



Photos by Patrick Mangan



# Start Your 2020 Victory Garden!

## Section 4: Soil Test Results, and Soil Amendments

A practical guide on the ins and outs of developing a backyard garden plot to grow your own fresh vegetables for a local, sustainable, secure food supply in the times we are having.

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# WELCOME BACK!

## Table of Contents: Where we have been and where are going...

### Previously:

- Section 1: Bitterroot Valley Climate data for gardening. Site selection for a garden, and keeping the deer out.
- Section 2: Garden soils, taking soil samples.
- Section 3: Garden beds, raised beds, and container gardening.

### Currently:

- Section 4: Soil amendments and preparing the garden. What a soil test analysis tells you.

### Coming Soon:

- Section 5: What to Plant? Seeding and transplanting plants when the time is right.
- Section 6: Watering and weed management in the garden.
- Section 7: What could possibly go wrong? Disease, insects, and other things to keep a watch out for. IPM management practices.
- Section 8: Harvest time! Canning and storage
- Section 9: Putting the garden beds to sleep for the winter
- Section 10: Next year...

# Soil Test Results and Amending Soils

## In this section:

- What a soil test reports back to you
- What some of the numbers mean, and some recommendations for soil improvement (if needed)
- Amending soil for the short and long term



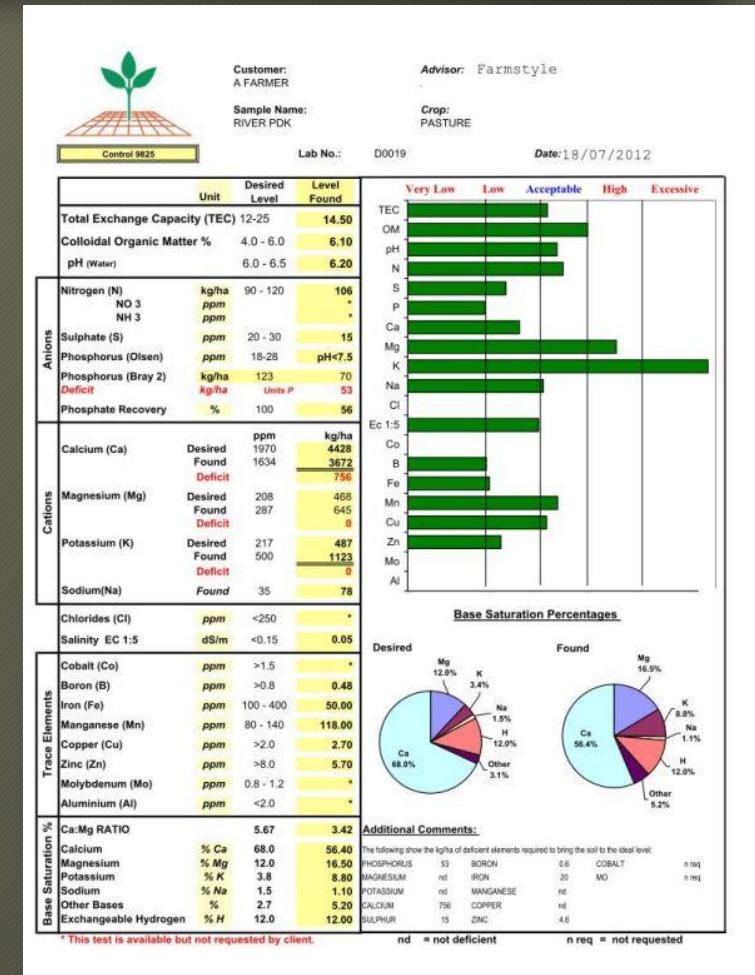
Image source: University of Maryland Extension  
<https://extension.umd.edu/hgic/topics/soil-fill-raised-beds>

# Unpacking a Soil Test

What are some key measurements it is taking about my soil?

Why is this information important to me?

