pH Management and Lime Material Selection and Application

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Acidity and pH

- Acidity = H^+ and Al^{3+}
- pH is a measure of H^+ activity

0 - - - - - - - - - - 7 - - - - - - - - - - 14

Acid Neutral Basic

1 unit change in pH = 10 X change in acidity

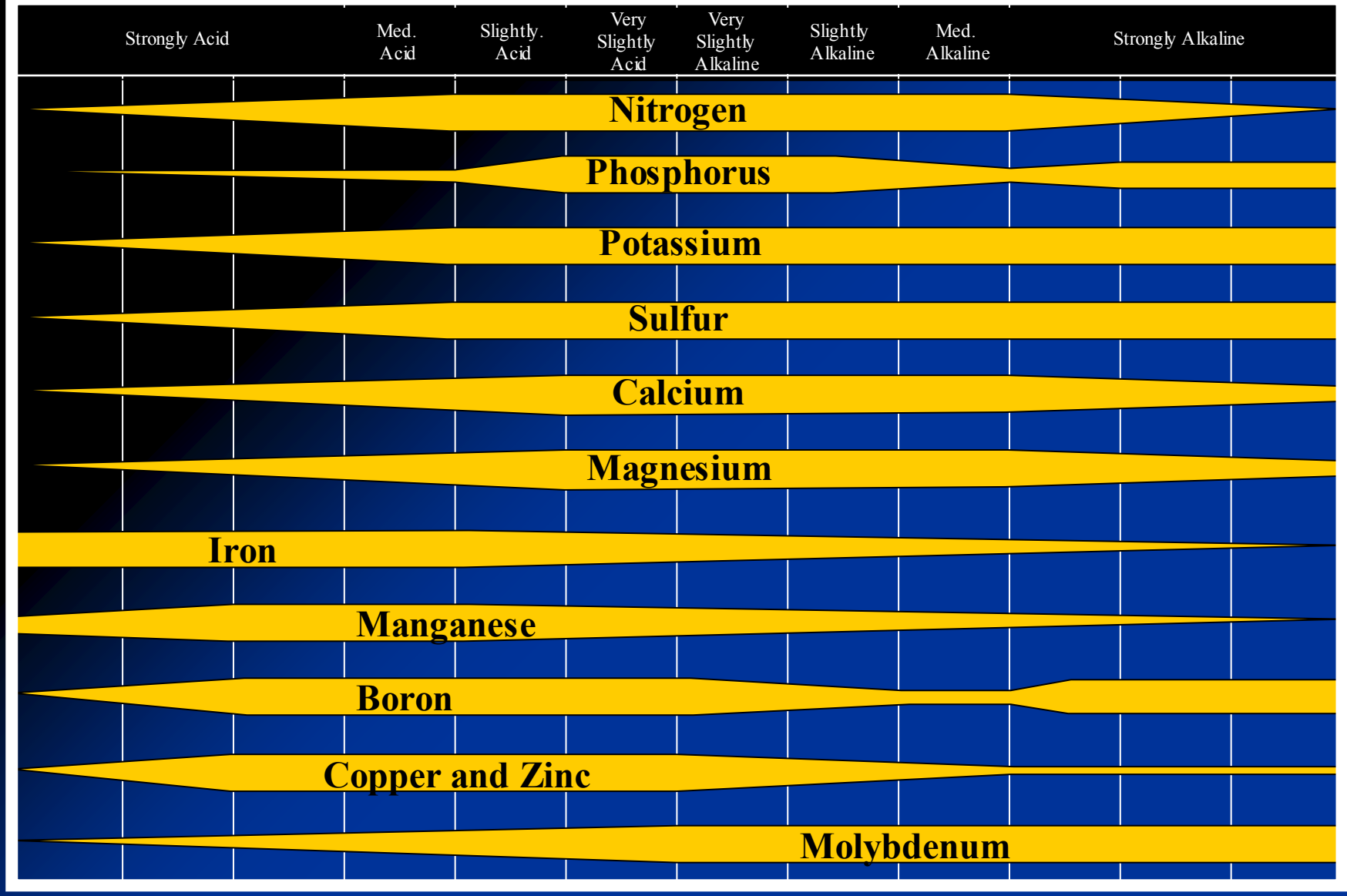
Favorable pH for Field Crops

Crop	Desired pH
Buckwheat	6.2
Clover	6.2
Corn	6.2
Grasses and pasture	6.2
Rye	6.2
Millet	6.2
Oats	6.2
Sorghum, sudangrass and sorghum sudan hybrids	6.2
Triticale peas	6.5
Birdsfoot trefoil	6.5
Wheat	6.5
Barley	6.5
Alfalfa	7.0
Soybeans	7.0

Benefits of Liming to Desirable pH

- Prevents the toxic effects of aluminum
- Increases availability of essential nutrients
- Supplies plant needs for Ca or Mg
- Improves soil conditions for microorganisms
- Increases effectiveness of some herbicides
- Improves soil structure

pH and nutrient availability



N Fixation by Alfalfa

Crop	N fixation (lbs/acre/yr)
Alfalfa	130-220
Clover	90-130
Vetch	45-130
Bean	25- 45
Soybean	45-130

N Fixation by Alfalfa

Factors that reduce N fixation:

- High soil ammonium or nitrate levels
- Low pH
- Poor general soil fertility status (P, S, Mo, Fe)
- Poor physical soil condition

Causes of Soil Acidity

- Leaching of basic cations (humid regions)
  - Ca^{2+}, Mg^{2+}, K^{+} leaving behind Al^{3+}
- Crop uptake of basic cations, release of acids
- Decay of plant residues
- Acid rain
- Reaction of nitrogen fertilizer

Acid Formation by N Fertilizer

$$2NH_4^+ + 4O_2 \rightarrow 2NO_3^- + 4H^+ + H_2O$$

(ammonium) (oxygen) (nitrate) (acid) (water)

Ammonium containing materials are acid forming

Acid Forming Reaction of N Fertilizer

