

Liming New Jersey Soils for Field and Forage Crops

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Introduction

The majority of soils and crops in New Jersey require a regular liming program to neutralize soil acidity and to supply crops with Calcium (Ca) and Magnesium (Mg). The first step in a liming program is knowing the optimum or target pH value of the crop to be grown. Many crops will grow over a wide range of soil pH but most field and forage crops perform best when soils are limed to pH 6.0 to 6.5. Alfalfa, being an exception, has a desired pH of 6.8 to 7.0. The target pH values for major New Jersey field and forage crops are listed in Table 1.

Soil pH alone cannot be used to determine the amount of liming material to apply to correct soil acidity. The second step in a liming program, therefore, is to have a soil fertility test performed. The soil test results provide the data needed to determine the lime requirement and the type of lime to use.

Lime Requirement

A soil's lime requirement depends on the total acidity that must be neutralized to raise pH to the desired level (target pH). It is important to understand that a soil pH measurement only indicates the concentration of active acidity in soil solution. Total acidity represents the active acidity in solution plus the amount of exchangeable acid cations held on clay and organic matter. For the purpose of lime recommendations, total acidity is estimated from soil texture plus soil pH or it is measured directly by titration (where it is referred to as buffer pH). Buffer pH measurements that appear on soil test reports from some laboratories are

Table 1. Target soil pH values for field and forage crop production.

Crop	Target pH	Lime When pH Falls Below
Field Crops		
Barley	6.5	6.2
Corn	6.5	6.0
Corn in Alfalfa Rotation	6.8	6.5
Oats	6.5	6.0
Rye	6.2	6.0
Sorghum	6.5	6.0
Soybean, Coastal Plain	6.2	6.0
Soybean, Piedmont & Mountain	6.5	6.0
Sunflower	6.5	6.0
Wheat, Coastal Plain	6.2	6.0
Wheat, Piedmont & Mountain	6.5	6.0
Forages		
Alfalfa	7.0	6.5
Corn Silage	6.5	6.2
Grasses	6.5	6.0
Bluegrass	6.5	6.0
Orchardgrass	6.5	6.0
Perennial Ryegrass	6.5	6.0
Reed Canarygrass	6.5	6.0
Smooth Broomegrass	6.5	6.0
Tall Fescue	6.5	6.0
Timothy	6.5	6.0
Grass/Alfalfa Mix	6.8	6.5
Clovers		
Alsike	6.5	6.0
Birdsfoot Trefoil	6.5	6.0
Crimson	6.5	6.0
Ladino	6.5	6.0
Lespedeza	6.5	6.0
Red Clover	6.5	6.0
White Clover	6.5	6.0
Sorghum/Millet Grass	6.5	6.0
White Clover/Bluegrass Mix	6.5	6.0



a measurement used to determine lime requirement and should not be confused with soil pH. The interpretation of buffer pH is specific to the buffer method employed by the laboratory and the properties of the soils in the region.

Rutgers Cooperative Extension determines lime requirement by measuring soil pH and soil texture, the latter of which is estimated by rubbing moist soil between the thumb and index finger. Soils are classified into one of four broad categories of soil texture: loamy sands, loams, sandy loams, or silt loams. Knowing the soil series helps to provide an estimate of soil texture.

Soil texture may be considered a fixed property of a soil because it is not readily changed. Thus, once soil texture is known and soil pH is measured, a soil's lime requirement can be determined by referring to the appropriate table for the crop.

Once growers know the soil texture, they may find portable pH meters to be helpful in the evaluation of their liming program (see fact sheet FS767, *Soil pH Measurement With a Portable Meter*). The lime requirement for a given soil also depends on the target soil pH. Alfalfa has a target pH of 7.0; the lime requirements for various initial soil pH levels and soil textures are shown in Table 2. For the majority of crops which have a target pH of 6.5, refer to Table 3. For lime requirements for soybean and wheat grown on sandy coastal plain soils, the target pH should not exceed 6.2 (Table 4). An excessively high pH increases the risk of developing a manganese deficiency in sensitive crops.

Crops with a desired pH of 6.5 can be grown with a lower pH (typically pH 5.6) on soils with higher organic matter content than on soils with low organic matter content.