Every company will format a test differently, but they should all report out key soil health information



# Soil Organic Matter

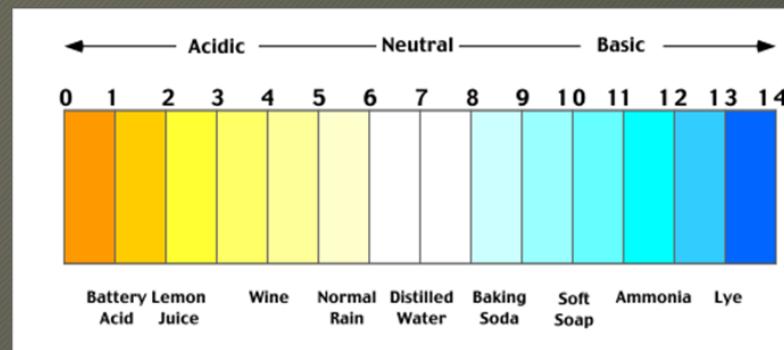
- Most soil tests will measure the percentage soil organic matter in the sample.
- Remember organic matter can store water, hold nutrients, provide a food source for microbes, and do many other important functions in the soil ecosystem.
- A good range is typically 4-6% in many garden soils where a gardener has been integrating some organic matter into the soil over time.
- Many un-amended Montana soils can be down around 2%
- Some work in Oregon is showing there may be an upper limit to soil organic matter at little more than 8% in garden soils. At that rate, sounds like the soil chemical qualities start doing interesting things.



Image source: SDSU Extension  
[https://extension.sdsu.edu/  
news/sdsu-extension-host-mitchell-soil-health-workshop-february-13](https://extension.sdsu.edu/news/sdsu-extension-host-mitchell-soil-health-workshop-february-13)

# Soil pH

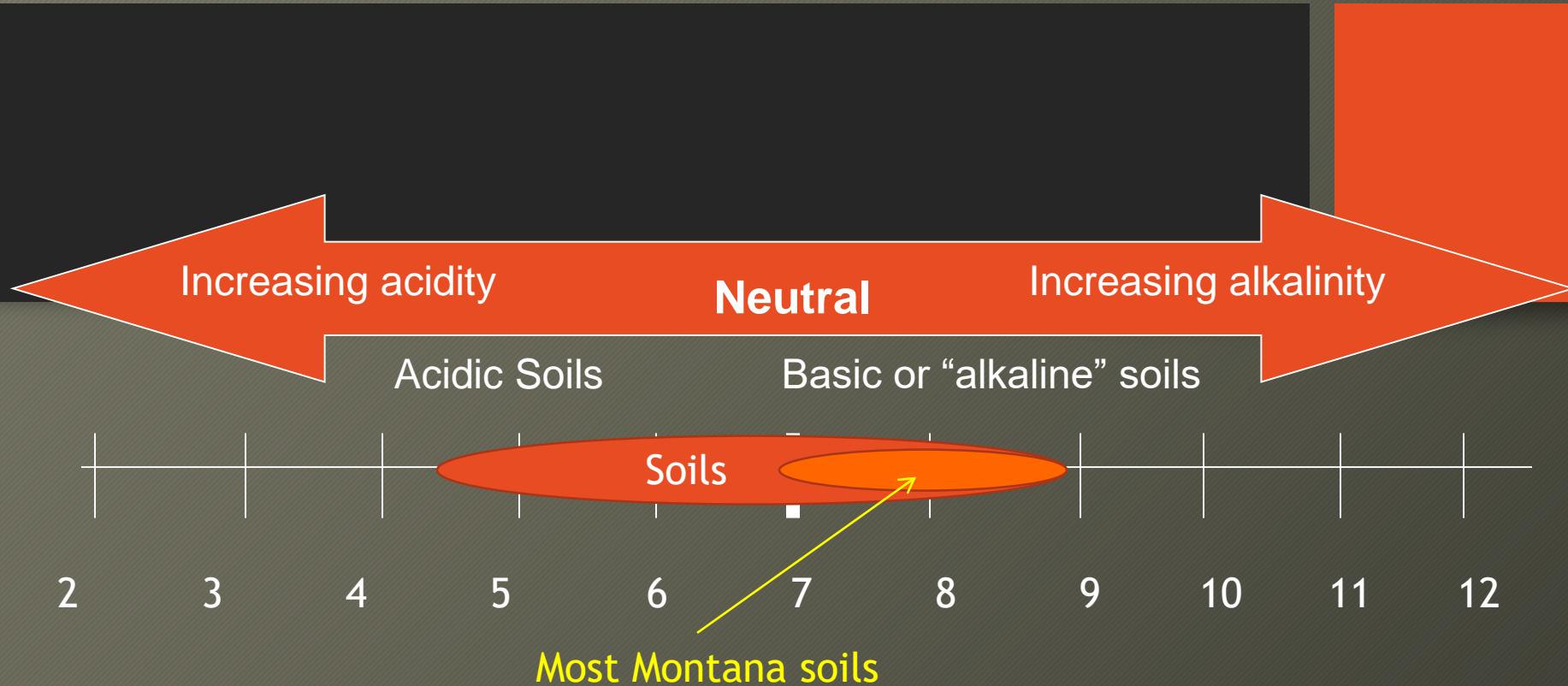
- Soil pH is a measure of the acidity or alkalinity of the soil and soil water solution. This measure can be highly influenced by soil parent material.
- pH is a logarithmic scale from 1- 14, with 7.0 being neutrally.
- A soil pH less than 7.0 is acidic, with the strength of acidity getting stronger as the number gets smaller.
- A pH of higher than 7.0 is alkaline, or basic, with the alkalinity of the soil increasing as the number gets greater.



