Importance of Aglime in Agriculture

Proper use of aglime is one of the most important management inputs in successful crop production. Excess soil acidity is a primary constraint to high, profitable yields and long-term soil productivity. Consider some of the benefits of a sound liming program.

- Aglime improves soil physical, chemical and biological properties
- Aglime improves symbiotic nitrogen (N) fixation by legumes
- Aglime influences the availability of plant nutrients
- Aglime reduces toxicities
- Aglime improves the effectiveness of certain herbicides
- Aglime supplies calcium (Ca), magnesium (Mg) and other minerals

Soil Physical, Chemical and Biological Properties

Beneficial soil organisms tend to be more active as soil pH increases to near neutral (pH 7.0). Crop residue decomposition is enhanced with pH levels in the recommended range for good crop production. This is an important factor for improving soil structure, soil aggregate formation, and organic matter levels. Aglime increases cation exchange capacity (CEC), thereby reducing leaching losses of nutrients such as potassium (K), Ca and Mg. It helps maintain a reservoir of soil N. It improves water retention and the efficiency of available moisture.

Symbiotic Nitrogen Fixation by Legumes

Aglime greatly improves symbiotic N fixation in legume crops grown on acid soils. The reasons are due to one or more of the following factors:

- Survival rate of symbiotic bacteria is increased. Activity rate of symbiotic bacteria is increased.
- General condition of the host legume is improved which increases the effectiveness of the bacteria after root infection.
- Increased symbiotic bacteria populations in the soil favor early and effective nodulation since infection depends upon chance encounters between root and microbe.

Availability of Plant Nutrients

Aglime improves both positional and chemical availability of essential plant nutrients. It improves soil aggregation and tilth, resulting in greater root proliferation. When soil pH is optimum, plants develop more finely divided and extensive root systems and are better able to utilize nutrients present in both surface and subsoils.

The chemical availability of several essential nutrients such as phosphorus (P) and sulfur (S) is improved by aglime use. Insoluble soil complexes of P and S are changed to more plant-available forms with aglime applications. Changes in soil pH affect the availability of the various plant nutrients differently, as illustrated in **Figure 1** on the next page. The availability of most nutrients is greatest in the soil pH range of 5.8 to 7.0.

The solubility of zinc (Zn), copper (Cu) and boron (B) increases as soils become more acid. Molybdenum (Mo) availability, unlike the other micronutrients, increases as soil pH increases. Proper management of soil pH for the crop being grown is an effective way to assure maximum availability of micronutrients, yet avoid their toxicities.

Depending on the source used, aglime can supply both Ca and Mg to help meet plant nutrient requirements. Although Ca deficiencies seldom occur in the field, Mg deficiencies are more common, particularly on acid soils. In such cases, dolomitic aglime is ideal to correct the acidity and supply Mg as a plant nutrient.


Soybean plant development suffered in the field area shown at left with acid soil condition. Manganese toxicity also affected the plants. With adequate pH, soybean plants in another area of the field (at right) showed normal growth and canopy closure. Aglime improves symbiotic N fixation in legume crops on acid soils.

