

## Plant Nutrition and Fertilization



Steve Renquist  
Oregon State University

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## Plant Nutrient Categories

- Primary Macronutrients
  - N, P, K, (C, O, H)
- Secondary Macronutrients
  - S, Ca, Mg
- Micronutrients
  - B, Fe, Mn, Mo,
  - Cu, Zn, Cl

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## Many Factors Can Influence Plant Nutrition

- Soil organisms- bacteria, fungi, algae, protozoa, nematodes, earth worms.
- Soil type, CEC and pH of the soil.
- Soil drainage and structure.
- Soil organic matter content.
- Soil nutrient content.

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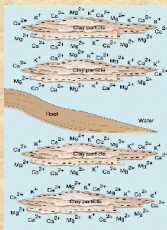
## Nutrient Availability

- 98% of the nutrients used by plants are taken up from the soil solution.
- Soluble available nutrients are in the ionic form.
- Cations (+) Anions(-)

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## Nutrient Availability

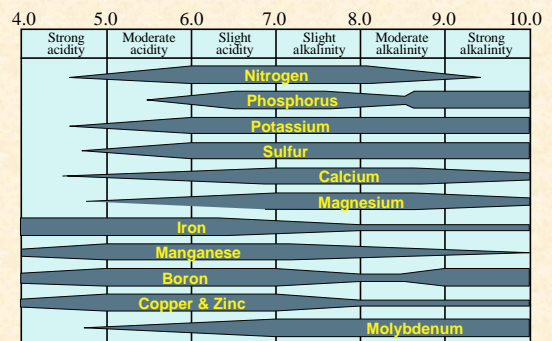
### Nutrient availability to plants



- Mineral soil particles and soil organic matter have negative charges on their surfaces and can attract cations.

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## pH & Nutrient Availability



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## Raising pH

- Use liming materials to raise the pH of acidic soils.
  - $\text{CaCO}_3 + 2\text{H}^+ \rightarrow \text{H}_2\text{O} + \text{CO}_2 + \text{Ca}^{2+}$
- Don't add  $\text{NH}_4$  fertilizers with liming materials, as N may be lost to the atmosphere.

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## Ca-deficient tomato



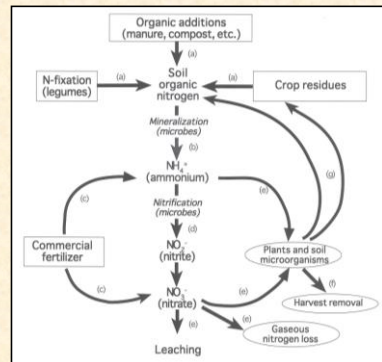
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## Ca-deficient apple



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## The Nitrogen Cycle



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## The Nitrogen Cycle

The Nitrogen Cycle

- Nitrogen is found in four different forms in the soil.
- Only two of them—**ammonium** and **nitrate**—can be used directly by plants.

Soil organic nitrogen		
$\text{NH}_4^+$ ammonium	$\text{NO}_2^-$ (nitrite)	$\text{NO}_3^-$ (nitrate)

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## Site History

- Low organic matter
- Intensively harvested
- No fertilizer added
- Lots of water

*These would lead us to suspect nutrient depletion.*

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## Nutrient Mobility

- Mobile
  - N, S, B, Cl, Na
- Somewhat Immobile
  - K, Ca, Mg
- Immobile
  - P, Fe, Cu, Mn, Mo, Zn

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## Demonstrated Deficiency Soil Testing

- Soil sample, every 3-4 years ok
- 1/2 pound is used to represent 2 to 4 million pounds of soil in the field
- separate sample from each area that differs in topography or past management practice

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GUARANTEED ANALYSIS 28-3-8	
Total Nitrogen (N)	28.00%
1.17% Ammoniacal Nitrogen	
26.83% Urea Nitrogen*	
Available Phosphate (P <sub>2</sub> O <sub>5</sub> )	3.00%
Soluble Potash (K <sub>2</sub> O)	8.00%

Derived from: Polymer-coated Urea, Polymer-coated Sulfur-coated Urea, Urea, Diammonium Phosphate, Muriate of Potash  
 \*6.6% Slowly Available Urea Nitrogen from Polymer-coated Urea and Polymer-coated Sulfur-coated Urea.  
 Chlorine (Cl), not more than 6.4%

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## Fertilizer Calculation

- Recommend 2 lbs. N/ 1000 sq. ft
- Using a 16-16-16 fertilizer
- $2 \text{ lbs N} \div .16 = 12.5 \text{ lbs} / 1000 \text{ sq. ft.}$
- Garden size  $25 \times 20 = 500 \text{ sq. ft.}$
- $500 \div 1000 \times 12.5 = 6.25 \text{ lbs } 16-16-16$