Calcium Carbonate Equivalent

Soil test recommendations for liming New Jersey soils should be reported in pounds of calcium carbonate equivalent per acre (lb CCE/acre) rather than as the amount of total oxides as was the practice prior to 1996 (New Jersey Agricultural Liming Materials Act, Amended 1996). Pure calcium carbonate (CaCO₃) has a CCE of 100% and is the standard against which all

Table 2. Pounds of calcium carbonate equivalent (CCE) recommended per acre for alfalfa with a target pH of 6.8 to 7.0.

Initial Soil pH	Soil Texture			Silt Loam
	Loamy Sand	Sandy Loam	Loam	
4.1–4.4	5400	7200	11600	13400
4.5–4.8	4500	6300	9800	11600
4.9–5.2	3600	5400	8100	9800
5.3–5.6	2700	4500	6300	8100
5.7–6.0	1800	2700	4500	6300
6.1–6.4	900	1800	2700	4500
6.5–6.8	0	900	1800	2700
Above 6.8	0	0	0	0

Table 3. Pounds of calcium carbonate equivalent (CCE) recommended per acre for crops with a target pH of 6.5.

Initial Soil pH	Soil Texture			Silt Loam
	Loamy Sand	Sandy Loam	Loam	
4.1–4.4	4500	5400	9800	11600
4.5–4.8	3600	4500	8100	9800
4.9–5.2	2700	3600	6300	8100
5.3–5.6	1800	2700	4500	6300
5.7–6.0	900	1800	2700	4500
6.1–6.4	500	900	1800	3600
Above 6.5	0	0	0	0

Table 4. Pounds of calcium carbonate equivalent (CCE) recommended per acre for crops with a target pH of 6.2.

Initial Soil pH	Soil Texture			Silt Loam
	Loamy Sand	Sandy Loam	Loam	
4.1–4.4	4000	4500	8000	8900
4.5–4.8	3100	3600	6300	7100
4.9–5.2	2200	2700	4500	5400
5.3–5.6	1300	1800	2700	3600
5.7–6.0	500	900	1200	1800
Above 6.2	0	0	0	0

liming materials are measured. Since the CCE of liming materials available in the state may vary from 40 to 179%, the amount of liming material needed to supply a given quantity of CCE will vary considerably. By law, the CCE of a liming material must be stated on the product label.

To calculate the corresponding application rate of a given liming material:

$$\text{Actual amount of liming material} = \frac{(\text{Soil test CCE recommendation})}{(\% \text{ CCE of liming material})} \times 100$$

Example: Soil test recommendation is to apply 2000 lb CCE/acre

Liming material purchased has 80% CCE

Actual amount of liming material required:

$$(2000 \div 80) \times 100 = 2500 \text{ lb liming material/acre}$$

To avoid the calculation refer to Table 5 to convert soil test recommendations for pounds CCE/acre to pounds of the actual liming materials to be applied. Application rates may be rounded off to the nearest quantity (nearest 100 pounds/acre) practical for spreading equipment.

Although liming recommendations should now be given in pounds CCE/acre, recommendations that are given as total oxides can be converted to CCE by multiplying by 1.79. Suppose the recommendation calls for 2000 pounds/acre of total oxides. Then, to convert the recommendation to CCE:

$$2000 \times 1.79 = 3580 \text{ lb/acre CCE}$$

Table 5. Conversion for pounds of calcium carbonate equivalent to pounds of actual liming material applied.

Pounds/Acre CCE Recommended by Soil Test ¹	Percent Calcium Carbonate Equivalent (%CCE) of Liming Material							
	70	75	80	85	90	95	100	105
	Actual Limestone Recommendation (lb/acre) ^{2,3}							
1,000	1,400	1,300	1,200	1,200	1,100	1,100	1,000	1,000
2,000	2,900	2,700	2,500	2,400	2,300	2,100	2,000	1,900
3,000	4,300	4,000	3,700	3,500	3,300	3,200	3,000	2,900
4,000	5,700	5,300	5,000	4,700	4,400	4,200	4,000	3,800
5,000	7,100	6,700	6,200	5,900	5,600	5,300	5,000	4,800
6,000	8,600	8,000	7,500	7,100	6,700	6,300	6,000	5,700
7,000	10,000	9,300	8,700	8,200	7,800	7,400	7,000	6,700
8,000	11,400	10,700	10,000	9,400	8,900	8,400	8,000	7,600
9,000	12,000	12,000	11,200	10,600	10,000	9,500	9,000	8,600
10,000	14,300	13,300	12,500	11,800	11,000	10,500	10,000	9,500
11,000	15,700	14,700	13,700	12,900	12,200	11,600	11,000	10,500
12,000	17,100	16,000	15,000	14,100	13,300	12,600	12,000	11,400
13,000	18,600	17,300	16,200	15,300	14,400	13,200	13,000	12,400
14,000	20,000	18,700	17,500	16,500	15,600	14,700	14,000	13,300

