
- Used to fine tune annual nitrogen application rates
- Used to rule out possible nutritional causes of poor plant performance

Agro-One Plant Tissue Analysis

Dairy One

Agro-One Soils Laboratory
730 Warren Road, Ithaca NY 14850
Phone: 800-344-2697 • Fax: 607-257-1350
E-mail: soil@dairyone.com Website: www.dairyone.com

Service package	Crops	Type of Report	Price per sample
180[a]	Form P[b] Tree Fruit and Small Fruit	Cornell interpretation and nutrient guidelines provided	$24.00
180	Form PTA[c] Field Crops	Results only at this time [e)]	$24.00
180	Form PTV[c] Vegetables and Hops	Results only at this time [e)]	$24.00
161 Nitrate-N	All	Results only at this time [e)]	$10.00

a) Service Package 180 includes total N, K, P, Ca, Mg, Mn, Fe, Cu, B, Zn and S
b) Cornell plant tissue analysis interpretation & guidelines are available for Fruit only at this time.
c) Plant tissue analysis reports for vegetables, hops & field crops show results only. No interpretation or nutrient guidelines available at this time.
d) Go to http://www.uvm.edu/extension/cropsoil/wp-content/uploads/HopFertilityManagementNE.pdf for more information on Hops
e) Interpretive nutrient levels for plant analysis are available for many agronomic and horticultural crops at http://www.aasl.psu.edu/Plt_nutrients.htm

When to Collect Leaves?

- Strawberry—first regrowth after renovation, youngest full-sized leaves (July)
- Blueberry—just before or during harvest, leaves from middle of this year's shoot, full sun (July-Aug)
- Raspberry—primocanes, youngest full-sized leaves (early Aug)

Generally best to avoid times when plant resources are being directed to fruit

How to Collect a Leaves?

- Sample healthy leaves that are well exposed to light.
- Leaves should represent the average condition of the planting and should not be damaged by: disease; insects; weather or mechanical injury.
- **AVOID** mixing leaves from different cultivars.
- **DO NOT** mix leaves from plants of different ages.
- **A minimum of 50 grams (~ 2 oz) fresh weight from a minimum of 30 leaves are needed per sample.**
- If possible, each leaf should be taken from a different plant within the sampled area
- Process for analysis as soon as possible

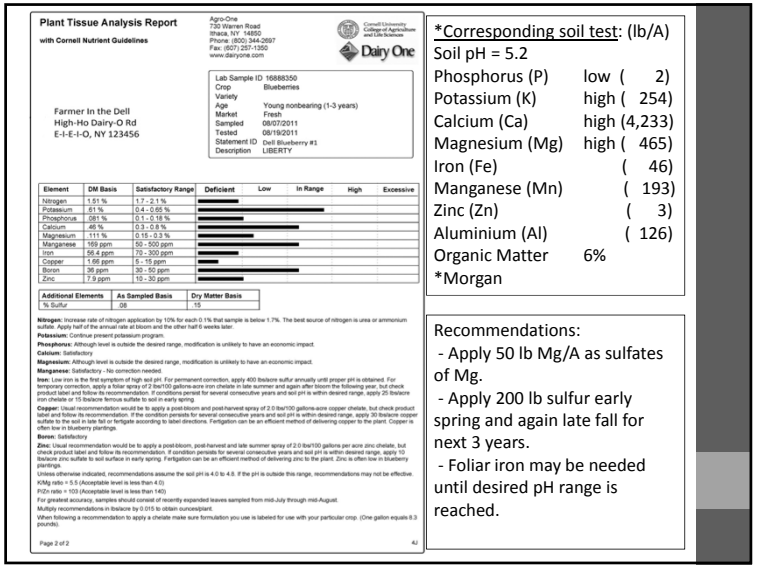
Preparing Leaves for Analysis

- Use distilled water for washing and rinsing the samples.
- **Gently** and **lightly** scrub the leaves together in distilled water.
- Change the water if it becomes dirty **or** after 8 to 10 samples (whichever occurs first).
- Shake to remove excess water and immediately rinse the sample in clean distilled water.
- Rinse again and shake.
- Transfer sample to paper bag, with top open and dry at room temperature until the leaves are brittle.
- **NOTE: DO NOT let leaves to stand in water – complete the washing and rinsing process in one minute or less.**

Standard Foliar Nutrient Ranges

Critical value, Normal Range

Nutrient	Strawberries Deficient below	Strawberries Sufficient	Raspberries Deficient below	Raspberries Sufficient	Blueberries Deficient below	Blueberries Sufficient
Nitrogen	1.9%	2.0 - 2.8 %	1.9%	2.0 - 2.8%	1.7%	1.7 - 2.1%
Phosphorus	0.2	0.25 - 0.4	0.2	0.25 - 0.4	0.08	0.1 - 0.4
Potassium	1.3	1.5 - 2.5	1.3	1.5 - 2.5	0.35	0.4 - 0.65
Calcium	0.5	0.7 -1.7	0.5	0.6 - 2.0	0.13	0.3 - 0.8
Magnesium	0.25	0.3 - 0.5	0.25	0.6 - 0.9	0.1	0.15 - 0.3
Boron	23	30 -70 ppm	23	30 - 70 ppm	20	30 - 70 ppm
Manganese	35	50 - 200	35	50 - 200	25	50 - 350
Iron	40	60 - 250	40	60 - 250	60	60 - 200
Copper	3	6 - 20	3	6 - 20	5	5 - 20
Zinc	10	20 - 50	10	20 - 50	8	8 - 30



Plant Tissue Analysis Report
with Cornell Nutrient Guidelines

Agro-One
730 Warren Road
Ithaca, NY 14850
Phone: (800) 344-2697
Fax: (607) 257-1350
www.dairyone.com

Dairy One

Farmer In the Dell
High-Ho Dairy-O Rd
E-I-E-I-O, NY 123456

Lab Sample ID 16888350
Crop Blueberries
Variety
Age Young nonbearing (1-3 years)
Market Fresh
Sampled 08/07/2011
Tested 08/19/2011
Statement ID Dell Blueberry #1
Description LIBERTY

Element	DM Basis	Satisfactory Range	Deficient	Low	In Range	High	Excessive
Nitrogen	1.51 %	1.7 - 2.1 %					
Potassium	.61 %	0.4 - 0.65 %					
Phosphorus	.081 %	0.1 - 0.16 %					
Calcium	.46 %	0.3 - 0.8 %					
Magnesium	.111 %	0.15 - 0.3 %					
Manganese	169 ppm	50 - 500 ppm					
Iron	56.4 ppm	70 - 300 ppm					
Copper	1.66 ppm	5 - 15 ppm					
Boron	36 ppm	30 - 50 ppm					
Zinc	7.9 ppm	10 - 30 ppm					

Additional Elements	As Sampled Basis	Dry Matter Basis
% Sulfur	.08	.10

Nitrogen: Increase rate of nitrogen application by 10% for each 0.1% that sample is below 1.7%. The best source of nitrogen is urea or ammonium sulfate. Apply half of the annual rate at bloom and the other half 6 weeks later.
Potassium: Continue present potassium program.
Phosphorus: Although level is outside the desired range, modification is unlikely to have an economic impact.
Calcium: Satisfactory
Magnesium: Although level is outside the desired range, modification is unlikely to have an economic impact.
Manganese: Satisfactory - No correction needed.
Iron: Low iron is the first symptom of high soil pH. For permanent correction, apply 400 lbs/acre sulfur annually until proper pH is obtained. For temporary correction, apply a foliar spray of 2 lbs/100 gallons-acre iron chelate in late summer and again after bloom the following year, but check product label and follow its recommendation. If conditions persist for several consecutive years and soil pH is within desired range, apply 25 lbs/acre iron chelate or 15 lbs/acre ferrous sulfate to soil in early spring.
Copper: Usual recommendation would be to apply a post-bloom and post-harvest spray of 2.0 lbs/100 gallons-acre copper chelate, but check product label and follow its recommendation. If the condition persists for several consecutive years and soil pH is within desired range, apply 30 lbs/acre copper sulfate to the soil in late fall or fertigate according to label directions. Fertigation can be an efficient method of delivering copper to the plant. Copper is often low in blueberry plantings.
Boron: Satisfactory
Zinc: Usual recommendation would be to apply a post-bloom, post-harvest and late summer spray of 2.0 lbs/100 gallons per acre zinc chelate, but check product label and follow its recommendation. If condition persists for several consecutive years and soil pH is within desired range, apply 10 lbs/acre zinc sulfate to soil surface in early spring. Fertigation can be an efficient method of delivering zinc to the plant. Zinc is often low in blueberry plantings.
Unless otherwise indicated, recommendations assume the soil pH is 4.0 to 4.8. If the pH is outside this range, recommendations may not be effective.
K/Mg ratio = 5.5 (Acceptable level is less than 4.0)
P/Zn ratio = 103 (Acceptable level is less than 140)
For greatest accuracy, samples should consist of recently expanded leaves sampled from mid-July through mid-August.
Multiply recommendations in lbs/acre by 0.015 to obtain ounces/plant.
When following a recommendation to apply a chelate make sure formulation you use is labeled for use with your particular crop. (One gallon equals 8.3 pounds).

