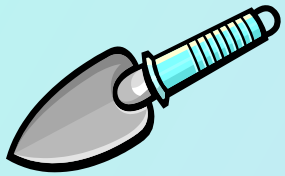


Create A Biodiverse Garden for Ecological Resilience

Northwest Chapter Vermont Master Gardeners
and the Vermont Extension Master Gardeners Program

Wendy Sue Harper, Ph.D.
(She/Her Pronouns)
Associate Faculty Prescott College
WSH Consulting



fungal-jungle.blogspot.com

Gardening for Ecological Resilience

- Creating bio diversity for biological buffering
- Great soil management for resilience

www.ukagriculture.com

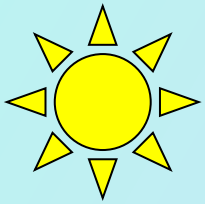
Traditional and Indigenous Practices

- Diachronic knowledge
- Synchronic knowledge

www.sare.org

Wendy Sue Harper

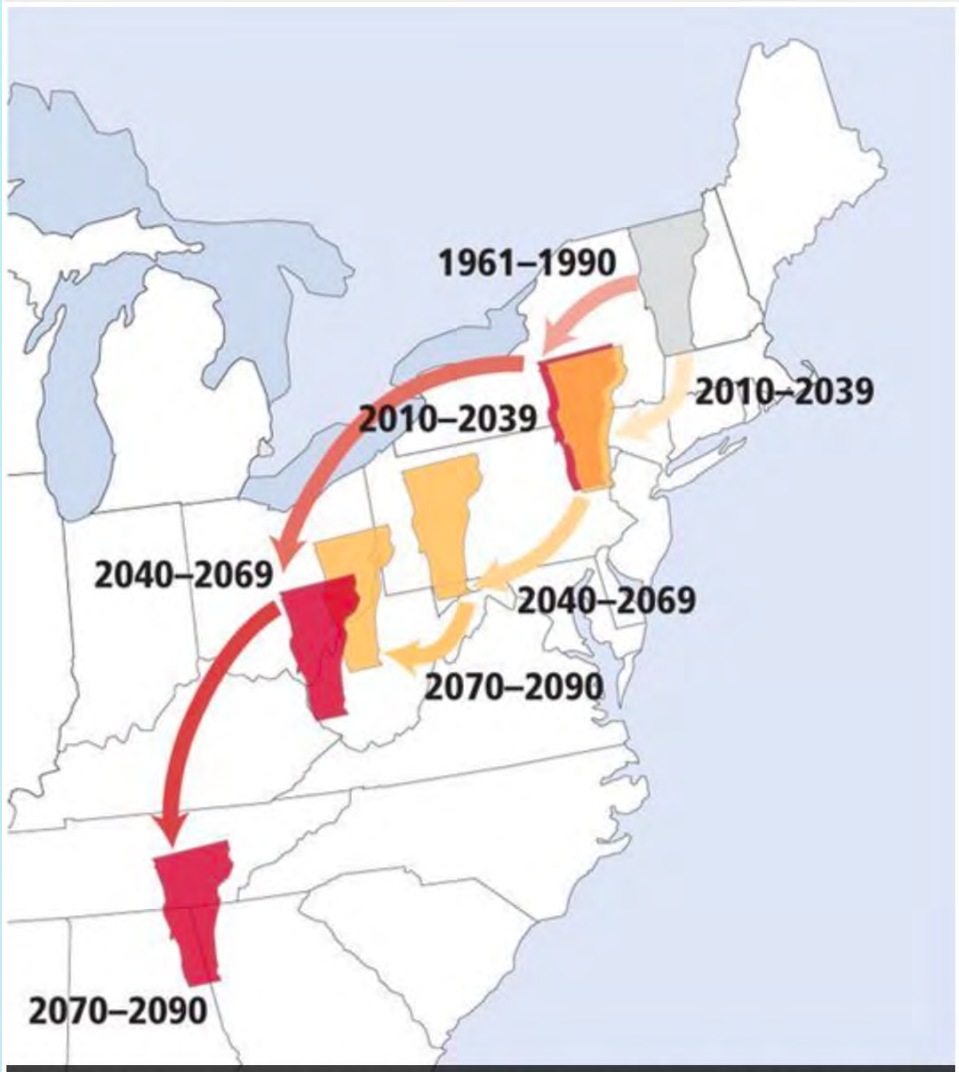
Texas A&M University



Resilience in Context

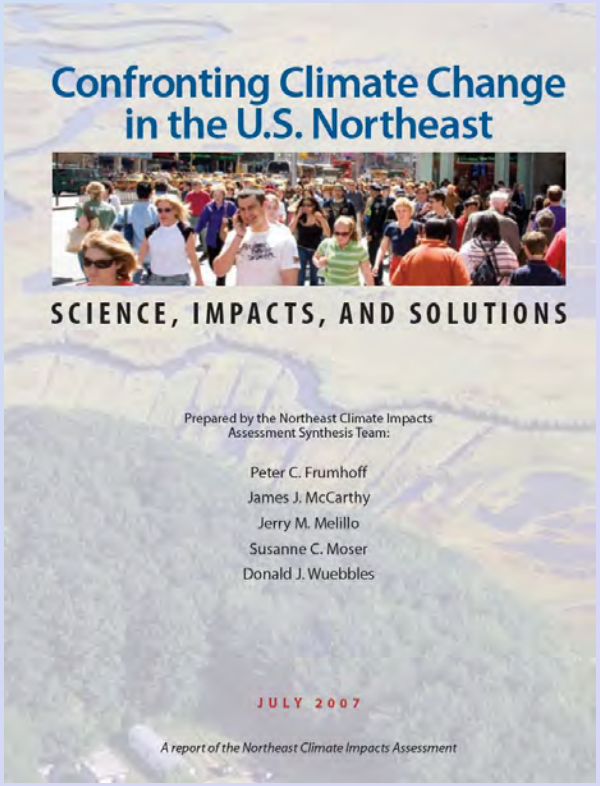
- **Ecosystem stability** is made up of three things:
  - Resistance: the ability to resist change under stress.
  - Resilience: the ability to bounce back after stress or disturbance.
  - Persistence: the ability to remain unchanged over time.

Why Resiliency



Changes in average summer heat index (the "feel" of temperature and humidity) could result in a Vermont climate more akin to that of southeastern Tennessee, according to this map created for the Union of Concerned Scientists for its 2007 study, Northeast Climate Impacts Assessment. Red arrows: Predictions based on higher emissions scenarios. Yellow arrows: Predictions based on lower-emissions scenarios.
(Photo: Courtesy Union of Concerned Scientists)

Red = High Emissions.
Yellow= Low emission



Why Resiliency

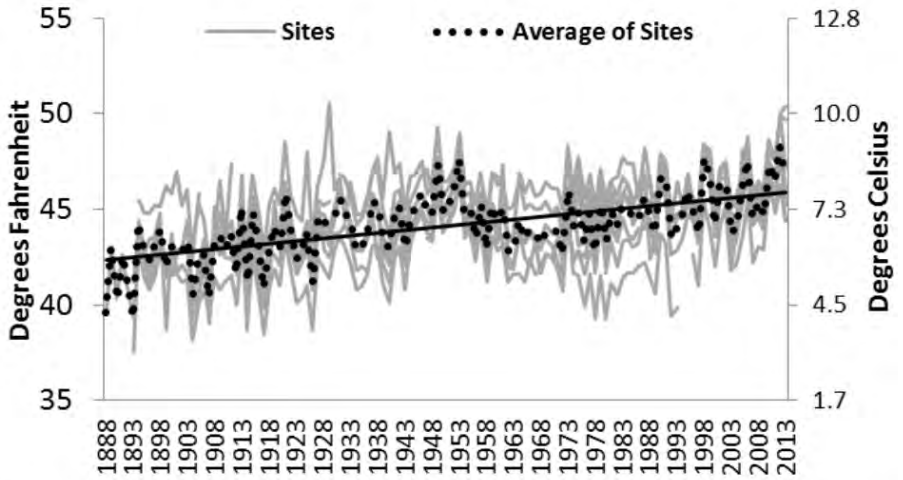
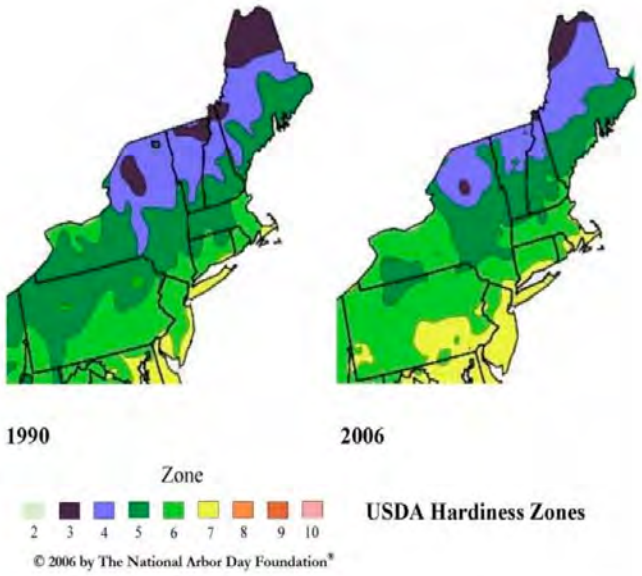


Figure 1.7. *Temperature change from 1888-2013 for 8 lowland (<1000 ft) climate sites in Vermont. Data source: (NWS 2014).*

Figure 1.11. *Change in USDA Hardiness Zones for the Northeast from 1990 to 2006.*