# pH

Most Montana soils are alkaline, due to the calcareous nature of our soils (soils containing a lot of Calcium), but there are a lot of places with acidic soil as well.

Vegetable plants are usually best suited for a pH between 6.5- 7.5.

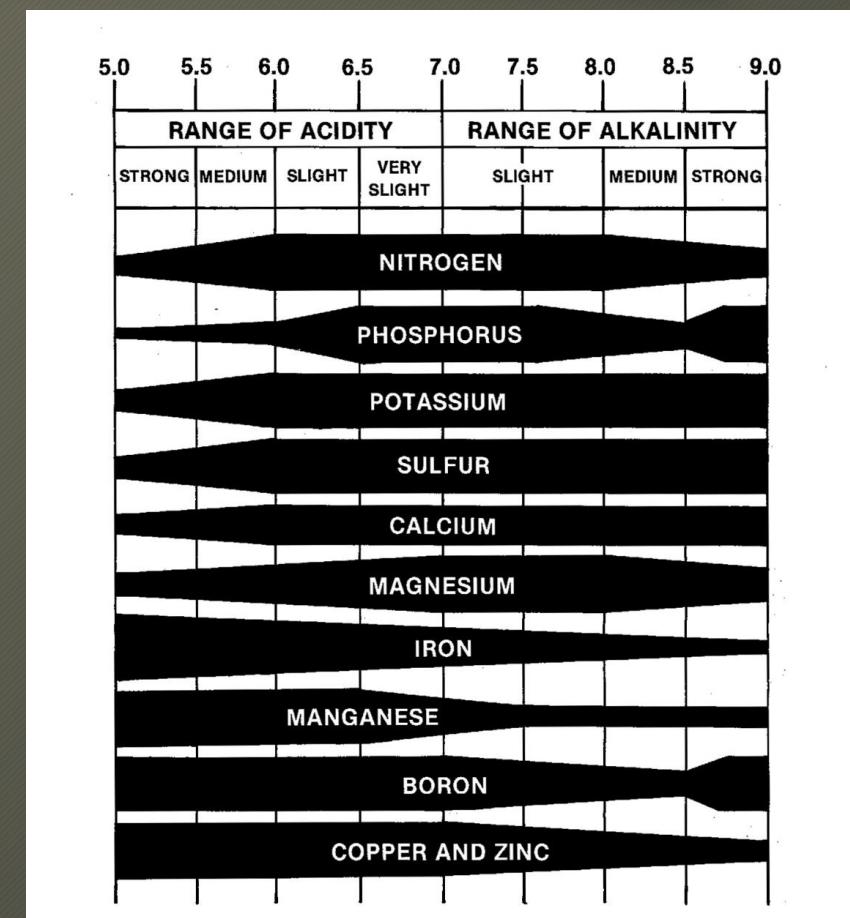


# pH affects nutrient availability

This graph is showing nutrient solubility and availability at different pH levels. The thicker the bar, the more available that nutrient is for plants to take up through roots.

You'll notice a happy medium right around pH 7.0

If soil pH gets too high or too low, it may make some nutrients immobile, and unavailable for plants. We can see this as a nutrient deficiency and may look like a plant disease.



# Cation Exchange Capacity

Cations are positively charged chemical molecules and elements. Clay particles are negatively charged particles. So just like magnets, opposites attract. We measure the ability of a soil to hold onto and store cations, called CEC.

- Indicates ability of soil to hold positively charged nutrients.
- Many essential plant nutrients carry positive charges. Example: Potassium ( $K^+$ ), Phosphorus ( $P^+$ ), Sulfur ( $S^+$ ), .
- A fertile soil has the capacity to attract and hold these nutrients.
- Reported as a number, a higher number, into the teens can be a good sign.