Effect of Change in pH on the Availability of Plant Nutrients

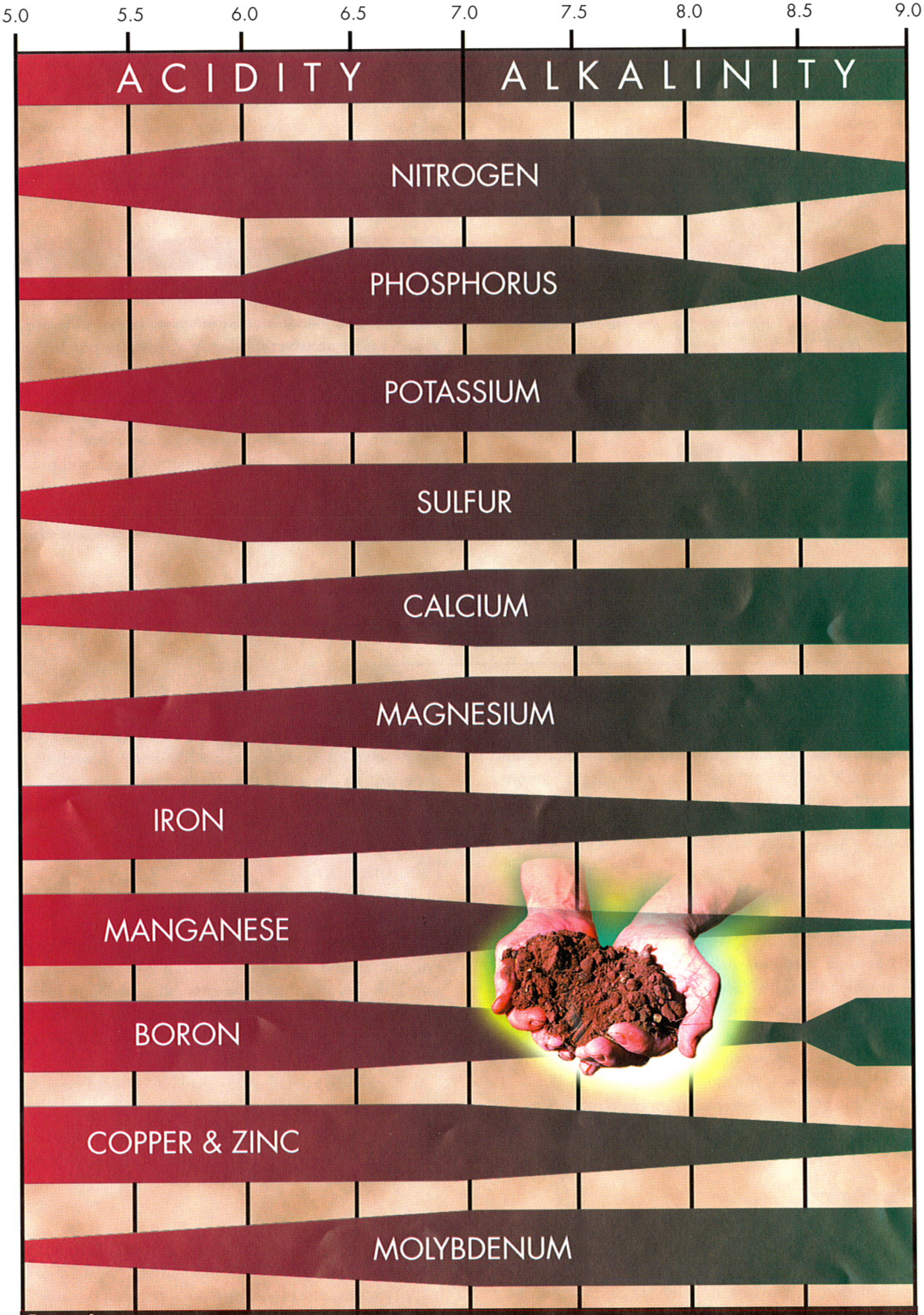


Figure 1

Aglime Quality And Types

Aglime is applied to neutralize soil acidity, raise soil pH and supply Ca and Mg. To bring about the expected benefits, aglime must react with the soil to neutralize soil acidity. Properties of aglime which affect its reaction with soil are chemical composition and physical properties. Chemical composition and purity determine how much acid can be neutralized by a given amount of aglime. The fineness of grind determines how rapidly the aglime will react with and neutralize acidity. Increased fineness of grind produces many more particles of aglime to react with soil particles.

How Aglime Quality Is Measured

Purity or Neutralizing Value

The purity of aglime is defined by its neutralizing value. Neutralizing value is given as a percentage of CCE when pure $CaCO_3$ is set at 100 percent (see previous section). It expresses the maximum percentage of the aglime that will become available for soil reaction. The speed of and degree of reaction are determined by fineness of grind and placement in the soil. The neutralizing value is determined by adding a known amount of aglime to a known amount of acid, and then allowing the neutralization to go to completion. The higher the CCE rating of the aglime, the greater the liming effectiveness. Some aglimes, such as dolomitic limestone, can have a rating higher than 100 percent.

