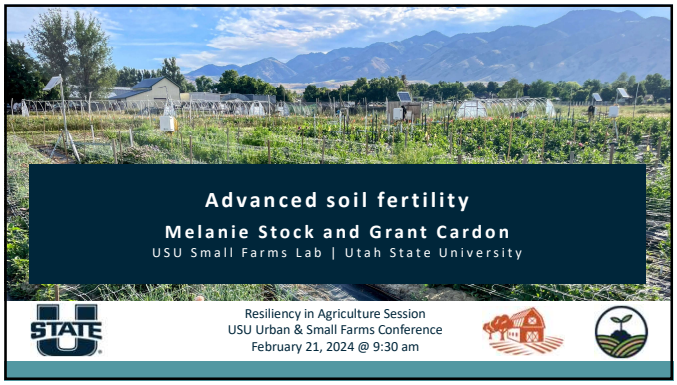

1

Handouts: diverseag.org (coming soon)

Topics

- Basics
  - Sufficiency
  - Definitions and Nutrient forms
  - Product labels
- Applying soil test recommendations
  - Example tests
  - Selecting products
  - Calculating product amounts
  - Tailoring to your area
  - Weights vs volumes for measurement
  - Compost and manure as amendments

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Basics: perspective on sufficiency, nutrient forms, and labels

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Goal: A focused, optimized approach

- Much can be done once or twice or three times – that later exacerbate issues and are expensive to correct. Best to avoid on the front end.
- Much can be done that doesn't hurt – or actually help.
- It's a balance between knowing our soils and feeding a living system with what is needed – and no more.

"An ounce of prevention is worth a pound of cure."

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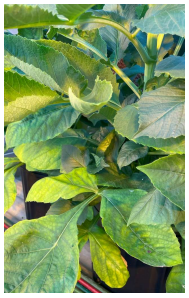
Plants need 14 mineral nutrients



- The soil is a nutrient bank. Plants uptake specific forms of nutrients.
- If one nutrient is deficient, plant productivity declines. Visual symptoms unreliable.
- If nutrient levels are above optimum, there is NO plant benefit.
- Sustainability and productivity goal: sufficient - not high - nutrients levels.
  - Environmental contamination
  - Unnecessary input cost reduces bottom line
  - Elevated salts

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The mineral nutrients:

Macronutrients (large quantities, % in tissue):

nitrogen	*sulfur*
phosphorus	magnesium
potassium	calcium

Micronutrients (small quantities, ppm or ppb)

iron	*zinc*	manganese
boron	copper	molybdenum
cobalt	chlorine	

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Element	Plant Form	Role in Plant
Nitrogen (N)	NO_3^- and NH_4^+	Part of proteins, chlorophyll, and nucleic acids
Phosphorus (P)	$H_2PO_4^-$ and HPO_4^{2-}	Energy transfer and building proteins, coenzymes, nucleic acids, and metabolic substrates.
Potassium (K)	K^+	Used in photosynthesis, carbohydrate translocation, protein synthesis, and more
Calcium (Ca)	Ca^{2+}	Used in cell walls; role in structure/permeability of membranes
Magnesium (Mg)	Mg^{2+}	Used in chlorophyll, and is an enzyme activator
Sulfur (S)	SO_4^{2-}	Part of plant proteins
Boron (B)	Several!	Helps move sugars and metabolize carbohydrates
Chlorine (Cl)	Cl^-	Involved with oxygen production in photosynthesis
Copper (Cu)	Cu^{2+}	Catalyst for respiration, and used in enzymes
Iron (Fe)	Fe^{2+} and Fe^3	Helps make chlorophyll and in enzymes for electron transfer
Manganese (Mn)	Mn^{2+}	Controls oxidation/reduction systems and photosynthesis
Molybdenum (Mo)	$HMoO^{4-}$ and MoO_4^{2-}	Involved in nitrogen fixation and transforming nitrate to ammonium
Nickel (Ni)	Ni^{2+}	Necessary for germination and the function of urease
Zinc (Zn)	Zn^{2+}	Helps regulate metabolic activity

Adapted from: Brady and Weil (2005)

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Let's cover some definitions

- Products intended to supply plant nutrients have 3 numbers: N-P-K, the percent nitrogen, phosphorus (as P_2O_5), and potassium (as K_2O).
  - The product is a fertilizer when the three numbers add up to > 24.
  - The product is an amendment when they add up to < 24.
- How much N is in a 10 lb bag of urea? 46% = 0.46 x 10 lbs = 4.6 lbs N/bag.