# Nutrients

- 17 elements are essential for plant growth

Oxygen  
Carbon  
Hydrogen  
Nitrogen  
Phosphorus  
Potassium  
Magnesium  
Calcium  
Sulfur

Iron  
Boron  
Chlorine  
Manganese  
Zinc  
Copper  
Molybdenum  
Nickel

Periodic Table of the Elements																		
H	Li	Be	Na	Mg	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge
1	3	4	11	12	19	20	21	22	23	24	25	26	27	28	29	30	31	32
He	Al	Si	P	S	Cl	Ar	13	14	15	16	17	18						
	B	C	N	O	F	Ne	5	6	7	8	9	10						
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	48	49	50	51	52	53	
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	80	81	82	83	84	85	
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	
Fr	Ra	Ac	Unq	Unp	Unh	Uns	Uno	Une	Unn									
87	88	89	104	105	106	107	108	109	110									
58	59	60	61	62	63	64	65	66	67	68	69	70	71					
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu					
90	91	92	93	94	95	96	97	98	99	100	101	102	103					
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr					

Much of the rest of a soil test report will detail the amounts of plant nutrients found in the soil. While there are 17 listed above, we will focus in on just a few macro-nutrients that plants will want in more than just trace amounts.

# Nitrogen (N)

- Favors vegetative “green” growth such as leaves and shoots
- Sources:



High N  
Fertilizers



Blood Meal\*



Fish Meal\*



Cottonseed  
Meal\*

\* = organic source

\*\*Plants will use A LOT more nitrogen annually compared to the other nutrients. That makes sense, because nitrogen supports all the vegetative growth, and that's a lot of the mass our garden plants produce.

# Phosphorus (P)

- Promotes good seed and fruit ripening, maturation, energy storage/transfer
- Sources:



Superphosphate



Diammonium  
Phosphate



Bone Meal\*



Rock Phosphate\*

\* = organic source

# Potassium (K)

- Stomatal regulation (gas exchange), new tissue growth, root and stem development, hardness, fruit flavor and color
- Sources:



Potassium  
Chloride



Potash\*



Seaweed Meal\*

\* = organic source

# So how much do I need?

- There's no easy answer to that question
  - Depends on many factors:
    - What you want to grow, and how heavy that plant feeds, and on what kinds of nutrients?
    - Some plants, called legumes, will use bacteria to take Nitrogen out of the air and put it back into the soil.
    - What are your long term fertility plans and what are you doing with your soil to "feed" it?

Check out this publication, "Feeding the Garden Soil" by MSU Extension Soil Scientist Clain Jones

[http://landresources.montana.edu/soilfertility/soil\\_scoop/ss\\_GardenSoil.html](http://landresources.montana.edu/soilfertility/soil_scoop/ss_GardenSoil.html)

Universal ballpark ideals for soil nutrient fertility measurements

Nutrient reported on test	A good optimal range annually
Nitrogen N (lb/ acre)	80-100 lbs/ acre
Potassium K (ppm)	250 ppm or more
Phosphorus P (ppm) Olsen P test	30 ppm

# Amending Soil to Develop Soil and Add Fertility

- Once you know where your soil fertility is at and what you are going to ask of it for the growing season you can consider adding amendments to build soil health and fertility.
- Adding amendments and building soil fertility is both a short term and long term goal and effort; you may need an infusion of nitrogen **THIS GROWING SEASON** for the corn you want to grow, AND you may also want to incorporate a green manure or cover crop that will add organic matter into the soil for the long term, which will increase the amount of nitrogen in the soil over time.



Image source: University of Maryland Extension  
<https://extension.umd.edu/hgic/topics/cover-crops-protect-and-improve-your-soil>

# Quicker Fertility Amendments for Growing

Sometimes you'll want to add nutrients and fertility treatments to your soil and gardening for the current growing season.

- You can incorporate compost and manures at the beginning of the season to feed the soil and release throughout the growing season
- You can add synthetic chemical fertilizers for rapid availability soon after addition.
- You can add organically derived nutrients for quick availability as well.
- While in-ground beds have several options for nutrient management, raised beds and especially containers will need some additional nutrients during the growing season.

# Organic versus Inorganic...

They each have benefits and detractions. A lot of it will come down to your personal desires, values, and the amount of time and investment you would like to put into it. Here is a comparison.