lbs of $CaCO_3$ needed to neutralize 1 lb of N

Fertilizer Material	lbs
Ammonium Nitrate	3
Urea	3
UAN	3
Anhydrous Ammonia	3
Ammonium Sulfate	6
Manure*	3*

* Effects vary with type of manure

Lime Requirements

- pH is a measure of active acidity
  - Tells you whether you need lime or not
- Exchangeable acidity is a measure of pH buffer capacity
  - Tells you how much lime you need

Lime Requirements

To determine lime requirements we need:

- Initial pH – Soil Test
- Target pH
  - For pH 7.0
    - Alfalfa, Soybeans
  - For pH 6.5
    - Barley, Wheat, Trefoil, Peas
  - For pH 6.2
    - Corn, Oats, Grasses, Clover
- Exchange Acidity or Buffer pH - Soil Test

Sampling for pH

- **Conventional tillage:**
  - Regular soil depth: 6-8 inches
- **Pastures:**
  - 0-6 inches depth
  - Apply when soils are dry to avoid rutting and reduce the risk of compaction.
- **No-till or minimum till:**
  - Two samples: 0-1 inch (surface) and 0-6 inches
    - If surface pH is too low but pH of the 0-6-inch core is ok:
      - Add 1 to 1 ½ tons of lime/acre to raise the surface layer pH.
    - If surface pH is ok but the pH of the 0-6-inch core is too low:
      - Legumes might be no-till seeded with a slightly lower overall pH but lime should be added.
    - If both samples are too low:
      - Do not use no-till methods for the establishment of legumes

Soil pH Test Kit

Aglime Materials

- A product whose calcium and magnesium compounds neutralize acidity
  - CaO - Calcium oxide
    (Lime, Burned lime, Quick lime)
  - $Ca(OH)_2$ - Calcium hydroxide
    (Hydrated lime, slaked lime)
  - $CaCO_3$ - Calcium carbonate
    (Calcitic limestone)
  - $CaCO_3$, $MgCO_3$ - Calcium and magnesium carbonates
    (Dolomitic limestone)