Aglime materials contain impurities usually consisting of clay, sand, and organic matter. These impurities reduce the CCE value of the aglime. Various state aglime laws and regulations require minimum neutralizing values for an aglime material. Minimum percentage values vary among states and materials being sold.

Table 2 gives the CCE for some common aglime materials. **Table 3** shows how tonnage values vary with the different ratings.

Particle Size or Fineness

Aglime is not very soluble in water, so it must be finely ground to effectively neutralize soil acidity. The finer the particle size, the faster the acid neutralizing rate. Finer sized particles have more surface area with which the acidity can react. Aglime of good quality should dissolve and react with the soil acidity in one to four years, but with some reduction in acidity taking place immediately after application and incorporation.

The fineness of grind of aglime is determined by sieving it through a series of screens. The higher the mesh number of the screen, the smaller the openings. To be of significant value, aglime particles must be ground finer than 10-mesh size. Particles retained on an 8-mesh screen dissolve so slowly that they have little neutralizing value. Particles passing an 8-mesh, but retained on a 60-mesh screen, are rated 50 percent effective. Particles passing a 60-mesh are rated 100 percent effective. Increasing fineness beyond 50-mesh screen gives little improvement in aglime performance, as shown in **Table 4**.

Moisture Content

Moisture content is important because water replaces an equivalent weight of potentially reactive aglime. The more water in aglime material, the lower the content of reactive materials per ton of product. For example, if an aglime material had a CCE of 90 percent and a moisture content of 20 percent, then the CCE would be 72 percent [90-0.2 (90) = 72].

Table 2

Acid neutralizing values for aglime materials.

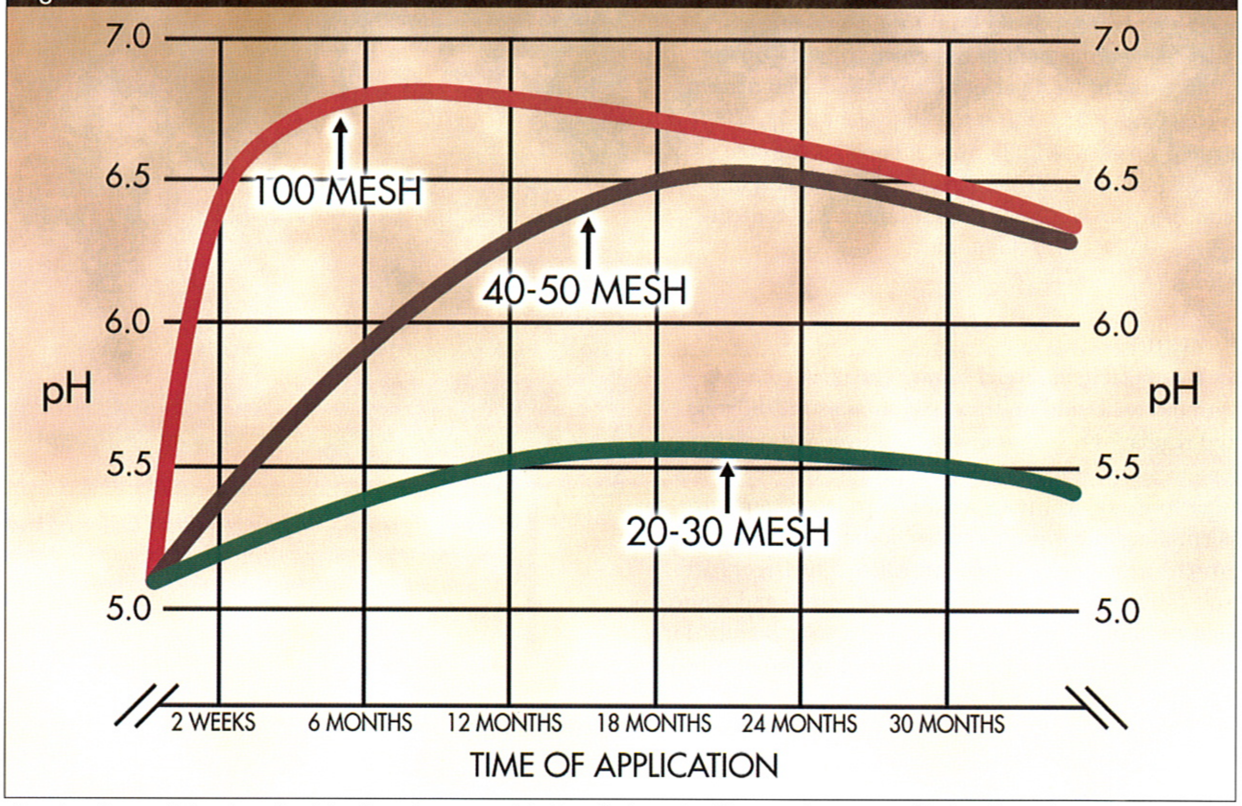
Aglime material	Calcium carbonate equivalent, %
Calcium carbonate	100
Calcitic limestone	85 to 100
Dolomitic limestone	95 to 108
Marl (Selma chalk)	50 to 90
Calcium hydroxide (slaked lime)	120 to 135
Calcium oxide (burnt or quick lime)	150 to 175
Calcium silicate	86
Basic slag	50 to 70
Ground oyster shells	90 to 100
Cement kiln dusts	40 to 100
Wood ashes	40 to 50
Power plant ashes	25 to 50
Gypsum (land plaster)	none
By-products	Variable