## ◎Organic

- Lower nutrient content by volume
- Nutrient content difficult to quantify (-)
- Slow release (+)
- Usually supplies organic matter (+)

## ◎Inorganic

- Not adding carbon into the soil (-)
- Easy to store (+)
- Higher analysis (+)
- Custom formulated (+)
- Easy to use (+)
- Liquid and solid (+)
- Environmental concerns?(-)

# Common Soil Amendments - some ideas

Amendment	Purpose	Cautions
Coarse Sand	Improve aeration/drainage	Can cause concrete-like affect in soil with heavy clay
Sulfur	Increase acidity	Will only change slightly and is short lived
Limestone (dolomite lime <chem>CaMg(CO3)2</chem>	Increase alkalinity	Will only change slightly and is short lived
Gypsum ( <chem>CaSO4·2H2O</chem> )	Decreases sodic conditions	Takes too long, benefits, short lived, displaces iron
Peat Moss	Increase water and nutrient holding capacity	Acidifying, not the most sustainable choice
Compost, Composted Manure	Increase water and nutrient-holding capacity	Watch for herbicide residual

# Adding Manures as Fertilizers

Livestock manures can be a great source of fertility. It has organic matter, feeds soil microbes, and releases slowly.

- Be careful to get fully composted manure, or it will tie up nutrients to finish composting first.
- As a long term strategy, manure can lead to the build up of K and P, but not N, so be balanced over time. You'll have to use more than just manures.
- Also be sure your manures do not have any herbicide residuals travelling in them.

**Amount of organic manure needed to add 2 lbs of actual nitrogen/1000ft<sup>2</sup> of garden**

Manure (dry)	N (%)*	P (%)*	K(%)*	Total lbs Per 1000ft <sup>2</sup>
Chicken	2 to 4.5	4.6 to 6.0	1.2 to 2.4	62
Steer	1 to 2.5	0.9 to 1.6	2.4 to 3.6	115
Dairy	0.6 to 2.1	0.7 to 1.1	2.4 to 3.6	150
Pig	0.5 to 1.0	0.3 to 0.7	0.1 to 2.0	133
Horse	0.3 to 0.6	0.1 to 0.2	0.3 to 1.0	225

\* Analysis is approximate

# Herbicide Carryover in Manures and forages

- This link will take you to a good publication to read through about herbicide residuals in manures, grass clippings, and hay forages that may find their way into your garden.
- <http://www.pesticides.montana.edu/documents/references/Montana%20Herbicide%20Carryover%20Booklet%2011-2011%20LO-RES.pdf>