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Looking at the fine print – more definitions

- "Available" or "soluble" nutrients are available right away – we usually do a split application of N with these (pre-plant and midway).
- "Insoluble", "organically-bound nutrients", or "slow release" are NOT available right away. They break down/decompose (mineralize) first. Pluses and minuses - important considerations.

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Here's our last definition: organic

1. **Organic matter** – the remains of decomposed plants/animals in soil.
2. **Certified Organic** – USDA program ensures product meets certain farming practice standards *e.g.* seed source, fertilizer, pesticides, etc. Official labels.
3. **Organic** (chemistry) – any compound with carbon in it, typically from something that was once alive. For example, the nitrogen inside a decomposing clover plant is considered "organically bound".

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Translating soil test recommendations into action

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Importance of soil testing, reiterated

- **Soil is a black box**. Testing informs what is needed to avoid deficiency and excessive levels – and save money.
  - **Optimize yield** by knowing what crops need on the front end
  - Using visual symptoms alone = often too late and misdiagnosis common
  - **Environmental sustainability**
- Companies invest in marketing and packaging. Plants need specific nutrients in specific forms. The rest is advertising.
- USU and BYU offer soil testing.
  - Routine often sufficient: Salinity, pH, P, K, texture.
  - High pH – check micronutrients.
  - Urban risks – consider trace elements.

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Check out these fact sheets: in-depth info!

- Soil sampling strategies, test selection, interpreting the report
- Examples and workbook

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Example soil tests – "the Utah Special"

- Loam – ideal texture, mix of sand silt and clay.
- pH – common in Utah.
- Salinity – watch compost/manure use, water.

Soil Test Results		Interpretations	Guidelines
Texture	Loam		
pH	7.8	Normal	
Salinity - ECe dS/m	2.00	High	
Phosphorus - P mg/kg	180	Very High	0 lbs P2O5/1000 sq ft
Potassium - K			
Nitrate-Nitrogen - N			

Soil Test Results		Interpretations	Recommendations
Texture	Silt Loam		
pH	7.2	Normal	
Salinity - ECe dS/m	3.30	Very High	
Phosphorus - P mg/kg	118	Very High	0 lbs P2O5/1000 sq ft
Potassium - K mg/kg	1051	High	0 lbs K2O/1000 sq ft
Nitrate-Nitrogen - N mg/kg	158		0 lbs N/1000sq ft*

Crop Type	Ideal pH[1]	Salinity Threshold [dS/m]
Apple	5.5–6.5	1.4
Artichoke	6.5–7.0	6.1
Blackberry	5.5–7.0	1.5
Corn	5.5–7.5	1.7
Bean, green	6.0–7.0	1.0
Beet	6.5–8.0	4.0
Broccoli	6.0–6.5[1]	2.8
Carrot	6.0–7.0	1.0
Cucumber	5.5–7.0	2.5
Garlic	6.2–7.0	3.9
Grape	5.5–7.0	1.5
Lettuce	6.0–7.0	1.3
Onion	6.0–7.0	1.2
Pea	6.0–7.5	3.4
Peach	6.0–7.0[4]	1.7
Pepper	5.5–7.0	1.5
Plum	6.8–8.5	2.6
Potato	4.8–6.5	1.7
Spinach	6.0–7.5	2.0
Strawberry	5.5–6.5	1.0
Sunflower	6.5–7.5[5]	4.8
Tomato	5.5–7.5	2.5
Zucchini	6.0–7.0	4.9

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Example soil tests: P and K

- Nutrients – High to Very High (aka excessive).
- No crop benefit. Applications NOT recommended.