Table 3

Amounts of aglime materials at different $CaCO_3$ equivalences required to equal one ton of 100 percent $CaCO_3$.

$CaCO_3$ equivalent of liming material, %	Pounds needed to equal one ton of pure $CaCO_3$
60	3,333
70	2,857
80	2,500
85	2,353
90	2,222
95	2,105
100	2,000
105	1,905
110	1,818
120	1,667

Figure 2



Reaction time and duration of activity depend upon particle size of aglime. Smaller particles react quickly, but do not last as long as larger particles. A mixture of fine and larger particles is optimum to give a rapid and sustained reaction.

Effective Calcium Carbonate Equivalent or Relative Neutralizing Value

If CCE and particle size relative effectiveness of an aglime material are known, then an 'Effective CCE' (ECCE) can be calculated. Various other terms are used as equivalent to ECCE. See **Effective Calcium Carbonate Equivalent (ECCE)** in the glossary. Particle sizes are divided into effectiveness ratings based on sieve analysis: 1) smaller than 50-mesh, 2) between 10 and 50-mesh, 3) larger than 10-mesh. Using these size groups, a reliable fineness factor (percent of aglime available based on fineness) can be determined. The formula is:

$$\text{ECCE} = \%\ \text{CCE} \times 1/2 \left(\begin{matrix}\%\ \text{passing} \\ \text{10-mesh}\end{matrix} + \begin{matrix}\%\ \text{passing} \\ \text{50-mesh}\end{matrix} \right)$$

An example calculation would be:

% CCE	**90**
Sieve analysis	
% on 10-mesh	**2**
% passing 10-mesh	**98**
% passing 50-mesh	**60**

ECCE = CCE x 1/2
(% passing 10-mesh + % passing 50-mesh) =
0.9 [1/2 (98+60)] = 0.9 (79) = 71.1

This indicates that 71 percent of the aglime would be effective immediately as compared to a pure calcium carbonate, ground to minus 50-mesh.

Table 4

The effect of fineness on availability of aglime.

Mesh size	Years after application: 1	4
	— PERCENT REACTED —	
coarser than 8	5	15
8 to 20	20	45
20 to 50	50	100
50 to 100	100	100

Choosing an Aglime Source

Availability is an important consideration in selecting an aglime source. Since dolomitic lime contains Mg, if Mg is deficient in the soil, it is a source of choice. The two major aglime sources are calcitic limestone and dolomitic.

Calcitic

Calcitic aglime is produced by mining and grinding $CaCO_3$ rock. When pure, it contains 40 percent Ca or 100 percent $CaCO_3$. It serves as the standard of comparison for neutralizing values of other aglime materials.