Page 2 of 2

*Corresponding soil test: (lb/A)
Soil pH = 5.2

Phosphorus (P)	low	(2)
Potassium (K)	high	(254)
Calcium (Ca)	high	(4,233)
Magnesium (Mg)	high	(465)
Iron (Fe)		(46)
Manganese (Mn)		(193)
Zinc (Zn)		(3)
Aluminium (Al)		(126)
Organic Matter	6%	

*Morgan

Recommendations:
- Apply 50 lb Mg/A as sulfates of Mg.
- Apply 200 lb sulfur early spring and again late fall for next 3 years.
- Foliar iron may be needed until desired pH range is reached.

Protocol for Tissue Analysis Interpretation

- Ensure that the soil pH is within the correct range
- Assess the status of the planting to determine if something other than nutrients could be limiting growth (disease, drought)
- Check the status of boron
- Look for specific nutrients that might be deficient
- Check for interactions/imbalances that exacerbate low nutrient levels
- Derive recommendations

Interpreting Tissue Analysis Test Results

- Tissue analysis tests are not meaningful for fertility guidelines unless the soil pH is within the correct range
- Soil test results do not always correlate with foliar test results for a variety of reasons
- Tissue analysis tests are useful for diagnosis, but not for detailed guidance unless growth and yield are good.
- Applying nutrients may result in a decrease in foliar concentrations under certain circumstances
- Correcting deficiencies or imbalances in established plantings is more difficult than amending soils prior to planting

Nitrogen Needed Annually

- Rate is determined by:
  - Crop
  - Plant age
  - Irrigation status
  - Mulching status
  - Leaf analysis results

See Cornell Pest Management Guidelines for Berry Crops (http://ipmguidelines.org/BerryCrops/) for guidelines to annual rates (50 – 100 lbs N/acre-year)

Nutrients Required after Establishment

- In many cases, no additional P, K, Mg or Ca will be required if the soil test recommendations were followed.
- Supplemental K and B may be required on sandier soils.
- Small amounts of sulfur may be required to maintain a low pH in some soils where blueberries are grown.

A leaf analysis will provide guidance on supplemental fertilizers after the planting is established.

Do not rely on the soil test for post-plant recommendations that do not involve soil pH.

Let's Review…

Don't rely on visual symptoms or what you've always done in the past . . .

- Prior to planting
  - Cornell soil health test
    - Includes Agro-one standard soil analysis and more!
- After plants are established
  - Annual tissue (leaf) analysis
  - Additional soil testing as needed every 2-3 years

Acknowledgements

- **Dr. Marvin Pritts, Project Leader**, Professor and Chair, Cornell University Department of Horticulture
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- **Mr. Jeff Miller, Project Team Member,** Agriculture Issues Leader, Cornell Cooperative Extension Oneida County
- **Mr. Mario Miranda Sazo, Project Team Member,** Tree Fruit and Berry Fruit Extension Specialist, Cornell Cooperative Extension Lake Ontario Fruit Team
- **Mr. Dan Welch, Project Team Member,** Extension Resource Educator, Cornell Cooperative Extension, Cayuga County
- **Dr. Harold van Es, Collaborator**, Professor, Cornell University Department of Crop And Soil Sciences
- **Mr. Robert Schindelbeck, Collaborator,** Extension Associate, Cornell University Department of Crop and Soil Sciences

Special thanks to **Ms. Janet Fallon**, Certified Crop Advisor, Agro-One.

Dairy One
14850 1-800-344-2697 x 2172
730 Warren Road Ithaca NY
www.dairyone.com

How to take a soil sample

Taking a representative soil sample is a needed to determine lime and fertilizer requirements and avoid costly over or under fertilization. Follow the guidelines below to help ensure the best results.

Order Your Soil Test Supplies

There are 3 ways to order soil sample boxes and sample information sheets:

- Call 1-800-344-2697 ext. 2172
- Email supply@dairyone.com. Be sure to include your account number and/or name, street address and daytime phone number plus items and quantity needed. Specify the type of sample information sheet needed.
- Directly from our website http://www.dairyone.com/Forage/OrderSupplies/

Establish a Sampling Schedule

Most soils should be sampled every 2 - 3 years; more often for sandy soils, high value crops or problem areas.

To avoid seasonal variation, try to sample at the same time every year for a given field or garden. Fall is generally considered to be the most reliable time to pull samples, especially when it comes to pH. Soil pH fluctuates and tends to be lower in the summer when temperatures are higher and soils are dryer. When soils dry out, salt concentrations increase allowing Ca^{++}, Mg^{++}, K^{+} to replace H^{+} and Al^{+++} on the soil surface. The extra H^{+} and Al^{+++} in the soil solution will temporarily decrease soil pH hence pH determination is more reliable in the Fall when soil moisture is a bit higher.

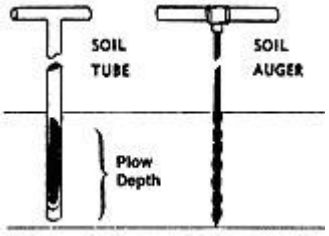
Use the Right Tool

Use tools that are clean and free of rust. Avoid brass or galvanized tools or containers that can contaminate samples with zinc or copper. Stainless steel probes or augers are best because they collect a continuous core through the entire sampling depth with a minimum disturbance of the soil (see Figure 1.). Avoid shovels or trowels.

.

Collect samples in a clean plastic bucket or plastic bag. Avoid collecting or shipping wet samples in plain commercial paper bags or boxes that are often treated with a product containing boron. Wet samples can leach boron out of the paper and contaminate the sample. If possible, send air dried samples in and Agro-One sample box.

Figure 1. Use a stainless steel probe or auger for best results.



Sample at the Proper Depth Based on Tillage

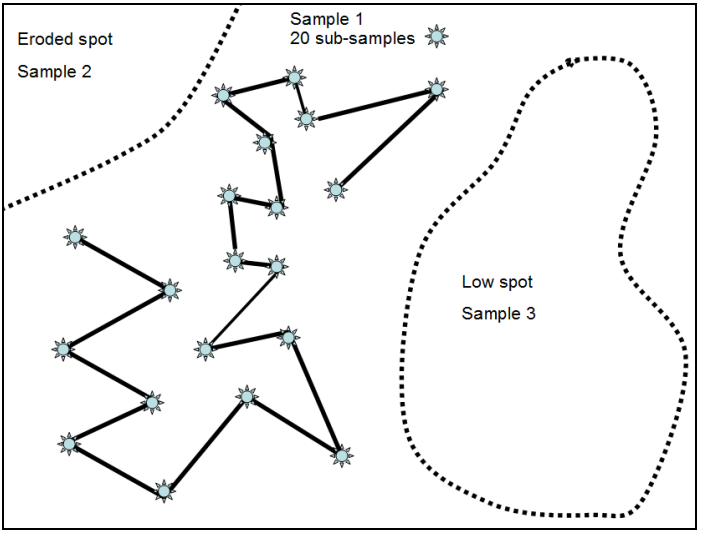
- **Moldboard plow** – surface to tillage depth (usually 6-7 inches).
- **Chisel plow and offset disk** – sample before tillage to ¾ of the tillage depth.
- **Reduced tillage systems** – No Till, Ridge till, Zone Till etc.
  Two Samples may be required. Sample between rows to avoid disturbed soil or fertilizer band.
    - Sample to 6 inch depth for pH and nutrient content.
    - Take a second sample to a 1 inch depth to determine if surface applied N has resulted in an acid layer that can reduce the effectiveness of triazine herbicides.