Soil Test Results		Interpretations	Guidelines
Texture	Loam		
pH	7.8	Normal	
Salinity - ECe dS/m	2.00	High	
Phosphorus - P mg/kg	180	Very High	0 lbs P2O5/1000 sq ft
Potassium - K mg/kg	875	High	0 lbs K2O/1000 sq ft
Nitrate-Nitrogen - N mg/kg	61.1		0 lbs N/1000sq ft*

Soil Test Results		Interpretations	Recommendations
Texture	Silt Loam		
pH	7.2	Normal	
Salinity - ECe dS/m	3.30	Very High	
Phosphorus - P mg/kg	118	Very High	0 lbs P2O5/1000 sq ft
Potassium - K mg/kg	1051	High	0 lbs K2O/1000 sq ft
Nitrate-Nitrogen - N mg/kg	158		0 lbs N/1000sq ft*

Test Category	PHOSPHORUS (P_2O_5) Test Result	PHOSPHORUS (P_2O_5) Fertilizer Recommendation	POTASSIUM (K_2O) Test Result	POTASSIUM (K_2O) Fertilizer Recommendation
Very Low	0–10	Add 0.3 lbs P_2O_5	0–70	Add 0.4 lbs K_2O
Low	11–20	Add 0.2 lbs P_2O_5	70–125	Add 0.2 lbs K_2O
Adequate	21–30	NONE	126–300	NONE
High	>31–60	NONE	>300	NONE

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Soil tests one step further

- Low nitrogen – most annual crop systems need added N in most years.
- 1st question – what amendment to use?
- 2nd question – how does 1-2 lbs N/1000 sq ft translate into a fertilizer amount?

Soil Test Results		Interpretations	Recommendations
Texture	Sandy Loam		
pH	7.6	Normal	
Salinity - ECe dS/m	0.90	Normal	
Phosphorus - P mg/kg	132	Very High	0 lbs P2O5/1000 sq ft
Potassium - K mg/kg	371	Adequate	0 lbs K2O/1000 sq ft
Nitrate-Nitrogen - N mg/kg	14.4		1-2 lbs N/1000 sq ft*

Test Category	NITROGEN (N) Test Result	NITROGEN (N) Fertilizer Recommendation
Very Low	<10	Add 0.3 lbs N
Low	10–25	Add 0.2 lbs N
Adequate	>25	NONE
High	-	NONE

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General N needs by crop

- Vegetable (lbs N/1000 sq ft)
  - **Low** intensity (pea, bean). 1 to 2 lb N
  - **Medium** intensity (most). 2 to 4 lb N
  - **High** intensity (corn, potato, onion). 4 to 6 lb
- Cut flowers (lbs N/1000 sq ft)
  - **Low** intensity (bulbs, lower-water users). 1 to 1.5 lb N.
  - **Medium** intensity (most – snap, stock, lisi, ranunc, delphinium…). 2 lb N
  - **High** intensity (dahlia). >2.5 lb N
- Fruit (lbs N/tree)
  - 0.01 to 0.04 lbs N, per year of age with annual limit of 0.3 lbs N per tree.
  - Vegetative growth an indicator for N.

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Q1: only N needed = use an N-only product.

- Product contains N (1st number on the product label): **N**-P_2O_5-K_20
- Preference for the second and third numbers to be 0
  - At least substantially less than % N.
  - Avoid "balanced" and "all purpose" fertilizers if P and K are not needed.
- Two examples, one conventional and one organic:
  - Urea, 46-0-0
  - Blood meal, 12-0-0

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Q2: How much to add? Depends on the product.

- If the soil test says I need **2 lbs** N/1000 square feet.
- How much urea, **46**-0-0, fertilizer is that?
  Answer: ~4 lbs of 46-0-0/1000 sq ft.
- How much 12-0-0 amendment is needed if I used this instead of urea?
  Answer: ~17 lbs of 12-0-0 (more because it is less concentrated)

lbs of nutrient recommended by soil test ÷ **# on bag/100** = **lbs of product** (to add to 1000 sq ft)

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What if my space is not 1000 sq ft?

- Divide amount by 1000 sq ft and multiply by your area (in sq ft) to tailor to your space. Let's pretend I have three beds, each 4 ft x 50 ft.
- My area per bed is: 4 ft x 50 ft = 200 sq ft.
  - *4 lbs of urea / 1000 sq ft. x 200 sq ft = 0.8 lbs urea per bed.*
  - *17 lbs of bloodmeal / 1000 sq ft. x 200 sq ft = 3.4 lbs bloodmeal per bed.*
- My area across all 3 beds is: 3 beds x 200 sq ft/bed = 600 sq ft.
  - *0.8 lbs per bed x 3 beds = 2.4 lbs urea across the 3 beds. OR*
  - *4 lbs of product / 1000 sq ft. x 600 sq ft = 2.4 lbs across the three beds.*