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## Formulas

- $\text{Lbs/acre N} \div \text{N\%} = \text{lbs of fertilizer needed}$
- $160 \text{ lbs N} \div 16\% = 1000 \text{ lbs of } 16-16-16$

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## Inorganic vs. Organic fertilizers

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>• <b>Inorganic fertilizer</b></li> <li>• Concentrated, high %</li> <li>• Highly reactive, can move pH up or down</li> <li>• Soluble</li> <li>• Uniform</li> <li>• Available</li> <li>• Hygroscopic-burns</li> </ul> | <ul style="list-style-type: none"> <li>• <b>Organic fertilizer</b></li> <li>• Bulky, low nutrient %</li> <li>• Slow release</li> <li>• Insoluble</li> <li>• Quality varies</li> <li>• Increases organic matter, water holding, feeds microbes, c.e.c</li> </ul> |
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## Commercial Fertilizers

Fertilizer	Grade	Acidity	Salt
• Anhydrous Ammonia	82-0-0	140	47.1
• Sodium Nitrate	16-0-0	-	100
• Ammonium Sulfate	21-0-0	110	69
• Urea	46-0-0	71	75
• Triple Super Phosph	0-45-0	0	10
• Potassium Chloride	0-0-60	0	116

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## Organic Fertilizers and Soil Amendments

Material	N	P	K	notes
• Blood Meal	12-15	1.2	1	soluble
• Bone Meal	2-4	15	25	Ca, TE
• Poultry manure	3-4	2-4	1.2	TE
• Compost	1-2	1	1	TE
• Steer manure	.6-2	.3	.5-1	salty
• Fish Meal	8	7	2	soluble
• Wood Ash	0	1	6	soluble

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## Adding Organic Matter

- Know your C:N ratios
- Grass clippings 10:1
- Cover crops 19:1
- Manure 22:1
- Corn stalks 50:1
- Wheat straw 84:1
- Wood chips 600:1

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## Estimating the Volume of Organic Amendments

Table 1. Estimating the volume of organic amendment needed.

Depth of amendment desired (inches)	Area of garden (square feet)*			
	200	500	1,000	2,000
	Organic material to add (cubic yards)			
1	0.6	1.5	3.1	6.2
2	1.2	3.1	6.2	12.3
3	1.9	4.6	9.3	18.5
4	2.5	6.2	12.3	24.7

\*To estimate square footage of a garden, multiply the length by the width (in feet).

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## Using Manure for Fertilizer

- Recent studies encourage composting first or applying aged manures close to planting
- Applying fresh manure (<2-3 months old) can spread salmonella bacteria to veg crops
- Orchard crops and vegetables trained to trellis are not as susceptible

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## Using Covercrops

- Adds organic matter
- Captures and recycles nutrients
- Reduces erosion
- Suppress weeds
- Can supply nitrogen



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## Fertilizer Application

- P, K, Mg, Zn are immobile and should be banded or incorporated into the soil.
- Incorporate N fertilizers when possible to lessen denitrification. The exception is coated or slow release when used on lawns.
- Apply N only when plant will capture

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## Basic Fertilization Regimes



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## Vegetable Crops



- Use blended or organic fertilizers
- Broadcast and incorporate
- N side-dressing in June or July

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## Orchard Crops



- Mostly N, Ca
- Spring application N for shoots and leaves
- Use shoot growth to judge impact
- Apply 1/8<sup>th</sup> lb actual N/yr of tree age

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## Turf-Lawns



- Time your application
- Tax time, Memorial Day, Labor Day
- Healthy turf 1 lb of actual N/ 1000sq ft
- Weak turf 2 lbs of N

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## Calculating lbs. Of N/1000 sq. ft.

- A 5,000 sq.ft. bag of Turf builder with a 30-3-3 analysis weighs 18.5 lbs.
- $18.5 \text{ lb} \times 30\% \text{ N} = 5.5 \text{ lbs. N per bag}$
- $5.5 \text{ lbs.} / 5 = 1.1 \text{ lbs. N per 1000 sq. ft.}$

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## Fertilizer Application Rates Healthy Turf, 1 lb N/1000 sq ft

- | • Nitrogen in Fertilizer | • Product to apply(lbs.) |
|--------------------------|--------------------------|
| • 10%                    | • 10                     |
| • 15%                    | • 7                      |
| • 20%                    | • 5                      |
| • 25%                    | • 4                      |
| • 30%                    | • 3.5                    |
| • 35%                    | • 3                      |
| • 40%                    | • 2.5                    |

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## Slow Release Fertilizers

- Used in potted plants and on lawns
- Reduces potential plant toxicity
- Reduces N leaching and runoff potential
- Similar action to organic materials

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