VERMONT CLIMATE ASSESSMENT

Considering Vermont's Future in a Changing Climate

A report by
The Gund Institute for Ecological Economics and
The University of Vermont
2014

http://vtclimate.org/

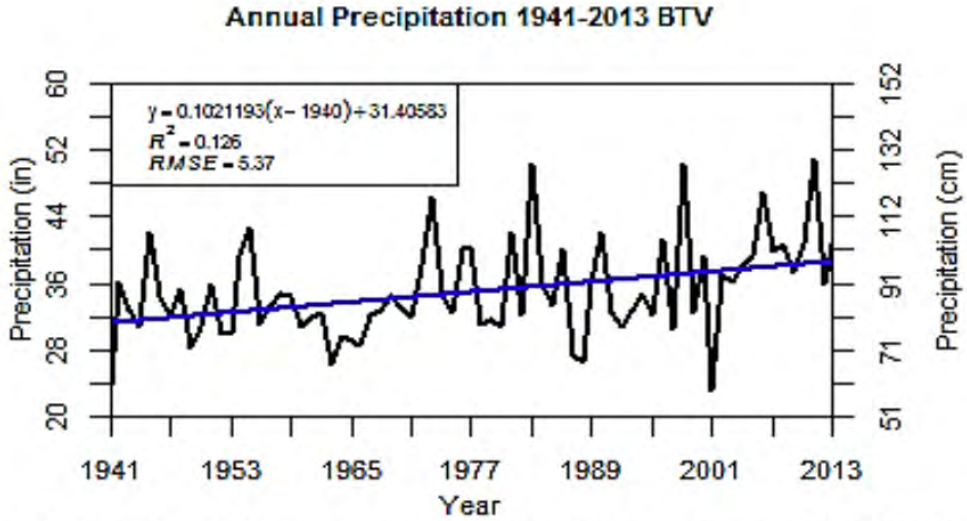


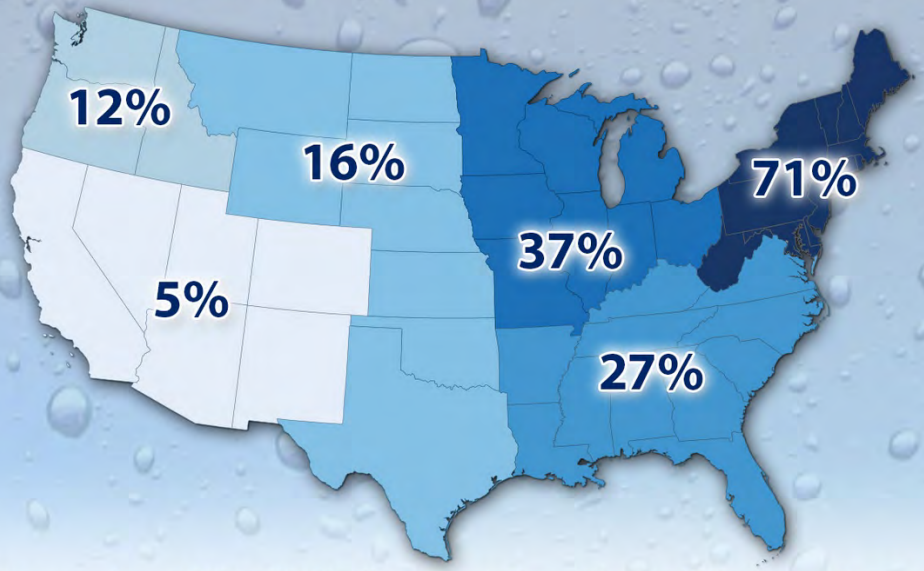
Figure 1.14. *Change in annual precipitation from 1941-2013 (BTV station).*

Why Resiliency

http://www.watershedmanagement.vt.gov/wqd_mgtplan/swms_appC.htm

Hurricane Irene on 8/27/2011.
NASA image courtesy Jeff Schmaltz, MODIS Rapid Response, NASA Goddard Space Flight Center.

Heavy Downpours Increasing

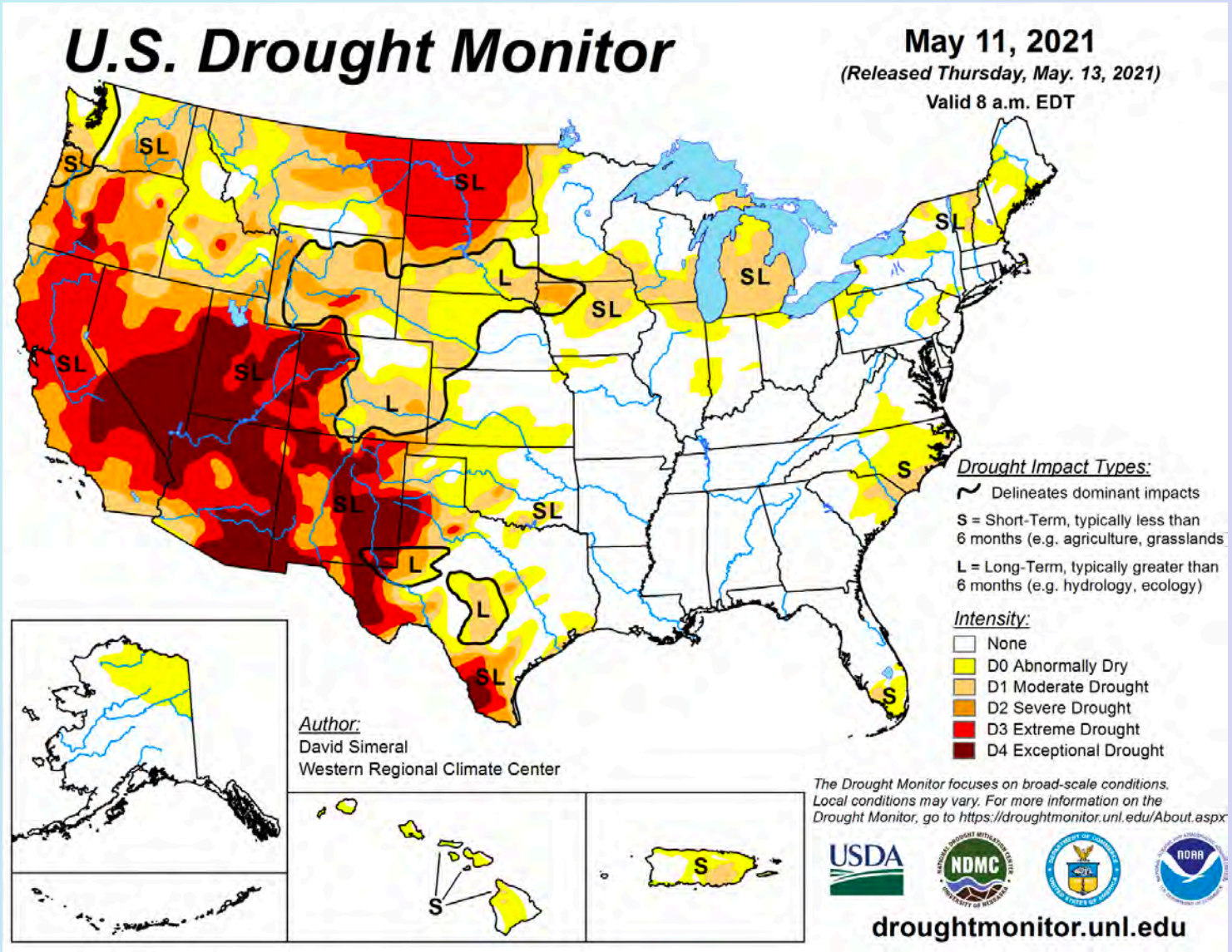


Percent increase from 1958 to 2012 in the amount of precipitation falling in very heavy events.
Very Heavy Precipitation is defined as the heaviest 1% of all daily events from 1958-2012.

Source: Kenneth Kunkel, Cooperative Institute for Climate and Satellites, North Carolina State University and NOAA NCDC

CLIMATE CENTRAL

Why Resiliency



Ecological Keys To Resilient Soil

- Build and maintain soil **tilth:**
  - Create a high biodiverse soil that acts like a sponge by building soil structure.
- Create and maintain **biological diversity:**
  - **M**anage your food web by creating habitat and food for diverse organisms.

Maintain active organic matter helps both- if done without nutrient enrichment.

(These three keys are tied to how you design and maintain your garden.)

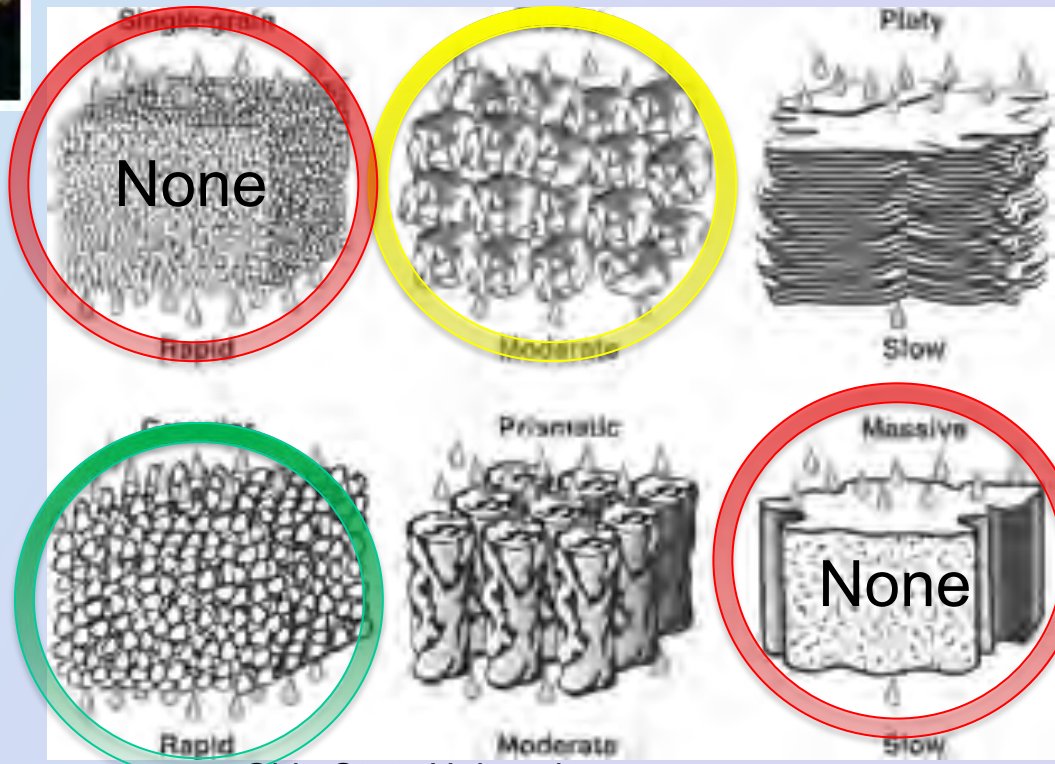
Create Great Soil Tilth

Good Tilth Means Good Soil Structure

University of Nebraska-Lincoln

- Think about being a root: Which soil can you grow through best! Get air and water from easiest!
- Think about being water. Where will you go?