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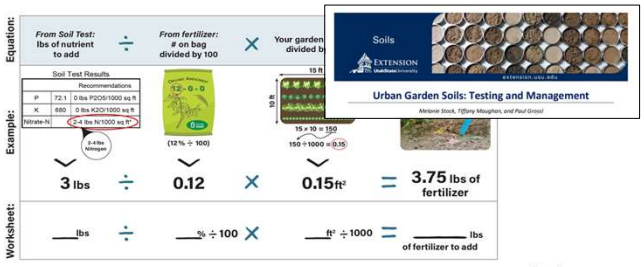
Worksheet for small spaces (beds)



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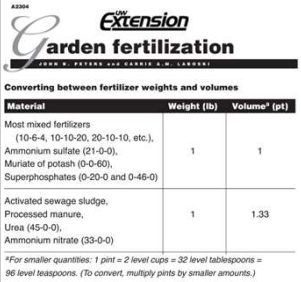
Must I work in weights, not volume?



- No, but scales make it pretty easy. Dedicate a kitchen (small space) or bathroom (large space) scale for tilizers.
- urchase smaller uct. Approximate ne bag was used.
- ert to volume , but a little more ensity is needed, uct.

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Compost and manure addition - specs.

	Compost Type	N	P_2O_5	K_2O	pH	Salinity [dS/m]
		---------- % ----------				
Manure-Based	Beef	1.1	0.9	1.3	8.5	4
	Chicken	1.4	5.8	2.8	8.2	16
	Dairy	1.0	0.7	1.5	8.5	8
	Goat	1.0	0.9	1.9	8.4	5
	Horse	0.7	0.3	0.9	8.6	4
	Mink	1.1	3.0	0.3	6.4	6
	Sheep	1.0	1.1	1.3	8.0	3
	Turkey	2.2	5.3	2.2	8.2	11
Other	Biosolids	1.8	1.5	0.2	6.9	5
	Commercial	1.3	0.9	1.0	7.8	5
	Municipal	1.2	1.1	0.7	7.8	5
	Plant-Based	1.4	0.9	0.9	7.9	3

- May use these to hit P need, then supplement N. Watch salinity!
- Composts – soluble and insoluble nutrients.
  - Generally in Year 1: ~5-10% of N released, 75% P, and most K
- Manure – has soluble and insoluble nutrients
  - Year 1: ~75% of N, P, K available. Weeks to months.
  - Years 2 & 3: ~10% of nutrients available

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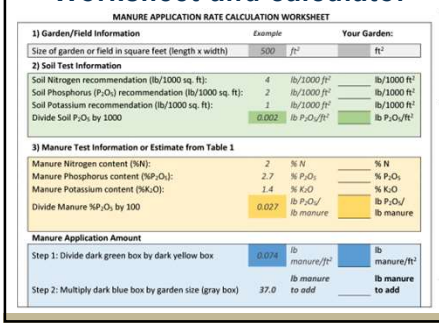
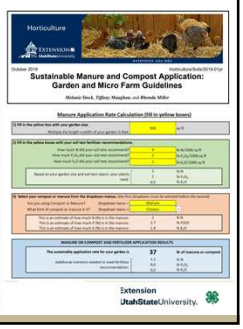
Worksheet and calculator





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Timing nutrient applications

- Best not to apply in fall – winter losses.
- All at once in spring vs. split applications in growing season: depends on fertilizer, crop, soil, and weather conditions.
- Soluble nutrients are available right away and last weeks to months
  - Consider split applications (early and mid-season)
  - Example: urea (46-0-0) – available right away, but should be mixed in and has burn potential if overapplied. Fish Emulsion (5-1-1) is also available right away, less likely to burn.
- Insoluble nutrients take several weeks to years to be available. Slow flow vs. crop demand timing.

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Summary

Adapted from Jerry Maguire (1996)

- Let a soil test guide nutrient applications.
  - Do not add nutrients that are not needed. Excess nutrients do not help crops and are an environmental contaminant.
  - Watch salinity too!
- For small spaces, soil test recs are in pounds of nutrient per 1000 sq ft.
  - Select a product based on its guaranteed analysis.
  - Convert lbs of nutrient to product based on the guaranteed analysis.
  - Measure your area and convert from lbs/1000 sq ft to your space.
  - We can estimate volume, instead of using weight.
- Careful on and credit compost and manure.

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Thank you!

Add questions to the Q&A and answer poll.

Contact info:

melanie.stock@usu.edu smallfarmslab.com @usu_smallfarms



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