Identify the Sampling Area

Commercial Field

- Take 15-20 plow depth core sub-samples using a zig-zag pattern in a management area representing < 20 acres (see Figure 2.).
- Avoid unusual areas such as dead furrows, old hedge rows, fence lines, old manure piles, lime piles or burn piles. Avoid wet areas or severely eroded areas.
- Take separate samples from areas within the field that vary widely from the rest of the field in color, slope, soil texture, drainage, productivity or crop history.
- Sample each contour strip separately if it is > 5 acres.
- Mix the 15-20 subsamples completely in a clean plastic bag or plastic bucket.
- Avoid sampling under extremely wet soil conditions. Wet samples usually leak in transit and some nutrients in very wet soils may undergo rapid biological transformations.

Figure 2. Suggested Sampling Pattern in a Commercial Field



Prepare Samples for Shipment.

If possible, spread wet samples in a thin layer on a clean surface and dry at room temperature. Do not use heat but a fan is acceptable to assist in drying. Remove large stones or sticks and break up large lumps or clods before mixing the sample thoroughly.

Complete the required information on the sample box before assembling and make sure that it matches the information on the sample information sheet. Place about ¾ - 1 pint of the mixed sample in the sample box then close it securely.

Fill Out the Sample Information Sheet Completely.

A completed sheet must accompany each sample. Required information includes;

- Customer name, address and contact information.
- Consultant/Extension Educator name, address and contact information
- Method of reporting results – fax, email or US Mail.
- Type of report required – with or without recommendations.
    - All Commercial NY samples must include a valid soil name if results are needed
    - All Home, Garden Landscape NY samples must include soil texture and soil drainage if results are to be reported.
    - All VT samples require soil drainage class if results are to be reported
- Method of payment – Dairy One or Agro One account number, DHIA herd code, credit card information or a check. Results will not be released until payment or billing information has been received.
- Sample information – sample identification, soil name (NY commercial samples), soil drainage & soil texture (NY Home, garden and landscape samples, soil drainage class (VT samples), and other required information should be filled in completely. Recommendations may not be generated if the information sheet is incomplete.
- KEEP A RECORD OF ALL SAMPLES SHIPPED including method and date of shipment. Dried ground samples will be stored at the lab for approximately 4 weeks to allow for additional test requests.
- Maintain records of your soil test results to assist in monitoring changes in soil fertility over time. This may be useful to adjust soil management to meet crop demands without costly over or under application of nutrients.

Ship Your Samples to:
Dairy One
730 Warren Road
Ithaca NY 14850
Phone: 1-800-344-2697 ext. 2172

Samples can be shipped via U.S. Mail, UPS, Fed Ex, DHL, etc. Selecting these carriers will require additional packaging and will incur additional shipping and handling costs. If using the USPS, the flat rate boxes will be your most economical way to ship samples.

In some areas, samples can be left at milk pick-up points by prior arrangement. Where available, samples will be picked up three times a week and delivered to the Dairy One facility in Ithaca the following morning.There is no shipping or handling charge for this service. Complete information on pick-up point locations, procedures and schedules can be found at: http://98.159.209.20/Truck_Stops.html

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Agro-One Soils Laboratory

730 Warren Road, Ithaca NY 14850 • Phone: 800-344-2697 • Fax: 607-257-1350
Email: soil@dairyone.com • Web: www.dairyone.com
Nutrient guidelines provided by Cornell University

Dairy One
Cornell University
College of Agriculture and Life Sciences

Multiple Sample Submission Form for NEW YORK State: Commercial Fruit Crops and Christmas Trees

(855) Modified Morgan Soil Test Package with Cornell Generated Nutrient Guidelines, $12 per sample

Go to http://www.dairyone.com/SoilLaboratories/ForageInfoSoil.pdf for other soil testing services available in NY, PA, VT, NH and MD

Nutrient guidelines will be reported ONLY if a valid soil name is provided.
For soil maps and soil names visit http://websoilsurvey.nrcs.usda.gov/app/

Grower Information:		**Commercial respresentative or CCE Educator:**		**Sample Origin**	
Name:		Name:		County:	
Street:		Street:			
City, ST, ZIP:		City, ST, ZIP:			
Email / Fax:		Email / Fax:			

# samples_____x cost per sample $_____ = Amount Due $_____		Credit Card Check One: [ ] VISA [ ] MasterCard [ ] American Express	3 digit CVC no. (on back of card) ___ ___ ___
[ ] Check payable Dairy One	[ ] Pre-Paid CNAL Bag	Card Number:	
Check No. _____	[ ] Bill Dairy One Account _____	Signature:	Expiration Date ___ ___/___ ___

SOIL INFORMATION

Visit http://websoilsurvey.nrcs.usda.gov/app/ for soil maps & names

LAB ID For Lab Use Only	CNAL Bag No.	**Sample ID Circle paired surface & subsurface samples**	Surface or Sub-surface [1]	Other tests (See Back)	Sample date	**Soil Name** *Required* [2]	Crop Code [3]	**Crop Name or Variety**	**Recommendations for (check one)**		**Maintenance Only Ground Cover?**	
									PRE-PLANT	MAINTENANCE	**Yes**	**No**
LAB USE ONLY												
LAB USE ONLY												
LAB USE ONLY												
LAB USE ONLY												
LAB USE ONLY												
LAB USE ONLY												

[1] **Indicate SR for Surface or SB for Sub-surface sample** [2] **Visit http://websoilsurvey.nrcs.usda.gov/app/ for soil maps & names** [3] **Crop Codes provide on back of this sheet**

GENERAL SOIL TEST INFORMATION

Standard tests and lime requirement are determined on all samples and are included in the analysis fee. Nutrient guidelines will be provided if a valid soil name is included.

The Modified Morgan Soil Test includes:
pH, Modified Mehlich Buffer pH (lime requirement), organic matter and extractable phosphorus (colorimetric), potassium, calcium, magnesium, aluminum, iron, zinc and manganese plus Cornell generated nutrient guidelines if a valid soil name is provided.

Sample Submission Instructions: Place about 1 cup of your well-mixed soil sample into the sample box, close the box and label. For deep rooted tree fruits, a surface (SR) soil sample from the 0 - 8 inch depth and a sub-surface (SB) soil sample from the 8 - 24 inch depth is needed since these crops obtain many of their nutrients from the subsoil. Samples should be sent in separate mailing boxes. Indicate paired surface and subsurface samples on the front of this sheet by circling the paired samples.

Fill out the submission form, fold & submit it with soil samples. Ship to Dairy One, 730 Warren Road, Ithaca NY 14850 by US Mail, UPS, Fed Ex, etc. Go to the Agro-One tab at www.dairyone.com for information about free overnight shipping and handling available in some locations. Results and nutrient guidelines are returned by US Mail, fax or email.