Soil Structure and Structureless Conditions (None)



Ohio State University

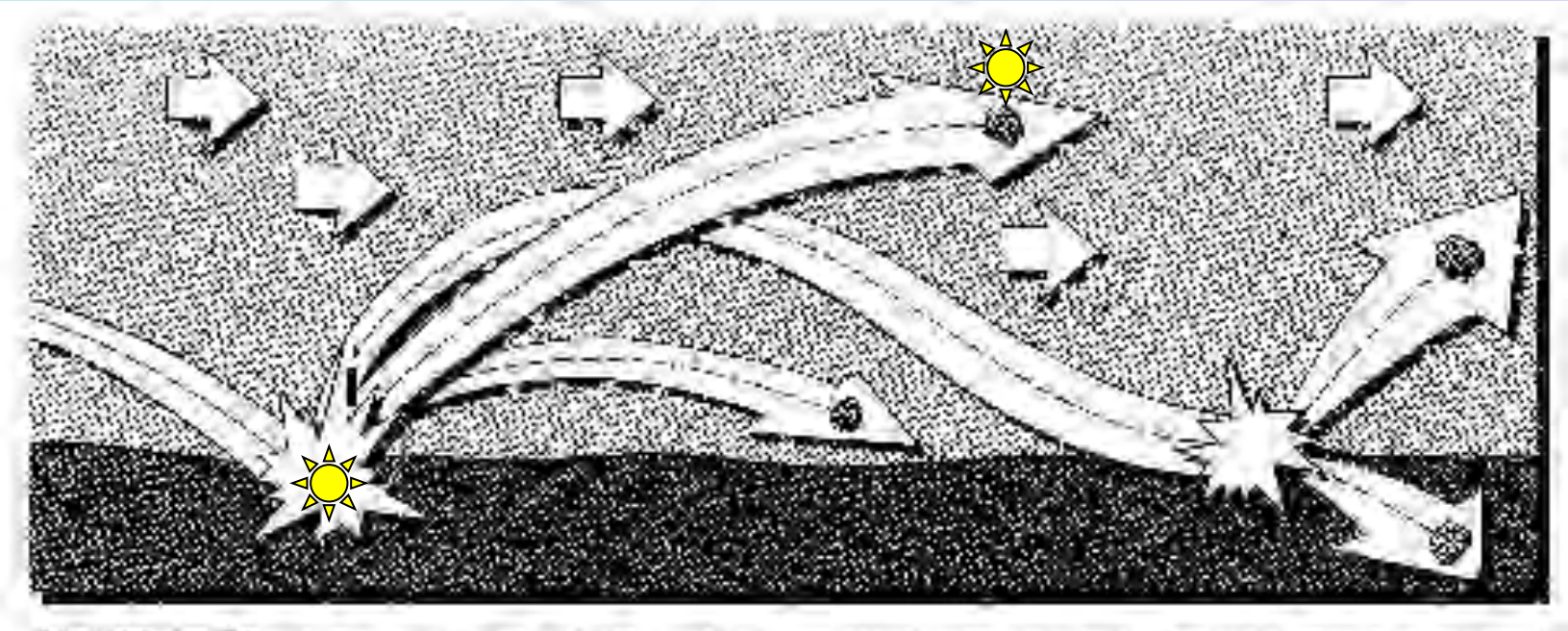
Tilth Prevents Erosion:

Erosion is the process of detachment and transport by wind or water

Prevent it by:

- Make the wind or water less erosive by slowing it down.
- Protect the soil from exposure to wind or water.
- Build the soils resistance to erosive forces.

(Brady and Weil, 2002)

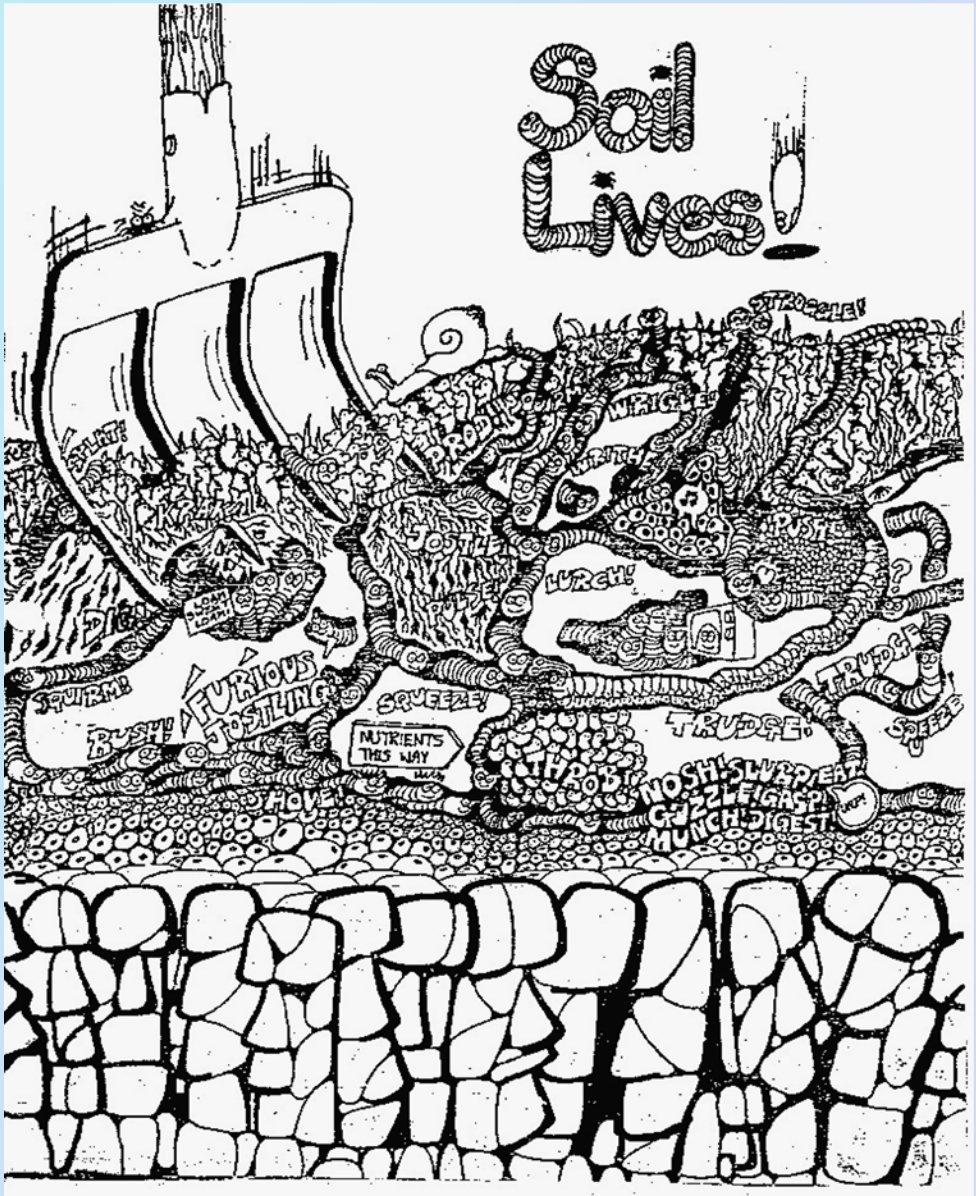


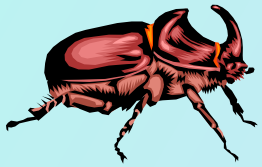
Maintain Soil Tilth by Building Soil Structure:

- Improves: infiltration and drainage, air exchange, moisture holding capacity, root penetration and seed germination!
- Lowers bulk density and reduces erosion!
- It ameliorates natural textural properties!

  - **Don't Destroy Your Structure**
  - Wait and work your soil when it has dried out enough
  - Add OM to improve soil structure
  - Keep soil covered to protect soil structure
  - Treat soil gently

Maintain Biological Diversity

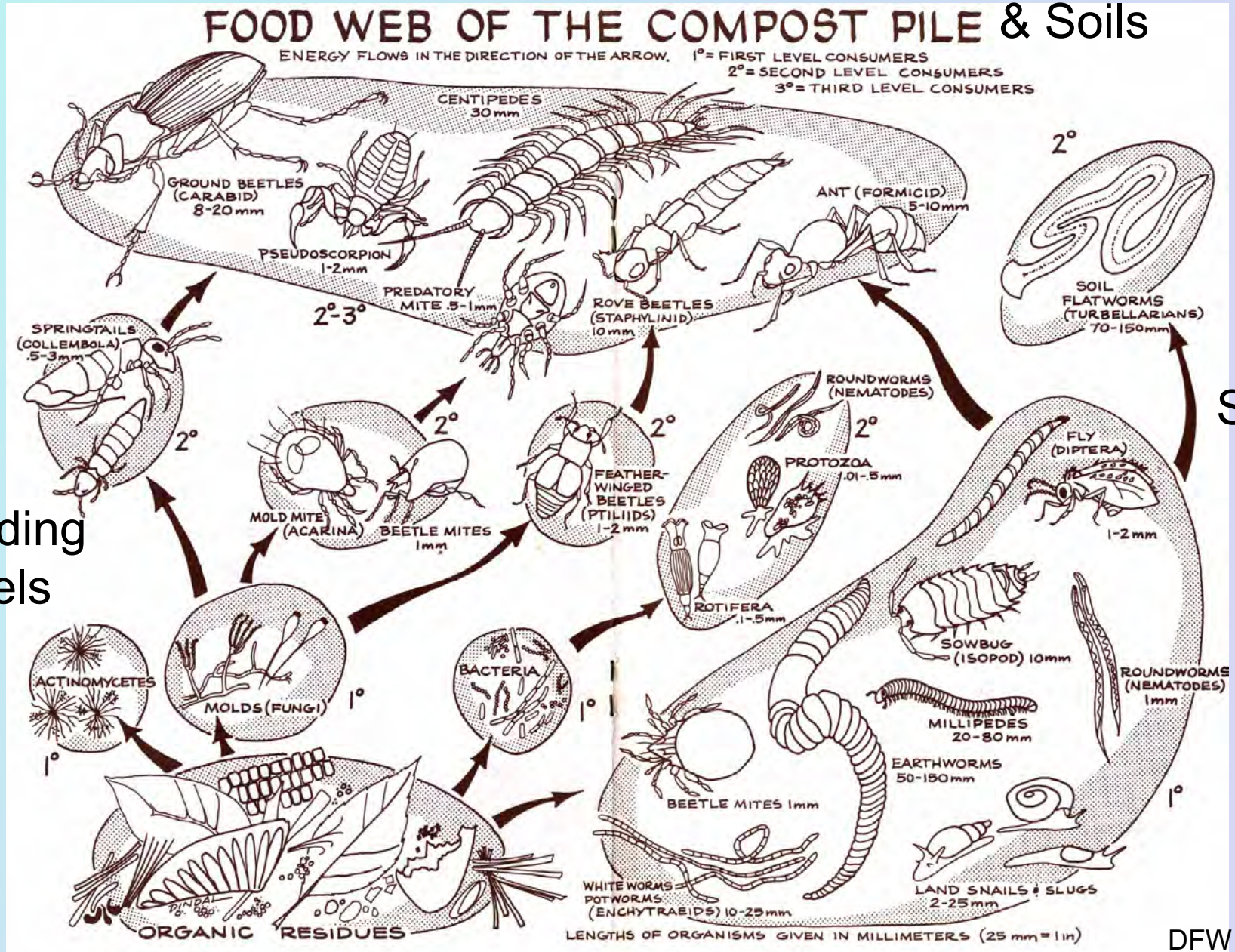




Biological Buffering

- “This dampening of plant susceptibility to insects and disease led Phelan et al. (1995) to propose the concept of *biological buffering*, which asserts that a more complex soil community supported by the influx of active organic matter tend to moderate fluctuation in the soil environment and greater ecological stability.” Phelan (2009)

