United States Department of Agriculture

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

AMENDING SOIL PROPERTIES WITH LIME

CODE 805

(ac)

DEFINITION

Adjust the soil pH with lime to change physical and chemical properties of the soil to achieve a conservation objective.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Improve plant productivity and health
- Improve plant structure and composition
- Improve habitat for soil organisms
- Improve water quality by increasing plant availability of applied nutrients
- Improve aggregate stability

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to cropland, pasture, and associated agricultural lands where the soil pH is below the desired range and lime can be applied to increase the soil pH to achieve a conservation benefit.

CRITERIA

General Criteria Applicable to All Purposes

The soil pH is a measure of the negative logarithm of the H+ ion activity ($pH = -\log[H^+]$). Therefore, a pH of 6 is 10 times the acidity of the pH of 7, and a pH of 5 would be 100 times more acidic than a pH of 7. The following formula describes the reaction that takes place when lime is added to an acidic soil:

$$CaCO_3 + H_2O \longleftrightarrow Ca^{2+} + HCO_3^- + OH$$

Safety precautions should be taken to prevent eye and lung exposure to lime dust.

Right Material:

The liming product must have an analysis to provide its Effective Calcium Carbonate Equivalent (ECCE). The ECCE is determined by the Calcium Carbonate Equivalent (CCE) and its fineness of grind. The CCE of several common liming materials are found in Table 1. As liming materials are ground finer, surface area of the liming material increases which will result in quicker reactions in the soil. Table 2 illustrates the common Fineness Factor Effectiveness (FFE) for different screen sized materials. Additionally, the liming product must be supported by the local Land Grant University.

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Table 1: Typical Calcium Carbonate Equivalent (CCE) ranges of common liming materials

Common Liming Materials	**CCE Range***
Calcitic Lime - CaCO3	75-100
Dolomitic Lime - CaMg(CO3)2	75-109
Hydrated Lime - Ca(OH)2	120-136
Burned Lime - CaO	179
Pel-Lime	90-95
Other Local Products	

*Range is due to variations in the purity of the base material.

Table 2: Common Fineness Factor Effectiveness for different sized liming material

Screen Mesh Size	**Fineness Factor Effectiveness**
8 (Coarse material)	0%
<60	50%
>60 (Very fine material)	100%

Calculating Calcium Carbonate Equivalent and Effective Calcium Carbonate Equivalent:

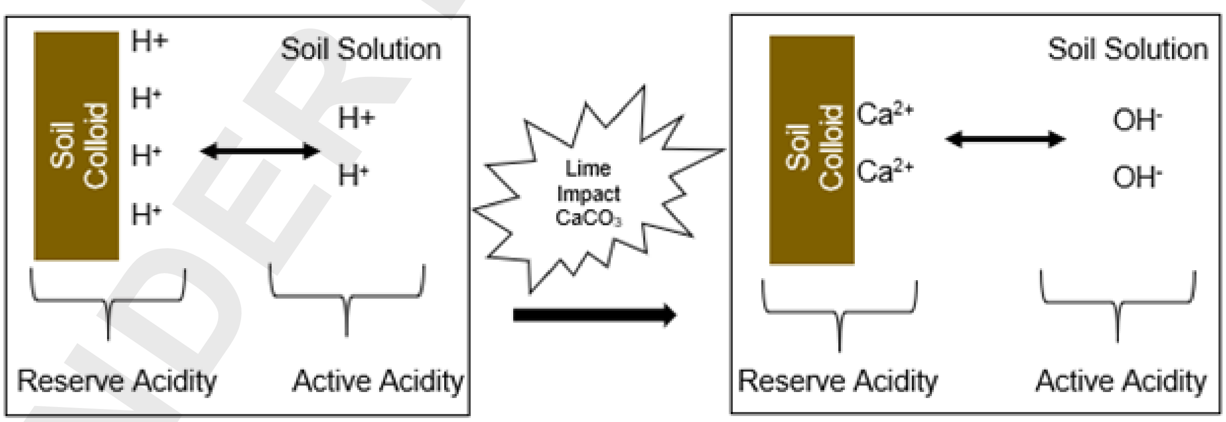
ECC = CCE x % Fineness Factor

ECCE (CCE/ton) = (CCE/100) x 2000 lbs

Right Rate:

Lime application rates must be sufficient to address the active acidity in the soil solution and the soil's pH buffer capacity or reserve acidity. Buffer capacity refers to the soil's ability to resist change in pH. Finer textures soils have significantly higher buffer capacity than coarser soils. The below schematic illustrates active and reserve acidity:

Figure 1. Impact of lime on active and reserve acidity



Lime application rates must be based soil test analysis for the planned cropping/tillage system and follow local Land Grant University (LGU) recommendations. Use soil tests no older than 3 years. Collect, prepare, store, and ship all soil samples following LGU guidance.

Soil test results must provide a recommendation for how much lime in CCE material is needed/ac to adjust the soil pH to the optimum range for the planned cropping system.

Application rates of lime will be based on the most pH sensitive crop in the planned crop rotation.

Right Placement

When soil incorporation or injection is feasible, and will not result in excessive soil erosion, lime should be incorporated or injected into the soil to increase its interaction with soil particles.