Supplies: Additional forms can be downloaded from www.dairyone.com under the Agro-One tab. Order soil test kits, manure sample kits, forage sample kits and sample sheets at 1-800-344-2697x 2142 or email: supply@dairyone.com

CROP CODES FOR FRUIT CROPS AND TREES

CODE	✔	Requires surface & sub-surface samples at establishment	CODE	✔	Requires surface & sub-surface samples at establishment
APP	✔	Apples	GPV	✔	Grapes, Vinifera
ACT	✔	Apricots	NEC	✔	Nectarines
BKB		Blackberries	NUR	✔	Nursery stock
BLB		Blueberries	PAR	✔	Pears
CHS	✔	Cherries, Sweet	PCH	✔	Peaches
CHT	✔	Cherries, Tart	PLM	✔	Plums
CUR		Currants	PRN	✔	Prunes
ELD		Elderberries	RSF		Raspberries, Fall
GOO		Gooseberries	RSS		Raspberries, Spring
GPA	✔	Grapes, American	STE		Strawberries, Ever bearing
GPF	✔	Grapes, French-American	STS		Strawberries, Spring

MISCELLANEOUS

CODE	CROP NAME	CODE	CROP NAME
TRT	Christmas Tree Topdressing (Maintenance)	IDL	**Idle land -** *Results only. No interpretation or nutrient guidelines provided.*
TRE	Christmas Tree, Establishment (Pre-plant)	OTH	**Other** - *Results only. No interpretation or nutrient guidelines provided.*

OPTIONAL TESTS, Results only. No interpretations will be provided for optional tests. *(Please enclose check for the total cost of all tests requested)*

Test	Cost per sample ($)
(836) pH in 0.01M $CaCl_2$	$5.00
(837) Soluble salts	$5.00
(838) No-till pH (0-1 inch)	$5.00
(861) Nitrate	$6.00
(840) Boron (Hot water)	$10.00

NOTE: Heavy metal and cation exchange capacity (CEC) testing are available through the Cornell Nutrient Analysis Lab (CNAL) Please contact CNAL directly at 1-607-255-4540, soiltest@cornell.edu or http:cnal.cals.cornell.edu

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Cornell University Cooperative Extension

SCNYAG South Central New York Agriculture Team

FRUIT & VEGETABLE PRODUCTION

Schuyler Tompkins Cortland Chemung Tioga

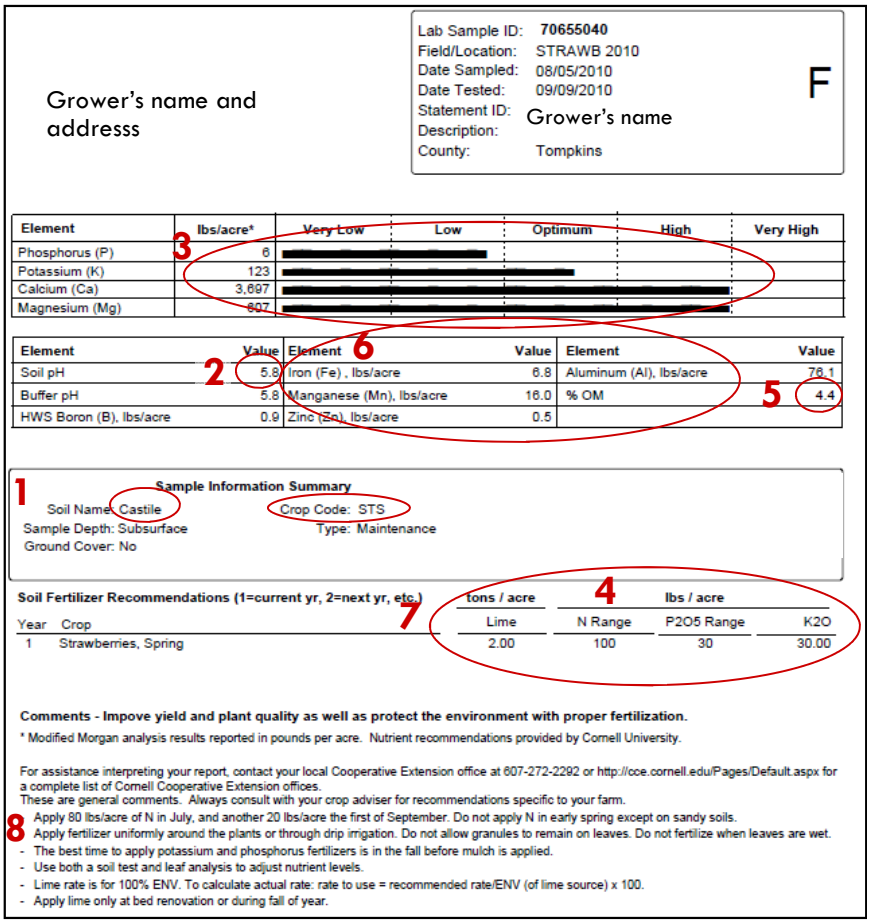
Understand your Agro-One Soil Test Results

1. Check the crop and soil name

Agro-One uses the soil name and cropping plans you report on your submission form to generate fertilizer recommendations specifically for your field, so it's important that they're accurate. Look up your soil's name on the Web Soil Survey, websoilsurvey.nrcs.usda.gov/, and don't leave the future crop plan blank on the form. If you're not sure what you're going to grow, at least list "mixed vegetables" as the upcoming crop. Also remember that the recommendations are only as good as the sample you took in your field. Your sample should be composed of a mixture of at least ten 8-inch soil cores from around the field.

2. Look at the soil pH

pH is a measure of soil acidity and affects the availability of most soil nutrients. For most crops, a pH between 6.0 and 7.0 gives the best nutrient availability. If the pH is too high or too low, adding more fertilizer won't fix the resulting nutrient deficiency. pH must first be corrected by adding lime (to raise pH) or sulfur (to lower pH). Check the fertilizer recommendations to see how much lime to add to your field. pH adjustments take time, up to a year, so amend the soil well in advance.



Grower's name and addresss

Lab Sample ID: 70655040
Field/Location: STRAWB 2010
Date Sampled: 08/05/2010
Date Tested: 09/09/2010
Statement ID: Grower's name
Description:
County: Tompkins

F

Element	lbs/acre*	Very Low	Low	Optimum	High	Very High
Phosphorus (P)	6					
Potassium (K)	123					
Calcium (Ca)	3,697					
Magnesium (Mg)	607					

Element	Value	Element	Value	Element	Value
Soil pH	5.8	Iron (Fe) , lbs/acre	6.8	Aluminum (Al), lbs/acre	76.1
Buffer pH	5.8	Manganese (Mn), lbs/acre	16.0	% OM	4.4
HWS Boron (B), lbs/acre	0.9	Zinc (Zn), lbs/acre	0.5		

Sample Information Summary
Soil Name: Castile
Crop Code: STS
Sample Depth: Subsurface
Type: Maintenance
Ground Cover: No

Soil Fertilizer Recommendations (1=current yr, 2=next yr, etc.)

Year	Crop	tons / acre Lime	lbs / acre N Range	lbs / acre P2O5 Range	lbs / acre K2O
1	Strawberries, Spring	2.00	100	30	30.00

Comments - Impove yield and plant quality as well as protect the environment with proper fertilization.

* Modified Morgan analysis results reported in pounds per acre. Nutrient recommendations provided by Cornell University.

For assistance interpreting your report, contact your local Cooperative Extension office at 607-272-2292 or http://cce.cornell.edu/Pages/Default.aspx for a complete list of Cornell Cooperative Extension offices.
These are general comments. Always consult with your crop adviser for recommendations specific to your farm.

- Apply 80 lbs/acre of N in July, and another 20 lbs/acre the first of September. Do not apply N in early spring except on sandy soils.
- Apply fertilizer uniformly around the plants or through drip irrigation. Do not allow granules to remain on leaves. Do not fertilize when leaves are wet.
- The best time to apply potassium and phosphorus fertilizers is in the fall before mulch is applied.
- Use both a soil test and leaf analysis to adjust nutrient levels.
- Lime rate is for 100% ENV. To calculate actual rate: rate to use = recommended rate/ENV (of lime source) x 100.
- Apply lime only at bed renovation or during fall of year.

pH details

pH can be measured using different methods, but for most samples, "water" extraction most closely mimics what plant roots feel. Calcium chloride is sometimes used to measure pH in very sandy soils, and is available for an extra fee. "Buffer pH" is the measure the lab uses to calculate how much lime your particular soil needs, since heavy soils have more buffering capacity and need more lime to change their pH than sandy soils.

3. Major nutrients: P, K, Ca, and Mg

The soil levels of these nutrients are reported in pounds per acre (lbs/A). If you prefer to use parts per million (ppm), convert by dividing in half (ppm = lb/A ÷ 2). The **relative levels** of the soil nutrients to the right of the lbs/A results are the most important to notice, since the same nutrient lb/A may be high for one soil type or crop while for another it is medium. "High" is considered to be a good level and may not generate a fertilizer recommendation. A "medium" level is considered to be adequate for the short term but nutrient supplementation may be recommended to maintain or build soil test levels for the future. Note that due to differences in extractants and lab procedures, the lbs/A nutrient levels are not comparable between labs. However, the *relative* levels of nutrients (high, medium, or low) should be similar between different labs.