The Ecology of Soil Organisms



& Soils

Sizes

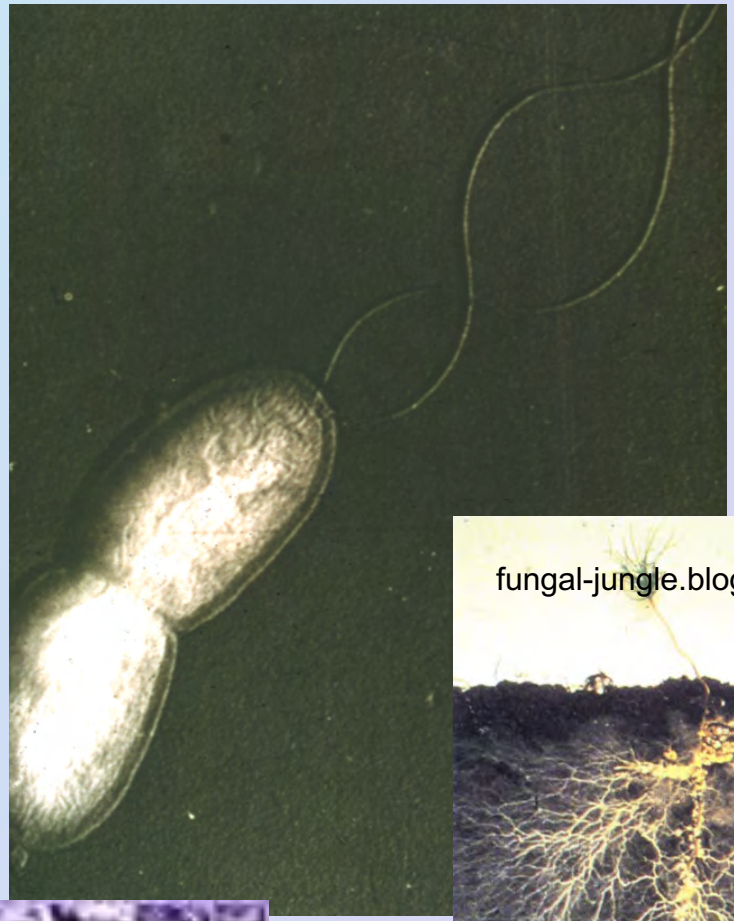
Feeding Levels

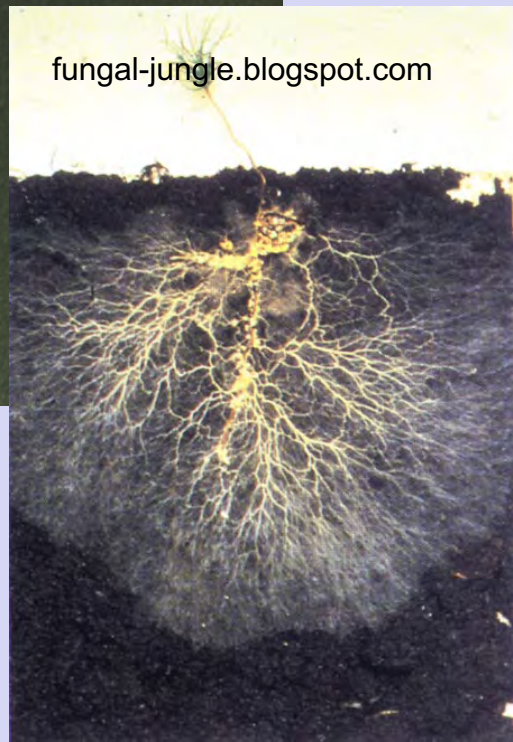
DFW

Invisible and Interconnected

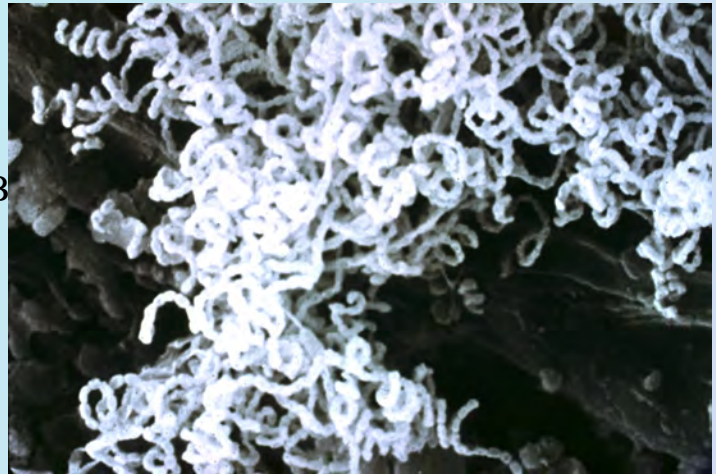
SMB

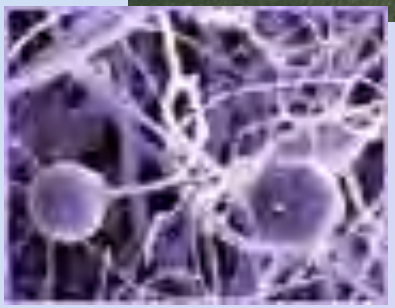
SMB





SMB

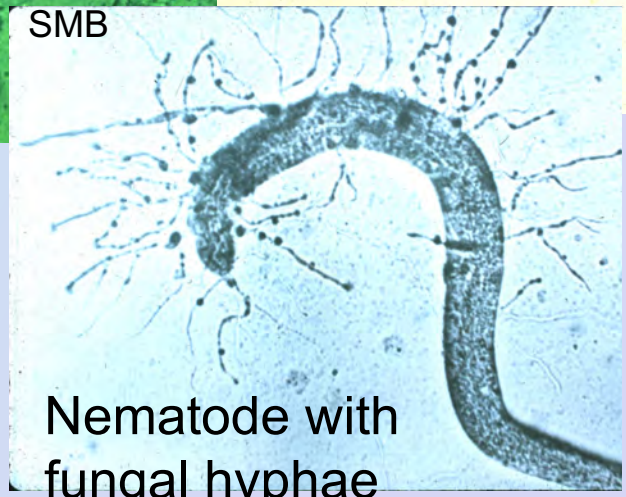




www.profileproducts.com

Interesting Relationships Between Microorganisms

Captured Nematodes

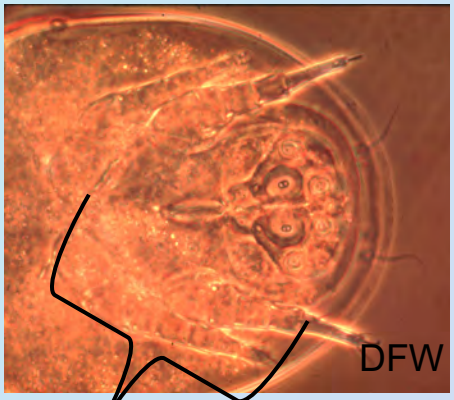


Population Checks and Balances.

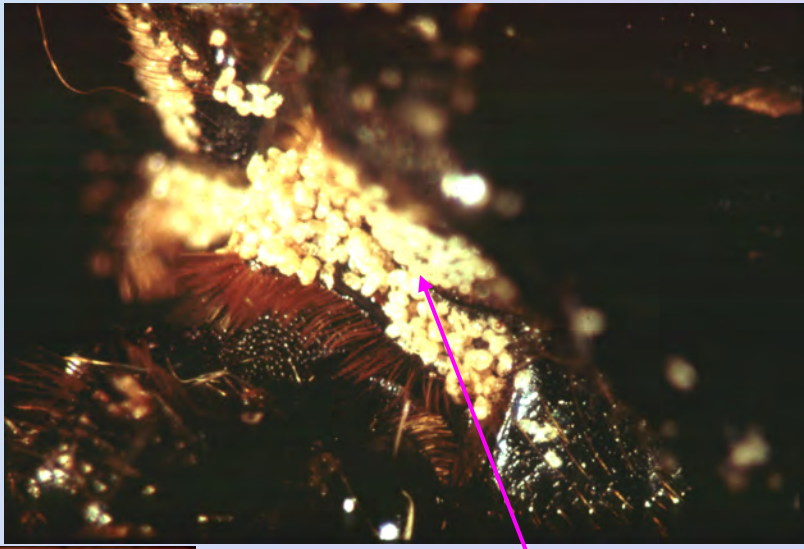
More Interesting Relationships!!