¹ The soil test recommendation assumes that the liming material meets the minimum standard requirements for fine-sized liming materials.

² The amounts of CCE recommended in the table are for increasing the pH of an 8-inch soil layer to the desired pH value. Multiply the number in the table by 1.25 to adjust a 10-inch plow layer to the desired pH.

³ It is not advisable to apply more than the following pounds of CCE per acre as a topdressing: loamy sand 2,000; sandy loam 3,000; loam 4,000; and silt loam 5,000. When fields are to be plowed and the CCE recommendation exceeds 3,000 pounds per acre, plow under half the needed amount and apply the other half after plowing and then disk in as deeply as possible.

Selection of Liming Material

The qualities of agricultural liming materials are described in detail in fact sheet FS905. Selection of an appropriate liming material depends on the degree of pH correction and the need to replenish soil Ca and Mg.

There are three fineness categories of agricultural liming materials sold in New Jersey. Fine sized liming materials are recommended when rapid neutralization of soil acidity is desired. Medium and coarse sized liming materials are best suited for maintenance of soil pH once the desired soil pH range has been attained through the use of fine sized liming material.

Select the appropriate liming material based on its Ca and Mg concentrations and the relative need for these nutrients in soil. Compare the soil test Ca and Mg values on the soil test report. When the soil test Mg level is *below optimum*, it is important to choose a liming material that contains a significant concentration of Mg. If the soil test level is *below optimum—very low or low*, use a liming material that has a minimum concentration of 9% Mg. If the soil Mg level is *below optimum—medium*, use a liming material that has 3.6 to 9% Mg. If the soil Mg level is *optimum or above optimum*, use a liming material that has less than 3.6% Mg. In general, the need for a liming material containing Mg occurs more frequently on sandy soils.

Time of Application

Lime is slow to react in soil. The desired soil pH increase may require several months. Thus, it is important to plan ahead and apply lime several months in advance of planting.

Lime can be applied at any time of the year if weather and soil conditions permit. Plan ahead and apply lime well in advance of planting crops that are sensitive to soil acidity. Fall applications have the advantage of allowing the lime to react in the soil prior to the start of the next growing season.

Careful attention to liming prior to planting peren-

nial crops is very important. Once the crop is established it is difficult to correct a soil acidity problem using surface applications of lime. Lime should be applied at least six months to a year in advance of planting to insure that the target pH has been achieved.

Soils naturally become acidic over time. The frequency of lime application varies with soil characteristics, cropping system, and fertilizer practice. Heavy use of ammonium and urea nitrogen fertilizers speed soil acidification. Soil testing for pH measurement should be performed every one to three years. Relime soils before their pH levels drop below the desired range to avoid development of excess acidity in the root zone.

Lime Placement

Lime applications are most effective at neutralizing acidity when they are spread uniformly and thoroughly mixed with the soil by plowing, disking, and harrowing. When applying large amounts of lime it is best to use split applications. Apply half the lime and plow it under. Next apply the other half to the plowed surface and disk it into the soil.

Whenever tillage is not possible (e.g. perennial crops, pastures, no-tillage systems) surface applications are recommended but the rate of pH adjustment is much slower. Monitor soil pH change and the need for lime so as to avoid higher lime requirements. Surface lime application rates should not exceed 3000 pounds CCE per acre.

Special Considerations

Alfalfa and most forage legumes are quite sensitive to soil acidity. Because lime reacts slowly, it is important to apply the lime well in advance of seeding to achieve the target pH. Measure soil pH annually in alfalfa fields. Maintain the soil pH between 6.5 and 7.0 during the life of the stand using surface applications of lime. For field crops in rotation with alfalfa, maintain the soil pH above 6.5.

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