"Morgan" versus "Mod Morgan"

Agro-One will use one of two chemicals to extract the nutrients in your soil sample before they are measured, either "Morgan" solution or "Modified-Morgan" solution. Cornell field crops experts prefer the Morgan solution because it reports P levels that correlate more accurately with recommendation database when soil P is low, allowing for more accurate P fertilizer recommendations for field crops. For fruits, vegetables, lawns and gardens, the more economical Modified Morgan solution will be used because the nutrient recommendations are, in almost all cases, identical to those based on the Morgan test.

Fact sheet prepared in 2011 by Molly Shaw, and reviewed by Steve Reiners (Cornell Veg Crops) and Janet Fallon (Agro-One)

SH

Cornell Soil Health Assessment 2012

Cornell Nutrient Analysis Lab (CNAL), G01 Bradfield Hall, Ithaca, NY 14853 (607) 255-4540

Soil Health Coordinator Bob Schindelbeck (607) 227-6055, rrs3@cornell.edu

E-mail: soilhealth@cornell.edu **Website: http://soilhealth.cals.cornell.edu**

NUTRIENT RECOMMENDATIONS FOR NY ONLY. Please provide the SOIL NAME
For soil maps and soil names visit http://websoilsurvey.nrcs.usda.gov/app/

Grower	**Commercial representative**
Grower name: _____	Representative name: _____
Address: _____	Address: _____
_____	_____
Phone: _____	Phone: _____ **County:**
Email:	Email:

Soil Health Analysis Cost

Basic Package* $45/ sample $_____

Standard Package $75/ sample $_____

Add-on Soluble Salts $7.50/ sample $_____

Add-on Metals Screening $17/ sample $_____ _____ **:Total**

[ ] Check enclosed (to: CORNELL UNIV.)
[ ] Paid Agent (name):
[ ] Bill Me:

*** See Back of Sheet (top) for Listing of Tests Performed in each Soil Health Package**

FIELD AND FARM INFORMATION

Field yields are:		**Field problems:**		**Farm Operation (check all that apply):**		
☐ high	☐ increasing	☐ crusting	☐ soil hard	☐ dairy	☐ organic	☐ research farm
☐ medium	☐ decreasing	☐ droughty	☐ diseases	☐ vegetable	☐ conventional	☐ commercial farm
☐ low	☐ constant	☐ stays wet	☐ other_____	☐ grain	☐ other_____	☐ garden

SOIL INFORMATION ★*Remember: 4-6 cups of soil are needed!*★

LAB ID (*Lab Use Only*)	**Field Identification**	**Date Sampled**

SOIL NAME (*REQUIRED*)	**Tillage Depth**	**Artificial Drainage**	**Manure / Organic Additions**
(ex. LIMA silt loam)	**2010** **2011** **2012** **1** = no till, **2** = 1-7 inch, **3** =7-9 inch, **4** = >9 inch	**1** = none, **2** = Inadequate, **3** =Adequate, **4** =Excellent	Type/ Animal Amount/ Acre [ ] 2010 [ ] 2011 [ ] 2012

CROP INFORMATION (see back of this sheet for Crop Codes)

% Legume Last Year	**Cover Crop**	**Past Year Crops**			**Future Crops**		
		3 yrs ago	2 yrs ago	Last yr	This yr	Next yr	Third yr
1 = 0%, **2** = 1-25%, **3** = 26-50%, **4** = 51-100%	**1** = Before next crop, **2** = Before 2nd years crop, **3** =Before 3rd years crop, **4** =Before all years crop						

FIELD PENETROMETER DATA COLLECTION (use SMALL 1/2" tip)

PENETRATION RESISTANCE	location 1		location 2		location 3		location 4		location 5		**Depth to Hardpan or a Restrictive Layer (inches):**
0-6 INCH Maximum	push 1	push 2	push 3	push 4	push 5	push 6	push 7	push 8	push 9	push 10	
6-18 INCH Maximum											

Record the highest resistance value encountered in each depth range. NOTE: A field penetrometer is available to borrow. Contact Bob Schindelbeck (at top of page) and it can be sent to you through the mail.

CORNELL SOIL HEALTH TEST INFORMATION

Field Crop and Vegetable Soil Health Package Analyses

Basic Package Analyses $45/ sample

Recommended applications: field crops, dairy, lawns

Soil pH, Mod. Morgan Extractable P, K, micronutrients
Soil Texture
Wet Aggregate Stability
Available Water Capacity
Surface/ sub-surface Hardness
Organic Matter
Active Carbon

Standard Package Analyses $75/ sample

Recommended applications: organic production, vegetable crops, problem diagnosis, soil health initializing, home gardens

Basic Package

PMN (Potentially Mineralizable N)
Root Bioassay

Landscape/ Urban/ High Tunnel Add-on Tests

Soluble Salts/ conductivity (CNAL test 1880) **$7.50/ sample** and **Sodium Absorption Ratio (SAR)**

Recommended applications: high tunnels, landscaped areas, lawns and urban areas, heavily composted areas, home gardens

Heavy Metal Screening $17/ sample
(CNAL test 2021, EPA Method 3051-6010)

Recommended applications: urban areas and gardens, home gardens, playgrounds, brownfields, heavily composted areas

The complete Cornell Soil Health Test Report, which includes the test results from the Basic and Comprehensive Packages listed above require about 4-6 weeks for completion and will be sent from the Soil Health Lab of the Cornell Nutrient Analysis Lab, G01 Bradfield Hall, Cornell University, Ithaca, NY 14853.

Please see the website http://soilhealth.cals.cornell.edu for specific field sampling and sample handling instructions. This website also contains the Cornell Soil Health Assessment Training Manual which outlines the soil analyses and how to interpret the Soil Health Test Report.

STANDARD SOIL FERTILITY GUIDELINES *(NY ONLY)*

The Cornell Nutrient Analysis Laboratory will be performing Soil Nutrient tests and will send results directly to the names listed on this submission form *in* ***New York only*****.** Soils from other States will only receive chemical level scores on the Soil Health Report.

Standard Nutrient Guidelines (NY only): pH, buffer pH (lime requirement), organic matter and Modified Morgan extractable phosphorus, potassium, calcium, magnesium, aluminum, sulfur, zinc, manganese and iron.
You will receive the soil Chemical results and nutrient recommendation guidelines within 2 weeks of sample submission.

CROP CODES

PERENNIAL AGRONOMIC CROPS

CODE	INITIAL ESTABLISHMENT	CODE	TOPDRESSING ESTAB. STANDS	CODE	INITIAL ESTABLISHMENT	CODE	TOPDRESSING ESTABL
ALE	Alfalfa	ALT	Alfalfa	CVE	Crownvetch	CVT	Crownvetch
AGE	Alfalfa-grass	AGT	Alfalfa-grass	GRE	Grasses	GRT	Grasses (brome, timothy)
ABE	Alfalfa-trefoil-grass	ABT	Alfalfa-trefoil-grass	GIE	Grass-intensive mgmt.	GIT	Grass-intensive managem
BTE	Birdsfoot-trefoil	BTT	Birdsfoot-trefoil	PIE	Pasture-rotation grazed	PIT	Pasture-intensive manage
BGE	Birdsfoot-trefoil-grass	BGT	Birdsfoot-trefoil-grass	PGE	Pasture w/improv. grazing	PNT	Pasture w/native grass
BCE	Birdsfoot-trefoil-clover	BCT	Birdsfoot-trefoil-clover-grass	PLE	Pasture with legumes	PGT	Pasture w/improved grass
BSE	Birdsfoot-trefoil-seed	BST	Birdsfoot-trefoil-seed	WPE	Waterways, pond dikes	PLT	Pasture w/legumes
CLE	Clover	CLT	Clover			WPT	Waterways, pond dikes
CGE	Clover-grass	CGT	Clover-grass				
CSE	Clover-seed production	CST	Clover-seed production				

ANNUAL AGRONOMIC CROPS

CODE	INITIAL ESTABLISHMENT	CODE	TOPDRESSING ESTAB. STANDS	CODE	INITIAL ESTABLISHMENT	CODE	TOPDRESSING ESTABL
BSP	Barley-spring	BUK	Buckwheat	RYC	Rye-cover crop	SOY	Soybeans
BSS	Barley-spring w/legume	COG	Corn-grain	RYS	Rye-seed production	SUN	Sunflower
BWI	Barley-winter	COS	Corn-silage	SOG	Sorghum-grain	TRP	Triticale, Peas
BWS	Barley-winter w/legume	MIL	Milet	SOF	Sorghum-forage	WHT	Wheat
BDR	Beans-dry	OAT	Oats	SSH	Sorghum-sudan hybrid	WHS	Wheat w/legume
		OAS	Oats seeded w/legume	SUD	Sudangrass		

MISCELLANEOUS CROPS- Results only. No interpretations or nutrient guidelines are provided for IDL or OTH.