Phoresy: Detritivore Hitchhikers

Phoretic Nematodes



Mites Sucker Disc



Immature Phoretic Mites

Plant - Microbial Relationships

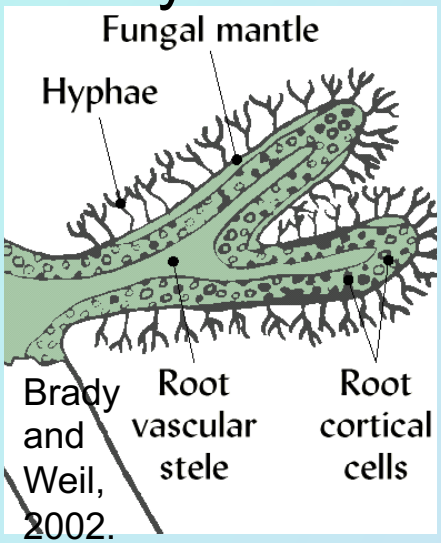
Rhizobium and Legumes: Mutualism

SMB

Plant - Microbial Relationships

Mycorrhizal Fungi

Ectomycorrhizae

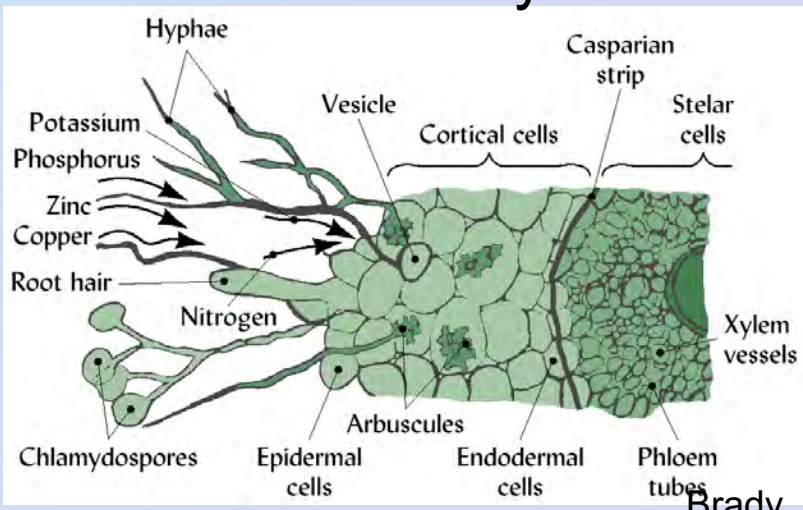


Brady and Weil, 2002.

www.profileproducts.com

SMB

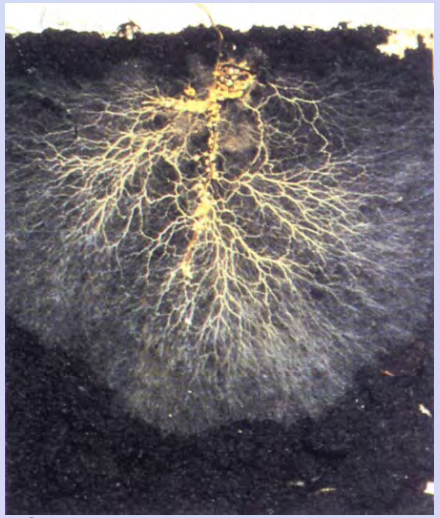
Endomycorrhizae



Brady and Weil, 2002.

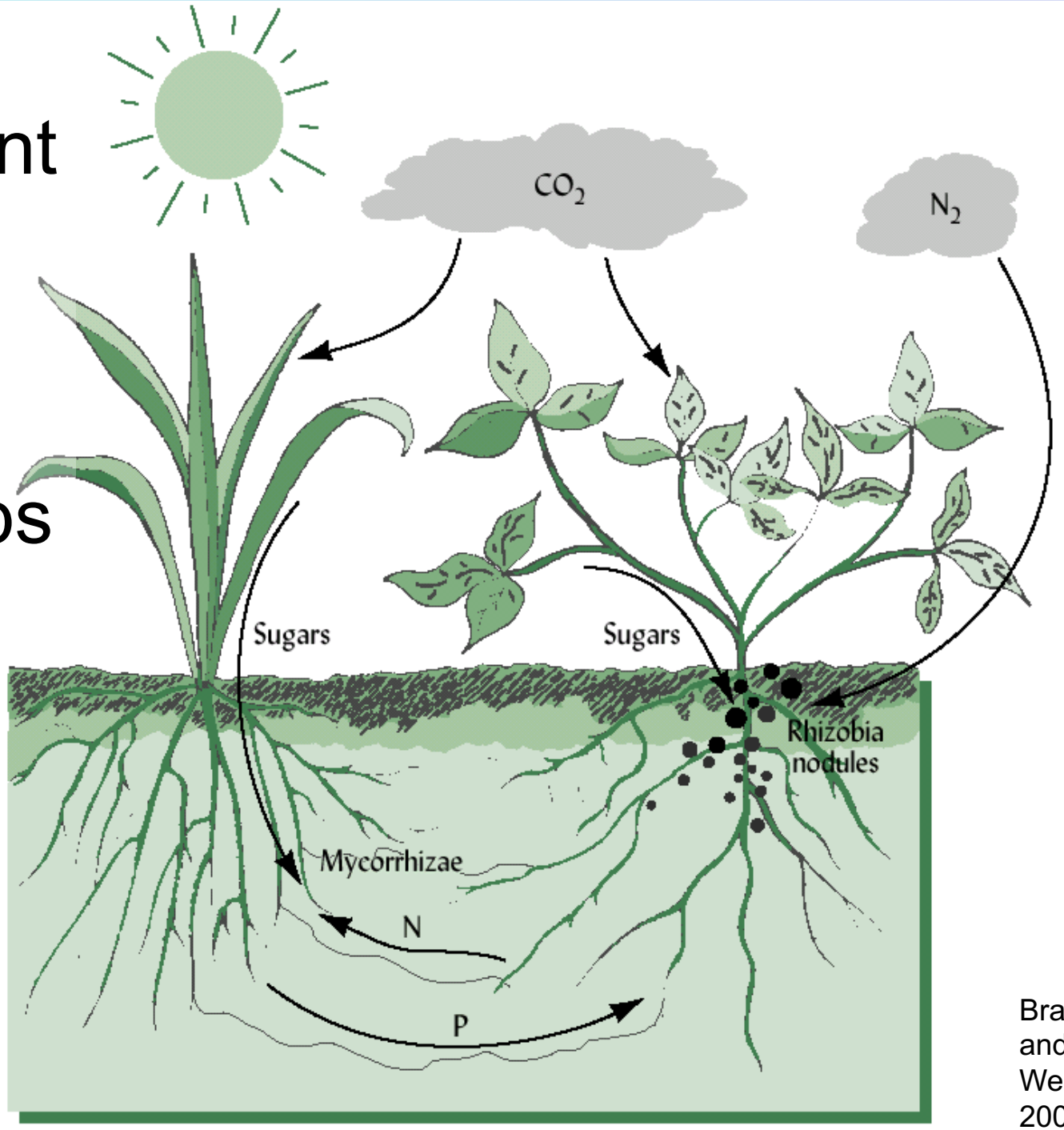
SMB

SMB



fungal-jungle.blogspot.com

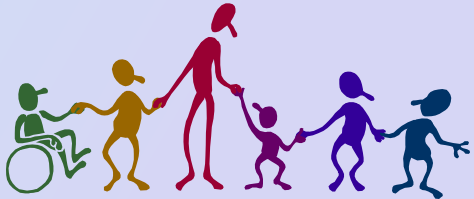
Plant-to-Plant Microbially Mediated Mutualistic Relationships



Brady and Weil, 2002.

Plant - Microbial Relationships
Disease Suppression Mechanisms

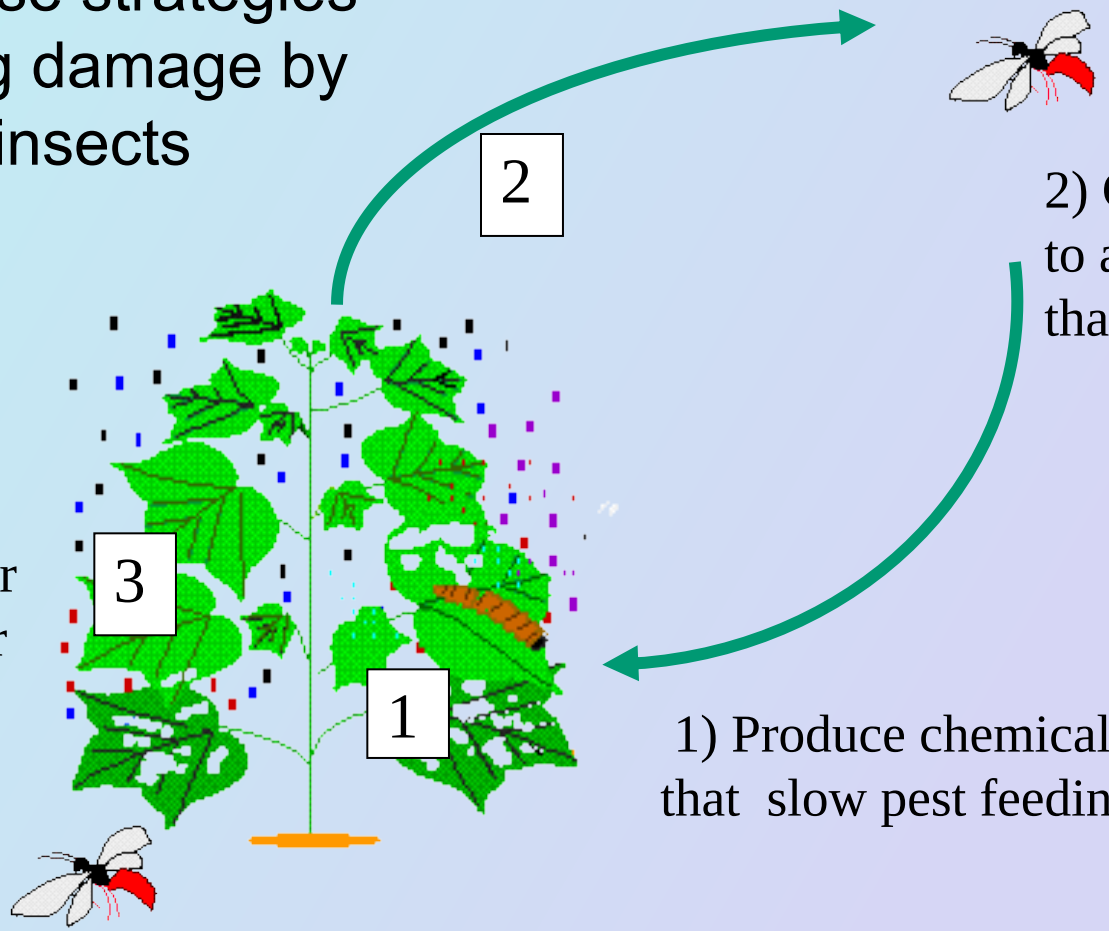
- The process of OM breakdown from OM additions:
  - compost
  - cover crops, manures, etc.
- Antagonists
  - *Bacillus, Entrobacter, Trichoderma, Streptomyces, Pseudomonas*, and more!
  - Single strains are not as effective as mixtures of microbes!
  - Antibiosis, Nutrient competition. Parasitism
  - Induced systematic resistant- plant vaccination (less common)
- Doesn't suppress all diseases: some easy, some hard
- Lasts about 6 months