When lime is not incorporated into the soil it will react quickly with the soil at the surface but will move very slowly through the soil profile and will have little effect past the first one to two inches of soil.

For sites where the land is in no-till management or pasture, surface applications of lime will still provide significant benefit, as the Nitrification of NH4 + near the soil surface is a major cause of soil acidification.

To improve the efficacy of unincorporated lime applications, use lime materials with a highest fineness of grind and ECCE available.

Right Timing

Applications of lime should be made as early as possible in the cropping system to allow for soil reactions to occur and increase the pH to the desired range.

Soil conditions should be sufficiently dry to prevent rutting and soil compaction during lime applications.

Risk Assessment

If soil disturbance will occur due to incorporation of lime, then analyze soil erosion with current erosion tools.

To optimize the placement of lime, applications of liming material should not take place on windy days.

Consult with LGU about potential nutrient releases from soils with high levels of soil test phosphorous following pH adjustments.

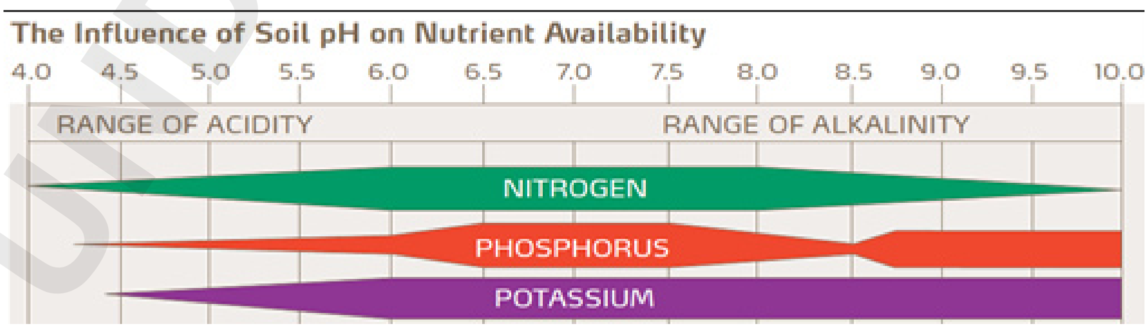
<u>Additional Criteria to improve habitat for soil organisms.</u>

Management of pH is a fundamental to all key soil health principles. Lime recommendations greater than 3000 lbs of CCE will be split applied.

<u>Additional Criteria to improve surface water quality by increasing plant availability of applied nutrients.</u>

Ensure the planned soil pH will result in the optimum range for essential nutrients. Applications are based on LGU recommendations for the most sensitive crop in the rotation.

Figure 2. Availability of Nitrogen, Phosphorus, and Potassium in soil as influenced by soil pH.



CONSIDERATIONS

On tilled crop fields with high lime requirements, consider split applying lime over a two-year period.

Consider the type of lime applied and nutrient deficiencies. For example, when soil Magnesium is low consider using dolomitic lime to help supply Magnesium.

If products such as biochar, fly ash, or other amendments are added to the soil after soil testing, they should be tested to determine their impact on soil pH.

To improve the effective placement of lime consider taking grid soil samples and apply using precision application technology.

To further improve soil health consider utilizing the following soil health principles.

- Minimize soil disturbance
- Maximize soil cover
- Maximize biodiversity
- Maximize presence of living roots

An evaluation of pesticide usage and impact of pH on pesticides should be a consideration as soil pH can affect the efficacy and degradation of pesticides.

Follow the Nutrient Management (590) CPS when applying plant nutrients.

PLANS AND SPECIFICATIONS

- Aerial site photograph(s), imagery, topography, or site map(s).
- Soil survey map of the site.
- Soil information including: soil type, surface texture, drainage class, permeability, available water capacity, depth to water table, restrictive features, and flooding and ponding frequency.
- Location of nearby residences, or other locations where humans may be present on a regular basis, that may be impacted by lime dust.
- Current and planned plant production sequence or crop rotation.
- Current soil test results with Lime Recommendations
- Lime test showing Effective Calcium Carbon Equivalent ECCE
- Listing, quantificaiton, application method, and timing of lime that are planned for use
- Guidance for implementation, operation and maintenance, and recordkeeping

OPERATION AND MAINTENANCE

Monitor field pH with additional soil sampling to determine when additional lime may be needed.

Calibrate application equipment to ensure accurate distribution of material at planned rates.

Maintain application records to document plan implementation and maintenance.

REFERENCES

K-State Research and Extension. 2015. Kansas State University Soil Testing Lab: Agricultural lime testing procedure. Manhattan, KS. agriculture-lime-testing-procedure—-july-1-2015.pdf (ks.gov)

Leikam, D.F., R.E. Lamond, and D.B. Mengel. 2003. Soil test and interpretations and fertilizer recommendations. K-State Research and Extension. Manhattan, KS. MF-2586.

USDA-NRCS National Agronomy Manual 4th ed., Feb 2011

Whitney, D.A. and R.E. Lamond. 1993. Liming acid soils. K-State Research and Extension. Manhattan, KS. MF-1065.