CODE	CROP	CODE	CROP
TRT	Christmas Tree, Topdress	IDL	Idle Land
TRE	Christmas Tree, Establishment	OTH	Crops not listed

NOTE: The complete list of crop codes can be found at http://www.dairyone.com/AgroOne/Agro_One_Crop_Codes.pdf

VEGETABLE CROPS

CODE	CROP	CODE	CROP	CODE	CROP	CODE	CROP
ASP	Asparagus	CFS	Cauliflower-seeded	MML	Muskmelon	RAD	Radishes
BND	Beans-dry	CEL	Celery	MUS	Mustard	RHU	Rhubarb
BNS	Beans-Snap	CRD	Chard	ONP	Onion-transplanted	SPS	Spinach-spring
BET	Beets	CHC	Chinese cabbage	ONS	Onion-seeded	SPF	Spinach-fall
BRP	Broccoli-transplanted	CKP	Cucumber-transplanted	PSL	Parsley	SQS	Squash-summer
BRS	Broccoli-seeded	CKS	Cucumber-seeded	PSN	Parsnips	SQW	Squash-winter
BUS	Brussels Sprouts	EGG	Eggplant	PEA	Peas	SWC	Sweet corn
CBP	Cabbage-transplanted	END	Endive/Escarole	PEP	Peppers	TME	Tomato-early
CBS	Cabbage-seeded	GAR	Garlic	POP	Popcorn	TOM	Tomato-all others
CAR	Carrots	LET	Lettuce	POT	Potatoes	TUR	Turnips
CFP	Cauliflower-transplanted	MIX	Mixed vegetables	PUM	Pumpkins	WAT	Watermelon

Dairy One

Cornell University
College of Agriculture and Life Sciences

Agro-One Soils Laboratory

Instructions for leaf sample collection from Vineyards, Small Fruit and Tree Fruit pt062811jbf

SMALL FRUIT

1. Time to sample.

***Strawberries*:** Sample the first fully expanded leaves after renovation or within the first 6 weeks after harvest.
***Raspberries*:** Sample healthy leaves on non-fruiting canes between August 1st and 20th.
***Blueberries*:** Sample healthy leaves between July 1st and August 30th.

2. What to sample.

Sample healthy leaves that are well exposed to light. These should represent the average condition of the planting and should not be damaged by: disease; insects; weather or mechanical injury.

AVOID mixing leaves from different cultivars.
DO NOT mix leaves from plants of different ages.

A minimum of 50 grams (~ 2 oz) fresh weight from a minimum of 30 leaves are needed per sample. If possible, each leaf should be taken from a different plant within the sampled area. Since an accurate recommendation is dependant upon a pH reading, we strongly suggest that you test the pH at this time and record it on the appropriate line of the information sheet.

Plants sampled should represent the average condition within the planting unless samples are being taken to determine cause(s) of a distinct problem or condition.

3. Soil conditions, past fertilizer practices and spray program.

Soil conditions, past fertilizer practices and spray program should be uniform (similar) over the entire sample area. If any of these conditions differ in different parts of the planting, it will be necessary to sample these areas separately.

4. Collecting and handling samples.

Detach leaves and remove the petioles. Place leaves in a dry paper bag or perforated plastic bag and immediately label the bag so that you will know the area this sample represents. Wash the leaves before they wilt to remove spray residues and dirt. Gently rub the leaves together in a mild detergent solution (dish washing detergent in tap water). See **Washing leaf samples** below for washing instructions**.** Place sample into dry paper bag with the top open and let dry at room temperature until the leaves are brittle.

5. Submission Form.

Fill out the information sheet and work sheet completely. Keep the work sheet for your own records to aid in interpretation at a later date. Be sure that the leaf sample bag and the information sheet are marked with the same ID#.

6. Packaging, payment, and mailing instructions.

The 180 Package cost per sample is $24. It includes Total N, P, K, Ca, Mg, Zn, Cu, Fe, B and Mn.

Please make check or money order payable to**:** Dairy One, 730 Warren Road, Ithaca NY 14850

7. Washing leaf samples.

Wash the leaf samples while still fresh, **before they wilt**. If a large number of samples need to be prepared, they may be stored overnight in a cold storage, refrigerator or ice chest to keep them drying out.

Use distilled water, available at most drug stores, for washing and rinsing the samples. Change the water if it becomes dirty **or** after 8 to 10 samples (whichever occurs first). **Gently** and **lightly** scrub the leaves together in distilled water.

Shake to remove excess water and immediately rinse the sample in clean distilled water. Again shake to remove excess water and immediately rinse the sample in clean distilled water. Again shake to remove excess water. Transfer sample to paper bag, with top open and dry at room temperature until the leaves are brittle.

NOTE: DO NOT let leaves to stand in water – complete the washing and rinsing process in one minute or less.

Additional submission forms for download are available on our website: www.dairyone.com

Dairy One

Cornell University
College of Agriculture and Life Sciences

P

P 091311 jbf

Agro-One Soils Laboratory

730 Warren Road, Ithaca, NY 14850 • Ph:800-344-2697 ext. 2179 • Fax: 607-257-1350
Email: soils@dairyone.com • Web: www.dairyone.com
Nutrient Guidelines provided by Cornell University

Plant Tissue Analysis Tree Fruit, Small Fruit and Vineyards (180) - $24 per sample (includes Total N, P, K, Ca, Mg, Zn, Cu, Fe, B, Mn)

Customer & Billing Information (Required) - Name and address information on front. Use front for a single sample and reverse side for multiple samples.

CUSTOMER NAME				COMPANY / CORNELL COOPERATIVE EXT. OFFICE / EDUCATOR			
STREET				STREET			
CITY	STATE	ZIP	COUNTY (required)	CITY	STATE	ZIP	COUNTY (required
FAX / EMAIL RESULTS TO:				FAX / EMAIL RESULTS TO:			

For prompt processing enclose a check payable to Dairy One, credit card information or valid Agro-One account number

Payment by Check

Amt $ _____ Check No. _____

Bill to Agro-One Account No. _____

Payment by Credit Card [ ] Visa [ ] Mastercard [ ] American Express

Card Number: _____ Expiration Date: _____

Signature: _____ 3-digit verification code: ____ ____ ____

(located on back of card)

Sample Information (Required for lab use)

Leaf sample No. _____ Date Sampled: _____

Field Name / No. _____ Collected by. _____

If soil sample submitted for this area:

Topsoil sample ID No. _____

Subsoil sample ID No. _____

Crop Information (Required for lab use)

Crop Code: _____

Check one:
[ ] Fresh market
[ ] Processing

This sample represents: (check one)
[ ] An average condition
[ ] A problem area

Apples Only

Variety: _____

[ ] Hard [ ] Soft

Age of Planting: (check one)
[ ] 1-3 yrs [ ] 4-7 yrs
[ ] >8 yrs

Crop Codes for Fruit ***NOTE A MINIMUM 50 GRAMS FRESH WEIGHT IS REQUIRED***

Code	Crop	Code	Crop	Code	Crop
APP	Apple	ELD	Elderberry	PAR	Pear
ACT	Apricot	GOO	Gooseberry	PCH	Peach
BKB	Blackberry	GPA	Grape – American	PLM	Plum
BLB	Blueberry	GPF	Grape – French American	PRN	Prune
CHS	Cherry – Sweet	GPV	Grape Vinifera	RSS	Raspberry – Spring
CHT	Cherry – Tart	NEC	Nectarine	RSF	Raspberry – Fall
CUR	Currents	NUR	Nursery	STS	Strawberry – Spring
* Recommendations not available for NUR code at this time.				STE	Strawberry - Everbearin

Soil Name if known:

Soil pH if known:

Sampled area (acres)

Soil Texture (check one)

[ ] Sandy [ ] Gravelly

[ ] Clay [ ] Loam

Soil Drainage (check one)

[ ] Very Good [ ] Fair

[ ] Good [ ] Poor

Comments:

Agro-One Soils Laboratory • 730 Warren Road, Ithaca, NY 14850 • Ph:800-344-2697 ext. 2179 • Fax: 607-257-1350
Email: soils@dairyone.com • Web: www.dairyone.com

Form P2 – Plant Tissue Analysis Multiple Sample Input Sheet (to Accompany Form P)

Farm Name

Account No.