Plant-Insect Mutualistic Relationships

Plants use a number of defense strategies following damage by feeding insects

Slide is Courteous of Fred Magdoff



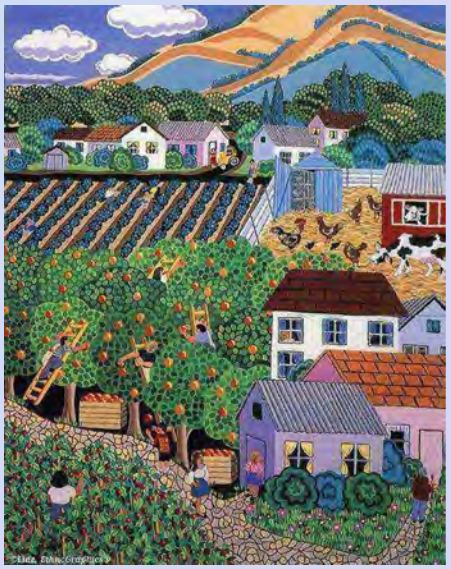
2) Give off signals to attract beneficals that attack the pests

3) Increase extrafloral nectar flow as food for adult beneficals

1) Produce chemicals that slow pest feeding

Healthy plants growing in health soils are usually less attractive to pests or better able to defend themselves.

Create Functional Biodiversity



- Increase Practices that Promote Biodiversity
  - Provide Diverse Organic Matter – Food Below Ground
    - Add Organic Residues
    - Add Manure or Compost
    - Grow Cover Crops
    - **Incorporate Plant Diversity**

  - Provide Diverse Habitat and Food Above Ground
    - Rotate Crops
    - Grow Cover Crops
    - Use Mulches
    - Plant Mixtures of Species
      - Interplant, Under-sow, Companion Plant, Polyculture
    - Plant Biological or Ecological Islands; Habitat and Food For Beneficial Organisms
      - Bio-strips, Flower Strips, Beetle Banks, Strip Insectary Intercropping, Vegetative Corridors, Hedge Rows
    - Selective Weeding

- Reduce Practices that Diminish Biodiversity
  - Reduce Tillage, Bare Land, and Chemical Inputs
  - Change Tolerance Levels for Pests
  - Use Integrated Pest Management

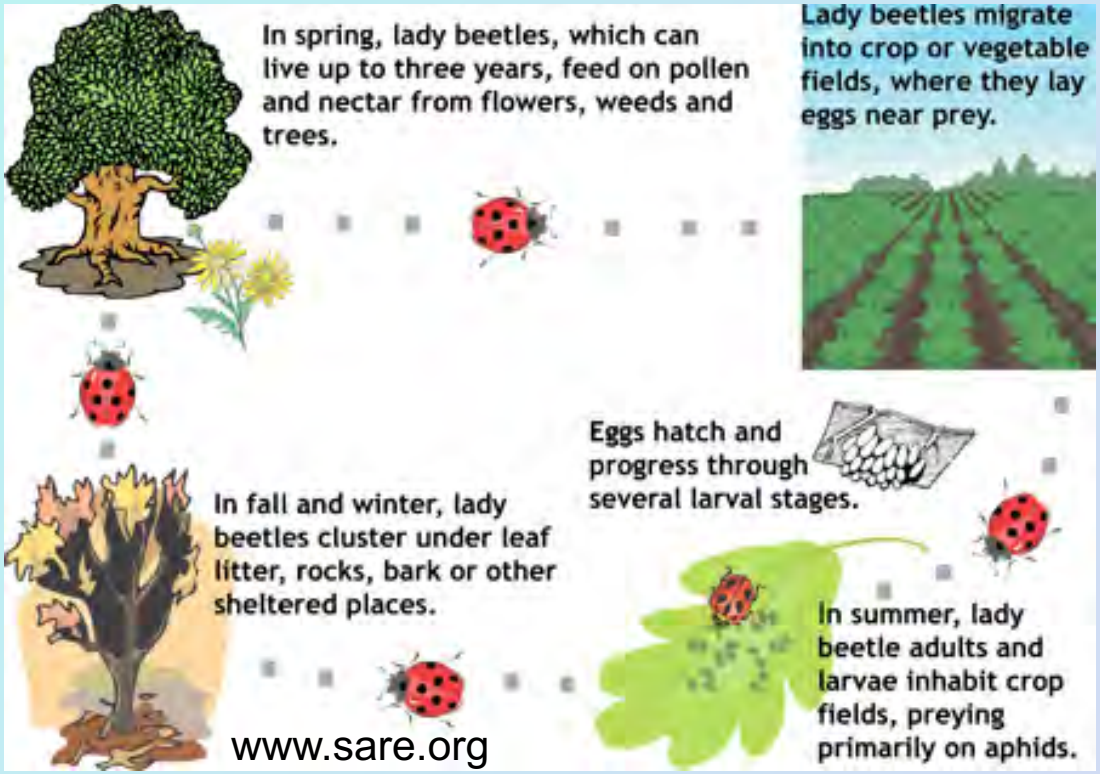
Biological or Ecological Islands

www.sciencemuseum.org.uk

Parasitic Wasp

Lacewing

Refugia or Conservation Head Lands




University of Minnesota Extension

Hedge Rows as Habitat

Wind Shelter Belt

www.sare.org

Vegetative Corridors

University of Idaho

Vegetation Barriers

Spined Soldier Bug

Texas A&M University

Praying Mantis

Mulch as Habitat

Spiders

DFW

Ground Beetles

Beetle Banks: Britain

http://www.orc.govt.nz/

www.snh.org.uk/

Ground Beetles and other Predatory Beetles

DFW

Oregon State University Extension

Intercropping: Living Mulches

www.sare.org

www.dereila.ca

Rove Beetle

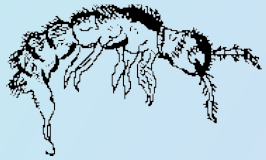
NCSU-IPM

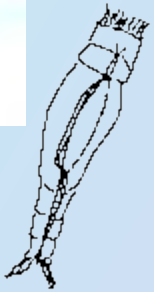
Bigeyed Bug

www.omafra.gov.on.ca/

Minute Pirate Bug

Keep Proper Soil OM Levels





Versus

Organic matter makes structure and feeds the biology!

(We want to do this without nutrient enrichment!)

DO
YOU
KNOW
What's
In Your
Dirt
?

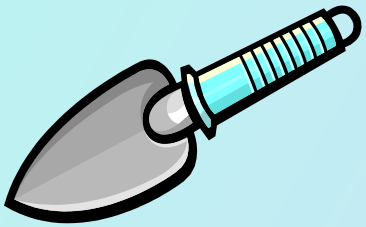
pH??

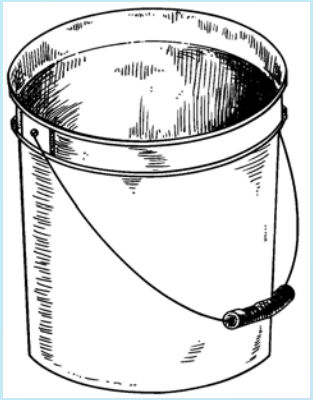
N-P-K??

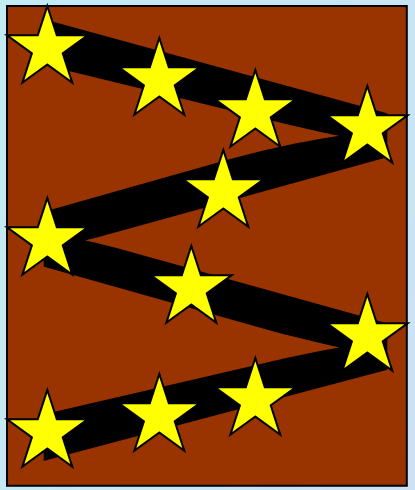
% OM??

Micronutrients??

Heavy Metals??







How to Take a Soil Sample

The reliability of a soil test is only as good as the sample you submit. The small amount of soil in the sample bag you send to the Agricultural Testing Lab must represent the entire area to be fertilized. Avoid unusual areas such as those where fertilizer or lime has spilled. Take samples before lime, fertilizer, or manure are added. Use only clean equipment for collecting soil samples.

Where to sample

The area to be sampled should be as uniform as possible in terms of soil type and cropping and fertilizing history. For practical purposes it should be an area you expect to fertilize as a unit. This means separate samples for annual mixed vegetables and a strawberry patch, for golf green and fairway, and for different major crops in a commercial nursery or vegetable operation. If you have a problem on part of a lawn, garden, or commercial production field, you may wish to determine if soil fertility is the cause by taking one sample to represent the "good" and the other to represent the "poor" area.

Take a good sample

Collect a number of cores or slices by walking in a zig-zag pattern over the area.
Mix cores thoroughly in a clean pail for a composite lab sample. The greater the number of collected cores mixed together, the better the sample will represent the average condition of the sampled area. Consider 10 cores as the minimum for home gardens and lawns up to 10,000 square feet in size. Larger areas should be represented by at least 15 to 20 samples.
Choose one of the following tools:

Soil Probe or Auger – A soil probe or auger, available from mail order catalogs and garden or farm supply outlets, is the best tool for sampling. An auger will be needed if the soil is very stony or gravelly. Simply push the probe (or push and turn the auger) into the soil to the desired depth, lift up to remove the core, and place it in the clean pail. Sampling depth should be 4 to 6 inches deep for lawns, turf, or other perennial sod, or tillage depth (usually 6-10 inches) for annually tilled crops.