Aglime – Reactions in Soil

Acid Soil

H^+

Al^{3+}

+ $CaCO_3$ (Calcium Carbonate)

Exchange **Step 1**

Neutral Soil

Ca^{2+}

Ca^{2+}

+ H^+ + Al^{3+} + CO_3^{2-}

Neutralization **Step 2**

$Al(OH)_3 + CO_2 + H_2O$

Neutral Compounds

Aglime Quality

- Neutralizing ability
  - Calcium Carbonate Equivalent (CCE)
    - The neutralizing ability of a liming material compared to pure calcium carbonate

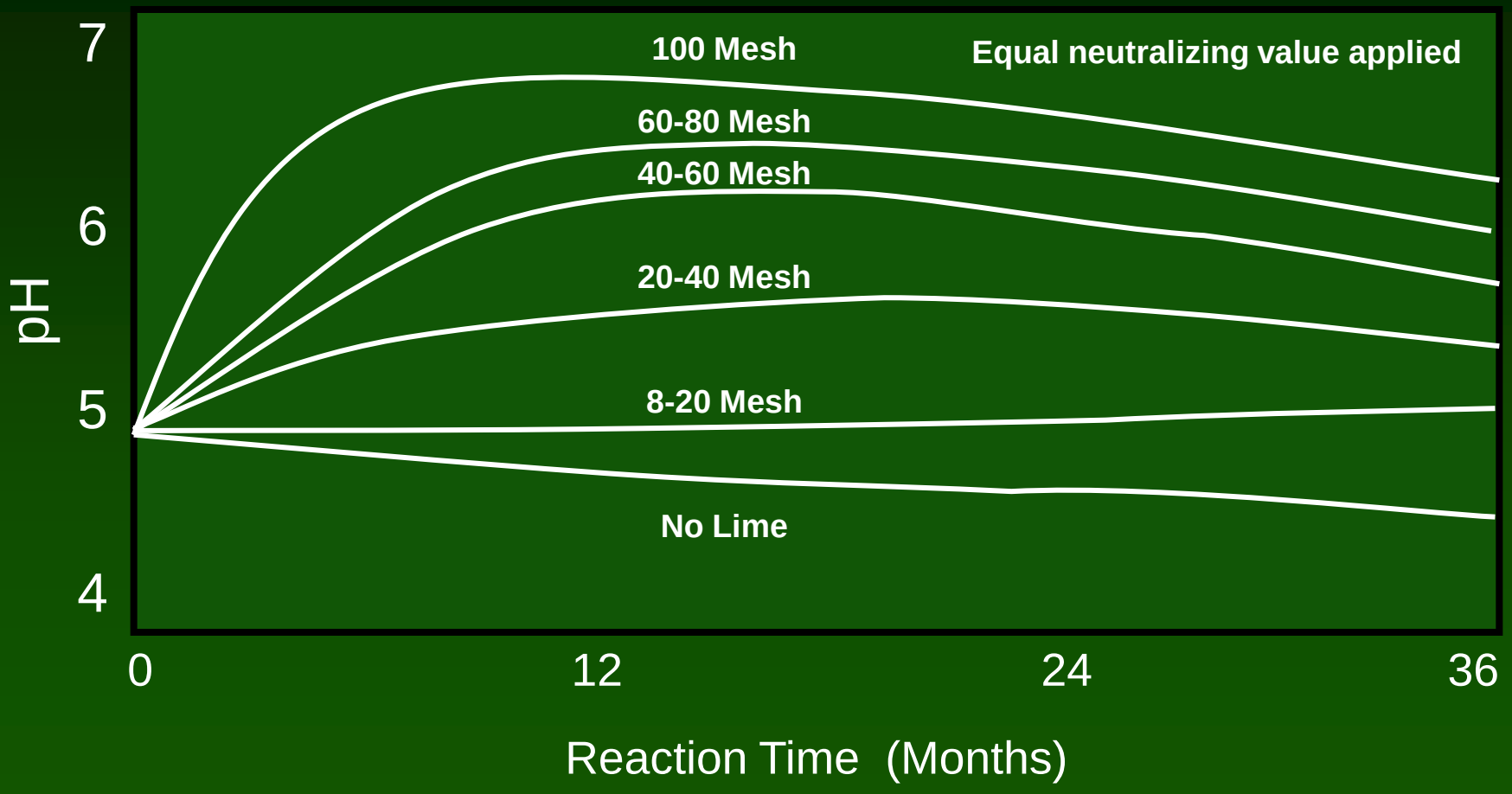
Aglime Quality - CCE

	Calcium Carbonate Equivalent
• $CaCO_3$	100
• $MgCO_3$	119
• CaO	179
• $Ca(OH)_2$	136
• $(Ca,Mg)CO_3$	109
• $CaSiO_3$	86

Aglime Quality - Fineness

- Fineness
  - Measured in mesh sizes (number of wires per square inch)
  - Determines speed of reaction
  - Does not alter the Calcium Carbonate Equivalent of a liming material

Aglime Quality - Fineness



Aglime Quality - ENV

- ENV = Effective Neutralizing Value
- ENV = CCE * Fineness factor
- Must be listed on bag and/or delivery slip

Cornell recommendations are for 100% ENV so

$$\text{Actual lime required} = \frac{\text{Recommendation}}{\text{ENV of limestone}} * 100$$

Tillage Depth Adjustments

Options:	Tillage depth for equation	Lime requirement adjustment
1-7 inches	6	*1.00
7-9 inches	8	*1.33
9+ inches	10	*1.67

Lime Guidelines - General

- When the lime requirements are greater that 3.0 tons/acre, split the applications by plowing down one-half of the lime and working the remainder into the surface.
- Generally, not more than about 6 tons of lime are recommended to apply with a 4 to 5 year period rotation.
- If more than 6 tons are required, apply 6 tons in a split application in the current rotation and test your soil again in 3 years.

Calcium and Magnesium Tips

- Maintain optimum pH