Dairy One

Cornell University
College of Agriculture and Life Sciences

GENERAL INFORMATION				**CROP**	**APPLES ONLY**			**MARKET TYPE**		**SOIL INFORMATION** – For your records only		
Lab ID For lab use only	**Sample ID** Ie. Leaf or Field ID. (Should match ID on sample bag)	**Date Taken**	**Sampled By**	**Code** See list on Form P	**Variety** (see list on www.agro-on.com/)	Type: 1 = hard 2 = soft	**AGE** 1 = 1-3 yrs 2 = 4-7 yrs 3 = >8 yrs	1 = fresh 2 = processing	**Rec's Requested** Y / N	**Soil Name**	**Texture** 1 = Sandy 2 = Gravel 3 = Clay 4 = Loam	**Drainage** 1 = Very Good 2 = Good 3 = Fair 4 = Poor

Standard Foliar Nutrient Ranges

	Strawberries		Raspberries		Blueberries	
Nutrient	**Deficient below**	**Sufficient**	**Deficient below**	**Sufficient**	**Deficient below**	**Sufficient**
Nitrogen	1.9%	2.0 - 2.8 %	1.9%	2.0 - 2.8%	1.7%	1.7 - 2.1%
Phosphorus	0.2	0.25 - 0.4	0.2	0.25 - 0.4	0.08	0.1 - 0.4
Potassium	1.3	1.5 - 2.5	1.3	1.5 - 2.5	0.35	0.4 - 0.65
Calcium	0.5	0.7 -1.7	0.5	0.6 - 2.0	0.13	0.3 - 0.8
Magnesium	0.25	0.3 - 0.5	0.25	0.6 - 0.9	0.1	0.15 - 0.3
Boron	23	30 -70 ppm	23	30 - 70 ppm	20	30 - 70 ppm
Manganese	35	50 - 200	35	50 - 200	25	50 - 350
Iron	40	60 - 250	40	60 - 250	60	60 - 200
Copper	3	6 - 20	3	6 - 20	5	5 - 20
Zinc	10	20 - 50	10	20 - 50	8	8 - 30

Cornell University Cooperative Extension
SCNYAG South Central New York Agriculture Team
FRUIT & VEGETABLE PRODUCTION
Schuyler Tompkins Cortland Chemung Tioga

Leaf and soil tests on local berry farms: Lessons from summer 2010

Molly Shaw, CCE South Central NY Agriculture Team

This past summer we sampled soils and leaves for nutrients on many of the local berry farms, and the results taught us quite a few lessons. The highlights are reviewed here.

For perennial crops like berries, the standard recommendations are to assess their fertilizer needs on a yearly basis with leaf tests, and to use soil tests periodically mainly to check the pH. Leaf tests are considered a more accurate view of what the plant has managed to take in than soil tests. The soil represents the "potential bank" of nutrients that the plant *ought* to have access to, while the leaf test tells you what it actually managed to get. We've found that having *both* the soil and leaf test side-by-side is necessary to really tease out what's going on with berry crop nutrients.

How to take a leaf test:
Leaf tests are taken during the main growing season and consist of about 50 leaves. For strawberries, sample the first full-sized leaves regrowing after renovation. For blueberries, take leaves in full sun from the middle of this year's growing shoot during or just after harvest. For raspberries, take the youngest full-sized leaves from primocanes before fruit is formed, in August. If you've used any sprays, you should wash the leaves in a dilute detergent solution, then rinse them with distilled water (use distilled so the water itself isn't adding minerals to the sample). Leaves are then sent to the lab where are dried out and ground up, and analyzed for the nutrient levels they contain. Soil tests can be taken at the same time as leaf tests, or any time the soil isn't frozen.

Reconciling soil and leaf tests

Ideally, the leaf test and the soil test would tell the same story. If the potassium level is low in leaves and also in the soil, simply follow the nutrient recommendations on one of the tests (or average them), and add more potassium in the fertilizer program. Similarly, it's a no-brainer when calcium is low in the leaf test, low in the soil test, and the soil pH is 5.6—add lime according to the soil test and you'll be good to go. **See figure 1.** The complications occur when the soil test and the leaf test seem to be telling a conflicting story.

When soil tests low for a nutrient, yet leaves test normal

There are times when the soil test levels of certain nutrients may be "medium" or even "low," but the leaf test levels of these same nutrients are normal. Normal leaf nutrient levels indicate that the plants are feeling well fed, despite the low soil levels.

First make sure that the leaf levels of the macronutrients (N, P, K, Ca, Mg) and boron are *all* adequate—that one low nutrient isn't the key holding back the rate of plant growth. ("Low" leaf levels of Mn, Cu, and Zn are not so worrisome because we don't have adequate research to determine what leaf level actually limits plant growth—keep reading below.) If leaf testing shows that the plants

Strawberries

Nutrient	Soil (lb/A)	Leaf (%, ppm)
Nitrogen	---------	Normal
Phosphorus	High	Normal
Potassium	High	Normal
Calcium	Low	Low
Magnesium	Medium	Low
Manganese	25.6	Normal
Iron	9	Normal
Copper	-----	Normal
Boron	-----	Normal
Zinc	5.7	Low
pH	5.6	-----
Organic Matter	2.4%	-----

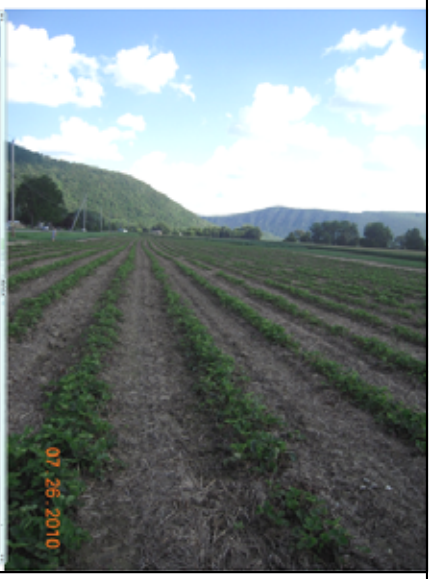


Figure 1: When soil and leaf tests tell the same story:
In these samples, soil test showed low pH, as well as less than adequate soil Ca and Mg. Not surprisingly, leaf Ca and Mg were also low. This grower will add 1.5 tons/acre of dolomitic lime, according to the soil test.

have adequate nutrients and the plants are growing well, no need to worry. Perennials fruits, unlike vegetable crops, can store nutrients within their bodies and have permanent root systems to scavenge in the soil. Believe the leaf test and don't add fertilizer that the plant doesn't need.

If the plants aren't growing vigorously but leaf tests show that the plants are getting adequate nutrients, you should look for something besides nutrients that is holding them back—winter injury, root rots, insect infestation, etc. Cyclamen mites on strawberries have been found to be more wide spread than previously thought, and are probably taking an invisible toll on strawberries yields at many farms. Plants whose growth is slowed by non-nutrient factors can find low soil nutrient levels adequate for their slow growth rate, while if they were growing faster, perhaps these same levels would not sustain their needs. **See figure 2.**

How can you know if your plants are growing "vigorously"? Particularly on the plant vigor end of things, it's hard to tell if your plants are smaller than they ought to be until you see a comparison. I learned a tremendous amount by simply visiting many different berry farms and comparing their plant health and their past management practices. As hard as it is in the height of the season, it's well worth a few hours to check out nearby berry farms.