Garden Trowel or Shovel – If a soil probe or auger is not available, collect your sample by pushing the blade of a garden trowel, shovel, or spade into the soil to the desired depth. Cut out a triangular wedge of soil and set it aside (to be replaced after sampling). Now slide your blade into the soil again taking a thin (half inch) slice from one side of the hole. With a knife, trim the slice to about a 1-inch strip of soil down the center of the spade – top to bottom. Save this "core" as part of your composite lab sample.

Mix the sample and fill the sample bag

Make sure that all the cores are thoroughly mixed together. Your soil test mailer contains a plastic bag intended for one lab sample; the form has space for up to 10 samples. Fill plastic bag about 1/2 full (approximately 1 cup) with the mixed sample. If submitting multiple samples, include one check for total being tested. Any clean plastic bag may be used; you don't have to use the ones in the kit.

https://www.uvm.edu/sites/default/files/Department-of-Plant-and-Soil-Science/AGTesting/How_to_Take_a_Soil_Sample.pdf

https://www.uvm.edu/sites/default/files/Department-of-Plant-and-Soil-Science/AGTesting/Garden_hort_questionnaire_09_01_201829.pdf

Soil Test Submission Form

The University of Vermont

Agricultural & Environmental Testing Laboratory and UVM Extension

For vegetables, fruits, lawn/turfgrass, trees, shrubs, and flowers. Home and Commercial. See crop list on back.

Main Contact (mailing address):	Copy to (Extension, consultant, etc.) or Billing Info.
Name:	Name:
Farm/Company:	Company/Agency:
Address:	Address:
City, State, Zip:	City, State, Zip:
Phone:	Phone:
E-mail:	E-mail:
Send results by: Mail___ or E-mail___	Send results by: Mail___ or E-mail___

Vermont county where samples were taken: _____ **Check here if Commercial operation:** ____

The basic nutrient test costs $14 per sample (1 bag of soil = 1 sample), and includes pH, available P, K, Ca, Mg, S, micronutrients, CEC, organic matter, and fertilizer recommendations for one crop. Recommendations for additional crops on the same sample are $2 each. Add $10 for heavy metal analysis (in addition to basic analysis, for a total fee of $24). Metals only analysis (no nutrient test) is $15 per sample (Crop Code Z2). One-half cup to one cup of sample required for all tests; any clean plastic bag may be used. Please print clearly.

Lab ID (For lab use only)	Field or Sample Name	Approx. area represented by sample	Crop Codes (see back of form; 1 crop included in $14 fee; add'l crops $2 each)	Check here for metals test	Fee
1		___sq. ft. ___acres			$
2		___sq. ft. ___acres			$
3		___sq. ft. ___acres			$
4		___sq. ft. ___acres			$
5		___sq. ft. ___acres			$
6		___sq. ft. ___acres			$
7		___sq. ft. ___acres			$
8		___sq. ft. ___acres			$
9		___sq. ft. ___acres			$
10		___sq. ft. ___acres			$

Use additional sheets for more than 10 samples.

Please include payment, unless prior arrangements have been made. Checks only, payable to UVM. Total fee $_____

If this form came in a pre-addressed mailer, one sample can fit in it. Otherwise, use a box or large envelope.

Send to: AETL, Univ. of Vermont, 262 Jeffords Hall, 63 Carrigan Drive, Burlington, VT 05405-1737

Other tests available on request. Email us at: agtesting@uvm.edu 802-656-3030 pss.uvm.edu/ag_testing
Test results are normally ready to mail/e-mail on the 2nd Monday after samples arrive at the lab.

Revised 10/28/2014

Mixed Vegetables: VMIX

Crop Codes for Home & Commercial vegetables, fruits, lawns, flowers, etc.

(Use Forage and Grain Crops form for hay, silage corn, row crops, pasture, and wildlife/conservation plantings)

Vegetables: (Home & Commercial)
(if Commercial, indicate on front of form)

- VMIX ..... Mixed vegetables
- VASE ..... Asparagus - Establishment
- VASM ..... Asparagus - Maintenance
- VBA ..... Basil
- VBEA ..... Beans: Dry/Snap/Lima
- VBEE ..... Beets, Swiss Chard
- VBRC ..... Broccoli, Cabbage, Cauliflower
- VCAR ..... Carrots, Parsnips
- VCE ..... Celery
- VCK ..... Collards, Kale
- VSWE ..... Sweet Corn, Early
- VSWF ..... Sweet Corn, Full Season
- VORC ..... Ornamental Corn
- VCU ..... Cucumbers, Melons
- VEG ..... Eggplant
- VGA ..... Garlic
- VLEA ..... Leafy Greens
- VLET ..... Lettuce
- VMU ..... Muskmelon
- VOKR ..... Okra
- VON ..... Onions, Leeks
- VORG ..... Ornamental Gourds
- VPEA ..... Peas
- VPEP ..... Peppers
- VPO ..... Potatoes
- VPU ..... Pumpkins
- VRA ..... Radishes
- VRHE ..... Rhubarb - Establishment
- VRHM ..... Rhubarb - Maintenance
- VSP ..... Spinach
- VSPT ..... Sweet Potato
- VSQ ..... Squash
- VTO ..... Tomatoes
- VTU ..... Rutabagas, Turnips
- VWA ..... Watermelon

Tree Fruits and Hops (Home & Commercial)
(if Commercial, indicate on front of form)

- FAE ..... Apples - Establishment
- FAM ..... Apples - Maintenance
- FPEE ..... Pears - Establishment
- FPEM ..... Pears - Maintenance
- FPLE ..... Plums - Establishment
- FPLM ..... Plums - Maintenance
- FSFE ..... Stone Fruit - Establishment
- FSFM ..... Stone Fruit - Maintenance
- FHE ..... Hops - Establishment
- FHM ..... Hops - Maintenance

Lab Data Only

- Y1 ..... Nutrient data only (no fertilizer recommendations)
- Z2 ..... Heavy metals only (no nutrient test) $15.

Turf (if Commercial, indicate on front of form)

- HA1 ..... Home or Comm. Lawn-Establishment
- HA2 ..... Home or Comm. Lawn-Maintenance
- T1E ..... Sports Turf/Golf Fairway-Establishment
- T1M ..... Sports Turf/Golf Fairway-Maintenance
- T2E ..... Golf Greens and Tees-Establishment
- T2M ..... Golf Greens and Tees-Maint (native soils)
- T2SM ..... Golf Greens and Tees-Maint (sand based)

Home Small Fruits and Landscaping

- HD1E ..... Home Blueberries-Establishment
- HD1M ..... Home Blueberries-Maintenance
- HD2E ..... Home Raspberries/Brambles-Establishment
- HD2M ..... Home Raspberries/Brambles-Maintenance
- HD3E ..... Home Strawberries-Establishment
- HD3M ..... Home Strawberries-Maintenance
- HD4E ..... Home Grapes, American Varieties-Establ.
- HD4M ..... Home Grapes, American Varieties-Maint.
- HD5E ..... Home Grapes, European Varieties-Establ.
- HD5M ..... Home Grapes, European Varieties-Maint.
- HC1E ..... Deciduous Trees, Shrubs & Vines-Establ.
- HC1M ..... Deciduous Trees, Shrubs & Vines-Maint.
- HC2E ..... Needleleaf Trees & Shrubs-Establishment
- HC2M ..... Needleleaf Trees & Shrubs-Maintenance
- HC3E ..... Acid-loving Trees, Shrubs, & Groundcover-Est.
- HC3M ..... Acid-loving Trees, Shrubs, & Groundcover –Maint.
- HB3E ..... Perennial Flowers, Roses, & Herbs-Est
- HB3M ..... Perennial Flowers, Roses, & Herbs-Maint.
- HB4 ..... Annual Flowers

Commercial Small Fruits, Ornamentals, and Nursery

- FBE ..... Blueberries - Establishment
- FBM ..... Blueberries - Maintenance
- FCE ..... Cranberries - Establishment
- FCM ..... Cranberries - Maintenance
- FRE ..... Raspberries/Brambles -Establishment
- FRM ..... Raspberries/Brambles - Maintenance
- FGAE ..... Grapes: American - Establishment
- FGAM ..... Grapes: American - Maintenance
- FGEE ..... Grapes: European - Establishment
- FGEM ..... Grapes: European - Maintenance
- FSTE ..... Strawberries - Establishment
- FSTM ..... Strawberries - Maintenance
- Nursery Trees & Shrubs:
  - N2E ..... Deciduous-Establishment
  - N2M ..... Deciduous-Maintenance
  - N3E ..... Fir-Establishment
  - N3M ..... Fir-Maintenance
  - N4E ..... Pine-Establishment
  - N4M ..... Pine-Maintenance
  - N5E ..... Spruce-Establishment
  - N5M ..... Spruce-Maintenance
  - N6E ..... Broadleaf Evergreen-Establishment
  - N6M ..... Broadleaf Evergreen-Maintenance
- N7E ..... Christmas Trees-Establishment
- N7M ..... Christmas Trees-Maintenance
- N8 ..... Cut Flowers

Soil Test Report

- Soil Test Results
- Recommendation
  - Limestone
  - Nitrogen
  - Phosphorus
  - Potassium
- Management Info
- Who to call
  - (From page 2)

The University of Vermont

Soil Test Report

Agricultural & Environmental Testing Laboratory and UVM Extension

Prepared For:

UVM Ag Testing Laboratory
262 Jeffords Hall
Burlington, VT 05401

agtsting@uvm.edu
802-656-3030

Sample Information:

Order #:	93
Lab ID:	S14-99034
	High
Area Sampled:	1 acres
Received:	3/18/2014
Reported:	3/14/2017
VT County:	Chittenden

Results

Nutrient	Low	Medium	Optimum	High or Excessive
Phosphorus (P):				
Potassium (K):				
Magnesium (Mg):				

Phosphorus is excessive!!!