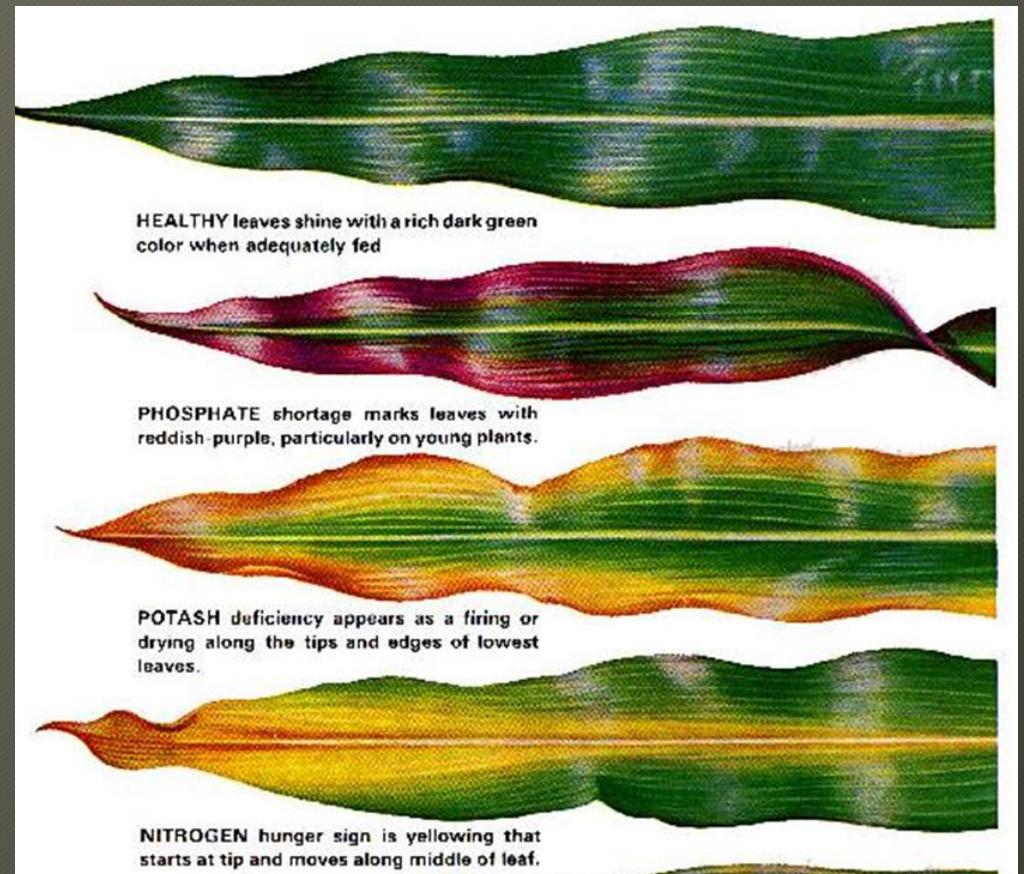
# Synthetic Fertilizers

- Chemical or synthetic fertilizers can help target specific nutrient needs.
  - The fertilizer bag or container will show how much of each of the macronutrients are in the mixture as a percentage
  - The first number is Nitrogen (N)
  - The 2<sup>nd</sup> Number is Phosphorus (P)
  - The third number is Potassium (K)
  - If there is a fourth number, it is Sulfur (S)



# Micronutrient Needs:

- Micronutrient deficiencies can show up as symptoms in garden plants from time to time.
  - Often times, a micronutrient deficiency will have a specific pattern to the symptom and how it appears on the plant.
  - If you are seeing challenges on your plants, take them to your local Extension Agent, they can help you identify what is going on, and if they are symptoms consistent with a micronutrient deficiency.
  - As we said a bit ago, pH can affect nutrient availability, so even if a soil test report says it is adequate, it might be chemically unavailable.
  - When accurately diagnosed, there are a number of opportunities to remedy, including foliar applications of micronutrients to get them into the plant.



# Green Manure Crops and Cover Crops

Two longer term strategies for building soil nutrients and health, green manure crops, and cover crops. They are similar and related, with slightly different applications for soil health.



Image Source: University of Georgia Extension  
<https://extension.uga.edu/publications/detail.html?number=B577>

# Green Manure Crops

- These are short-lived crops that we plant in garden beds with the express purpose of integrating more organic matter into soil.
  - 1) We plant a fast growing crop
  - 2) We let it grow up a little bit
  - 3) We till it under the soil to incorporate the plant tissues into the soil, where it will decompose, add organic matter to the soil, and release the nutrients it holds in the green material.



Image Source: Washington State University Extension  
<http://pubs.cahnrs.wsu.edu/publications/pubs/fs218e/>

# Cover Crops

- Cover crops are typically sewn into a garden bed after the harvest of the vegetable crop for the season. These crops will germinate and provide soil coverage in the bed for the remainder of the growing season, and often frost-kill in the fall. The residues sit on the soil surface over winter and then gardeners plant into those residues, or till them into the soil in the following spring.
  - Cover crops can also be targeted to do specific things to soils:
    - Legumes will fix nitrogen into the soil.
    - Tillage radish and collard greens will punch big macro-pores down into the soil for water infiltration and air exchange.
    - Oats and triticale can build green matter to incorporate into the soil and suppress weed growth.
  - We will talk more about cover crops in Section 9= Putting the garden bed to sleep.



A buckwheat cover crop sown into a raised bed in the fall.

# Using a Rototiller...

- Tillers can be great at flipping the soil and integrating organic matter into the soil.
- A couple of things to think about:
  - Rototillers can bury organic matter deeper than it needs to be, and can cause delays in its breakdown.
  - The vibrations of the machine can compact the soil layers at depth, below where the tines reach, creating longer term problems.
  - Tillers break the soil structure up. It is like continually hitting the “restart button” on your soil development.
- INSTEAD: consider using a spade to turn SOM into the soil shallowly, and without compaction. It won’t masticate and break apart soil structure in the same way.



# Next Up!

- In Section 5 of the Victory Garden Guide we will talk about plants and getting ready to plant in your garden!
  - Seeds and transplants
  - Information available to you
  - When to do it!



# Questions?

- If you have thoughts or questions, feel free to reach out to your local extension agent.

Or, give me a call

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