Strawberries

Nutrient	Soil (lb/A)	Leaf (%, ppm)
Nitrogen	---------	Normal
Phosphorus	Low	Normal
Potassium	High	Normal
Calcium	High	Normal
Magnesium	High	Normal
Manganese	16	Normal
Iron	6.8	Normal
Copper	-----	Normal
Boron	-----	Normal
Zinc	0.5	Normal
pH	6.1	-----
Organic Matter	5.3%	-----

Figure 2: When soil tests low for a nutrient, yet leaf tests are normal: Phosphorus is low in the soil, yet adequate in the leaves—no phosphorus fertilizer is needed. These berries aren't particularly vigorous—in this case I think cyclamen mites are to blame.

Blueberries

Nutrient	Soil (lb/A)	Leaf (%, ppm)
Nitrogen	---------	Normal
Phosphorus	Medium	Normal
Potassium	High	Normal
Calcium	High	Normal
Magnesium	Medium	Normal
Manganese	36	Normal
Iron	28	Low
Copper	-----	Low
Boron	-----	Normal
Zinc	1.2	Low
pH	5.2	-----
Organic Matter	5.3%	-----

Figure 3: Improper pH can make soil nutrients unavailable to plants At 5.2, the pH is a bit too high for blueberries, inducing an iron deficiency. This grower will topdress with 200 lbs of sulfur each spring and fall until the pH comes down closer to 4.5 Adding sulfur faster than this runs the risk of burning plant roots. Two pictures illustrate the classic yellowing between the veins that you see with iron deficiency in blueberries caused not by lack of iron in the soil, but by the soil pH being too high.

When soil tests high for a nutrient, yet leaf test is low

Other times, the soil test can show adequate nutrient levels while one or more nutrients are low in the leaves. In this case, the puzzle is to determine what is preventing the plant from taking up the nutrient in the soil; adding more soil nutrient is not going to fix the problem.

1. Improper pH can make soil nutrients unavailable to plants. The classic example of this happening is when pH is too high for blueberries, leaf iron is usually low. Iron-deficient blueberries will show "interveinal chlorosis," green veins with yellowing between the veins. Blueberries are adapted to a low pH soil (about 4.5), and when pH creeps up two things happen that induce iron deficiency: 1) the higher the pH, the less soil iron is in a chemical form that the plant can use, and 2) within the plant itself, blueberries aren't very good at managing their iron supplies when calcium and nitrate are abundant as they are at higher pH's, so higher levels of Ca and NO_3

interfere with blueberries' use of iron in their leaves. In blueberries, iron deficiency (as shown by the leaf test) is caused by pH being too high, not low iron levels in the soil. The solution is to lower soil pH with sulfur. **See figure 3.**

2. Drought can interfere with plant nutrient uptake. We saw this quite a bit in 2010 with calcium and strawberries. We saw several strawberry fields where pH was fine as were soil calcium levels, but leaf calcium was low. Calcium has to be dissolved in the soil solution to move into plant roots, so when water is scarce, the plant roots can't reach the calcium present in the soil. Same deal with blossom end rot on tomatoes and peppers. In 2010 in central NY we had a dry spell in July, and many times after renovation strawberries got a little neglected on the watering end of things. We saw the same thing with potassium—lack of water was limiting its uptake. The solution is to water after renovation! **See figure 4.**

3. Low boron. Boron is important for plant growing tips, including roots. When it's limiting, roots don't grow adequately and the plant can't reach the other nutrients that are present in the soil. In these cases, you can see adequate soil levels of a nutrient while the leaves still test hungry. Strawberries seem particularly sensitive to low boron, and many of the strawberry fields showed low boron in the leaf tests as well as the soil tests. In these fields, applying boron according to the leaf test will probably fix the other nutrient deficiencies.

Strawberries

Nutrient	Soil (lb/A)	Leaf (%, ppm)
Nitrogen	---------	Normal
Phosphorus	High	Normal
Potassium	High	Low
Calcium	High	Low
Magnesium	High	Normal
Manganese	11.0	Normal
Iron	5.5	Normal
Copper	-----	Low
Boron	0.9	Low
Zinc	0.9	Low
pH	6.2	
Organic Matter	3.9%	

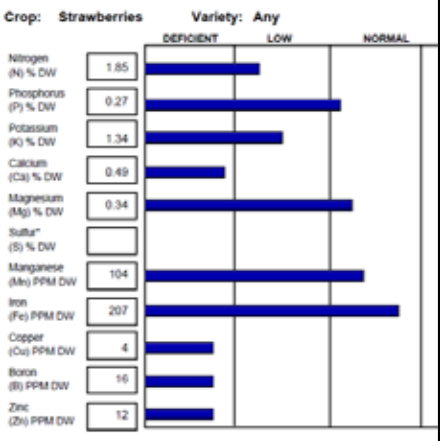


Figure 4: Drought can interfere with plant nutrient uptake
Calcium and Potassium are low in the leaf test although soil levels are fine and pH is good. Low P and K are probably due to drought, though in this case boron is also low, and this could be limiting root growth. This grower will fall fertilize with boron (5 lbs/A solubor) according to the leaf test recommendations. In addition, this farm had been using 15-15-15 to fertilize strawberries, but since soil levels of P and K are high, they can switch to an all-nitrogen fertilizer like urea and save money.

Raspberries

Nutrient	Soil (lb/A)	Leaf (%, ppm)
Nitrogen	---------	Normal
Phosphorus	Medium	Normal
Potassium	High	Low
Calcium	High	Normal
Magnesium	High	Normal
Manganese	27.4	Normal
Iron	2.4	Normal
Copper	-----	Normal
Boron	-----	Normal
Zinc	1.0	Normal
pH	6.2	
Organic Matter	4.9%	

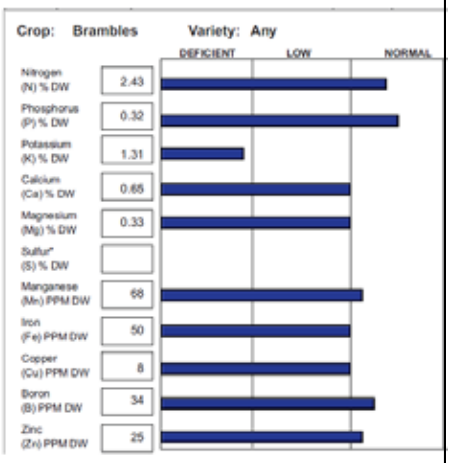


Figure 5: Plants are fruiting and sucking K from plant leaves
Almost all the raspberry leaf samples we took in 2010 had low K in leaves, while soil levels were fine. Leaf samples are supposed to be taken before fruiting, but raspberry fruiting happened earlier than we expected in 2010 because of the warm summer. Developing fruit was pulling K from the leaves at the time of sampling, resulting in low K in the leaves. There is no need to fertilize with K when soil levels are high.

Plants are fruiting. 2010 was a warm year, and raspberry season was advanced. We planned to sample fall-bearing raspberries in mid-August before fruit set, but this year fruiting came early, so we ended up sampling individual primocanes that didn't yet have any berries while other canes on the same plant were beginning to develop fruit. Berries have high K levels, so we see lower K levels in leaves as they feed developing fruit. By sampling a little late, when resources were being put to fruit, we got low K levels in leaves while we had adequate K in the soil. **See figure 5.**

What about micronutrients?

Many of our leaf tests show low zinc and low copper. Soil tests report a number for Cu and Zn, but don't give an interpretation about whether that level is high, medium or low. Marvin Pritts, Cornell Berry specialist, says that research hasn't been done on berries to definitively determine what levels of Cu and Zn limit yield. That would take a study where micronutrient levels were varied and yield responses measured. The "adequate" levels have been determined by sampling extremely healthy plants, noting their micronutrient levels, and assuming that levels lower that those measured were "low". Leaf tests tend to recommend micronutrient applications to bring up levels of zinc and copper, but Marvin suspects that it's not worth the fertilizer investment in most cases. We saw plenty of berry fields in our survey whose leaf tests reported "low" levels of Zn and Cu but which were performing admirably, so at this time we recommend not worrying about reportedly low Zn and Cu levels.

It's worth it to soil and leaf test

Each farm's unique soil/leaf tests provide a different puzzle with different questions to answer. The observations above applied to several farms, and there were other scenarios besides these. Of the 14 local berry farms that did soil/leaf tests this summer, changes is fertilization practices were recommended for 12 of them. A soil test costs about $16, leaf test $24—$40 well spent considering the value of your berry crop!

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