Analysis	*Value Found*	*Optimum Range (or Average *)*	*Analysis*	*Value Found*	*Optimum Range (or Average *)*
Soil pH (2:1, water)	7.0		Boron (B)	0.8	0.3*
Modified Morgan extractable, ppm			Copper (Cu)	0.9	0.3*
Macronutrients			Zinc (Zn)	2.6	2.0*
Phosphorus (P)	74.4	4-10	Sodium (Na)	46.0	20*
Potassium (K)	200	100-160	Aluminum (Al)	10	35*
Calcium (Ca)	2491	**	**Soil Organic Matter %**	2.6	**
Magnesium (Mg)	150	50-120	**Effective CEC, meq/100g**	14.2	**
Sulfur (S)	29.0	11*	**Base Saturation, %**		
Micronutrients			Calcium Saturation	87.6	40-80
Iron (Fe)	6.0	7.0*	Potassium Saturation	3.6	2.0-7.0
Manganese (Mn)	5.2	8.0*	Magnesium Saturation	8.8	10-30

** Micronutrient and S deficiencies are rare in Vermont and optimum ranges are not defined; thus average values in Vermont soils are shown instead.*
*** Ranges for Calcium, Organic Matter, and Effective CEC vary with soil type and crop.*

Recommendations for Home Vegetable (mixed) (HMIX) *Home*

Limestone (Target pH of 6.8)	Nitrogen, N	Phosphate, P_2O_5	Potash, K_2O
lbs / 100 sq ft	lbs / 100 sq ft	lbs / 100 sq ft	lbs / 100 sq ft
0	0.25 - 0.3	0	0

Comments:

Soil tests normally do not measure nitrogen because its availability changes rapidly depending on temperature, moisture and microbial activity. Instead, N application rates are based on plant uptake needs. See enclosed fact sheet for more information.
If your micronutrients are low, the addition of compost or a volcanic material such as Azomite may be beneficial.
Soil test values for phosphorus and potassium are above optimum. Only a source of nitrogen is necessary this year.
Your soil tested OPTIMUM or HIGH in both phosphorus and potassium. Add 4-5 lb per 100 sq. ft. of a high-nitrogen, low-phosphorus fertilizer, such as 6-2-1, 7-3-4; OR 8-10 lb per 100 sq. ft. of alfalfa meal; OR whatever your local supplier recommends.

If you have questions about this soil test report, contact the UVM Extension Master Gardening Helpline; from Burlington: 656-5421; from all other parts of the state: 1-800-639-2230. If you leave a message, please include the Lab ID (begins with S).

Reference:

FYI

- Interpretation of soil test results to help you figure out what all this soil test information means.

Interpretation of UVM Soil Test Results

Test Level

LOW: A low test result indicates a need for substantial addition of fertilizer, compost, or manure to raise soil test levels. There is a high probability of yield increase with amendment. The recommendation for a low testing soil is designed to gradually build up the nutrient level to optimum. Low pH indicates a need for lime, unless you are growing acid-loving plants such as blueberries or azaleas.

MEDIUM: A medium test result suggests that a moderate amount of added fertilizer, compost, or manure is needed for best results. Nutrient levels are lower than optimum for most types of plants.

OPTIMUM: This is the most desirable soil test range for both economic and environmental reasons. There is a low probability of crop response to added nutrients. But, in order to maintain soil tests in this range for successive years, a portion of crop removal needs to be replaced, so small additions of fertilizer, compost, or manure may be necessary to maintain these levels or for demanding crops. Small amounts of phosphorus in the plant row may be helpful in early spring plantings (starter fertilizer).

HIGH or EXCESSIVE: Soil test levels are higher than needed for optimum growth or yield. Excess nutrients are a potential source for environmental problems such as accelerated algal growth in ponds and lakes. Occasionally there will be plant growth problems due to nutrient imbalance. There is a very low probability of crop response to additional nutrients, except for potassium-demanding crops. A low rate of starter fertilizer may be needed.

Analysis Descriptions

pH is a measure of soil acidity, with lower numbers being more acid. Most garden and horticultural plants grow well between pH 6.0 and 7.2, although acid-loving plants such as azalea or blueberry prefer a lower pH. Soil pH tends to naturally decrease over time. Application of ground limestone (calcium carbonate) or wood ash will raise pH; elemental sulfur (S) can be used to lower it. If magnesium (Mg) is low, high-magnesium (or "dolomitic") limestone should be used. For field crops other than alfalfa, liming to pH 6.2 is recommended. If you plan to grow alfalfa as part of a rotation, you should lime to pH 6.8.

Nitrogen (N) recommendations are based on general N needs of various plants, derived from field research on field crops. We do not routinely test for soil nitrogen, except at certain times of the cropping season (such as the spring PSNT test), because N availability changes rapidly depending on time of year, temperature, moisture, and microbial activity.

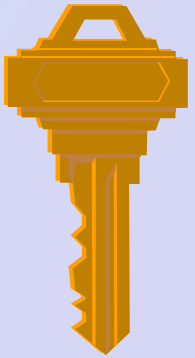
Available phosphorus (P or phosphate) reflects the amount of P that can be easily utilized for plant growth. Phosphorus is readily tied up in soils, especially acid soils and those with pH above 7.0. Because plants are not efficient at taking up P when soils are cold, placing P near the roots where it's needed can be beneficial to early season plant growth. Excessive P can contribute to accelerated algal growth in ponds and lakes.

Potassium (K or potash), Magnesium (Mg), and Calcium (Ca) are all plant nutrients that exist in the soil as positively charged ions or "cations." Potassium is frequently deficient in non-clay soils and, therefore, is a common ingredient in mixed fertilizers. Most soils that are limed to the proper pH provide adequate calcium. Magnesium can be low in sandy soils but often quite high in "heavier," clay soils.

Effective CEC (Cation Exchange Capacity) is based on the soil test quantities of Ca, Mg, and K. CEC reflects the ability of soil to "hold" these cations. A normal range is from below 5 in sandy soils low in organic matter to over 20 in clayey soils or those high in organic matter. Base Saturation % describes the proportions of the CEC that are occupied by Ca, Mg, and K ions. No CEC estimate is given for acid soils (pH<5.5).

Aluminum may also occupy part of the CEC; it is not a plant nutrient but contributes to soil acidity, and is used in estimating both lime and phosphorus needs.

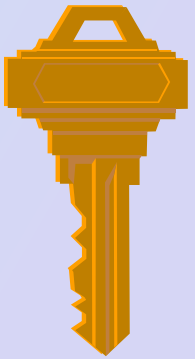
Ecological Keys To Resilient Soil



- Management for active organic matter:
  - Builds soil tilth, infiltration, resistance to surface structure being broken down.
  - Increases water holding capacity.
  - Feeds the food web to create complex relationships for stability.
  - Suppresses of pests.
  - Provides slowly mineralized N, which does not stimulate weeds like soluble forms.

(OM ameliorates natural soil properties.)

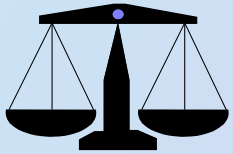
Ecological Keys To Resilient Soil

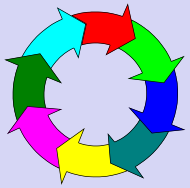


- Create and maintain biological diversity:
  - Create sources of foods with diverse plantings and organic matter additions.
  - Create habitat with plant you choose to promote beneficial insects and pollinators and build soil tilth.
  - Minimize practices that negatively impact biological diversity.

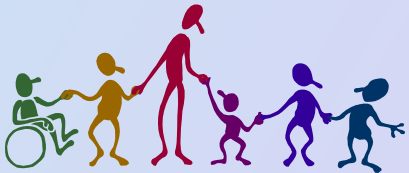
(Biodiversity provides biological buffering.)

Biodiversity and Soil Management For Food and Habitat Means….

- Management ➡ Stability ➡ 
- Ecological Balance
  - Resistance: System's desistance to degradation
  - Resilience: System's ability to bounce back
  - Persistence: System's ability to remain unchanged
    - Efficiency of Soil Processes
      - nutrient cycling
    - Self-Regulation or Self-Sufficiency (Emergent Properties)
      - Mutualistic organism relationships
      - Pest checks and balances



- Stability – Biologically Buffered System



Any Questions?

Biological Slide References

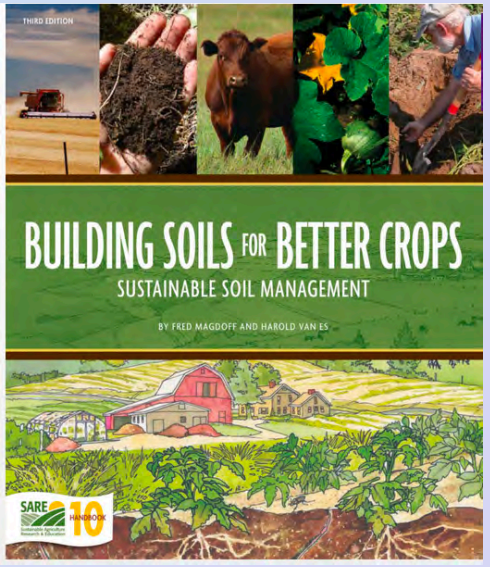
- DFW: The Decomposer Food Web: Ecology of organisms of compost and soil litter by Dr. Daniel Dindal, Professor Emeritus, Soil Ecologist, SUNY-Syracuse

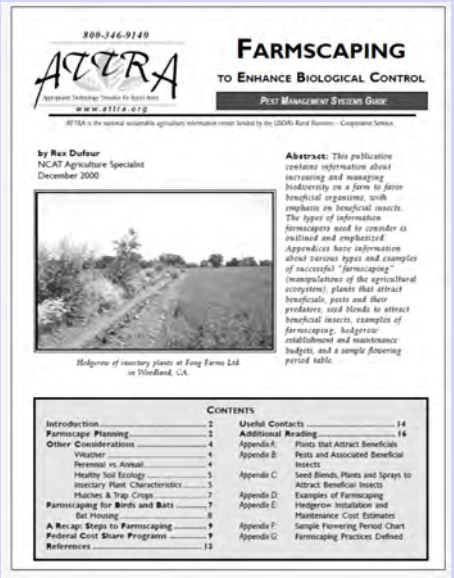
- SMB: Soil Microbiology and Biochemistry from Soil Science Society of America

- WSH: Wendy Sue Harper, Ph.D.

Free Useful Resources

- *Building Soils for Better Crops*. 2009. by Fred Magdoff and Harold van Es. Sustainable Agriculture Network. Handbook Series Book 10. http://www.sare.org/publications/bsbc/bsbc.pdf
- *Farmscaping to Enhance Biological Control* by Rex Dufour. ATTRA. 2000. https://attra.ncat.org/product/farmscaping-to-enhance-biological-control/




800-346-9140
ATTRA
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FARMSCAPING
TO ENHANCE BIOLOGICAL CONTROL
PEST MANAGEMENT SYSTEMS GUIDE
by Rex Dufour
NCAT Agriculture Specialist
December 2000
Abstract:
Hedgerow of insectary plants at Fetzer Vineyards in Hopland, CA.
CONTENTS

The End