- Maintain at least minimum sufficiency levels of Mg and K
- Don’t worry about ratios unless they are far out of balance
  - Ca:Mg <1
    - Ca Deficiency, soil physical problems
  - Mg:K<1
    - Animal health

pH and Lime Management

- Lime Guidelines for Field Crops in New York
- Agronomy Fact Sheet # 5: Soil pH for Field Crops
- Agronomy Fact Sheet # 6: Lime Recommendations
- Agronomy Fact Sheet # 7: Liming Materials
- Agronomy Fact Sheet # 48: Buffer pH to Derive Lime Guidelines
- Agronomy Fact Sheet # 54: Timing of Lime Applications for Field Crops

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News RSS

- 12/17/10: New Student Intern Impact Story: Joseph Foster.
- 12/03/10: New value of manure calculator and tutorials added to the: Nutrient Management Curriculum.
- 11/17/10: New whole farm mass nutrient balance software: MNB_1.0.
- 10/28/10: Latest Additions to the Agronomy Fact Sheets Series: #55: Tissue Testing for Corn, Alfalfa and Soybeans, and #56: Winter Triticale Forage.
- 10/2/10: New Story: Manure Expo Highlights (Manure Manager Magazine).
- 9/21/10: Webcast: Novel Approaches to Manure Application in No-Till (Livestock and Poultry Environmental Learning Center).
- 5/16/10: New York Corn Systems Cover Crop Survey: For Farmers with Experience *with* Cover Crops or For Farmers *without* Experience with Cover Crops (Print, Complete and Mail).

Featured Links

- Cornell Nutrient Guidelines for Field Crops
- Agronomy Factsheets
- Impact Statements
- Nutrient Management Tutorials
- Nitrogen Management on Dairy Farms

Events

2011 Northeast Region CCA Conference
November 29-December 1, 2011. Register by November 5 for an early registration discount.

Photo Gallery

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