In Western Oregon . . .

Liming Pays!

Liming pays by increasing crop yields. And lime increases yields several ways—by reducing soil acidity, by adding calcium, and by increasing the ability of phosphorus to be used by plants. Lime also increases legume yields by increasing the amount of nitrogen fixed by soil bacteria.

Lime doesn't leach out as fast as was once thought, and must be finely ground to react with soil acids.

NO LIME

THREE TONS LIME PER ACRE

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Agricultural Experiment Station · Oregon State College · Corvallis

Lime Increases Clover, Grain Yields, Leaches Slowly, OSC Research Results Show

Liming western Oregon soils means spending some money to make money. Those who don't lime are probably neglecting their biggest soil fertility problem and missing a chance to increase profits, according to soil scientist Tom Jackson.

But why do western Oregon soils need lime? How much lime is needed? What does lime do when it is added to the soil? And how long will finely ground lime stay active in the soil?

Research results combined with established liming principles can answer these questions.

Lime is calcium carbonate

Winter rains percolating through the soil for thousands of years have carried away calcium and magnesium, leaving the soils acid. Lime is primarily calcium carbonate, but may contain magnesium carbonate. These carbonates react chemically with soil acids forming water and carbon dioxide. Soil acidity is reduced and soluble calcium or magnesium replace the acids.

Thus, liming does two things.

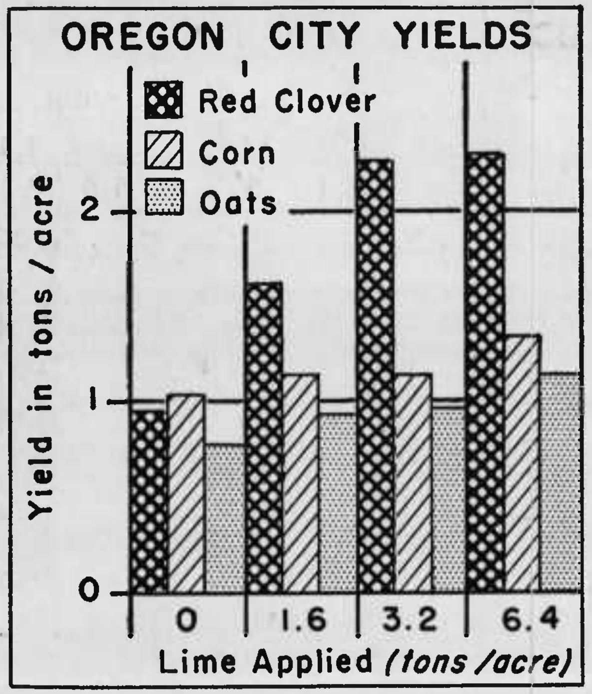
1. Adds calcium.
2. Partly neutralizes soil acids, and the pH (a measure of soil acidity) is increased.

The combined result of adding calcium and neutralizing a portion of the soil acids has many effects on the soil:

¶ Increases the number and activity of important soil microorganisms, especially soil bacteria.

¶ Increases the breakdown of soil organic matter, and releases nitrogen, phosphorus, sulfur, and other nutrients for plant use.

¶ Increases nitrogen fixed by certain types of bacteria that grow on legume roots. You should be able to get 200 to 300 pounds of available nitrogen per acre from well-limed, irrigated clover pastures that are adequate in phosphorus and potash.



LIME APPLIED over 14-year period. Applications made each time red clover planted. Corn, oats, followed in rotation.

OREGON CITY TRIALS

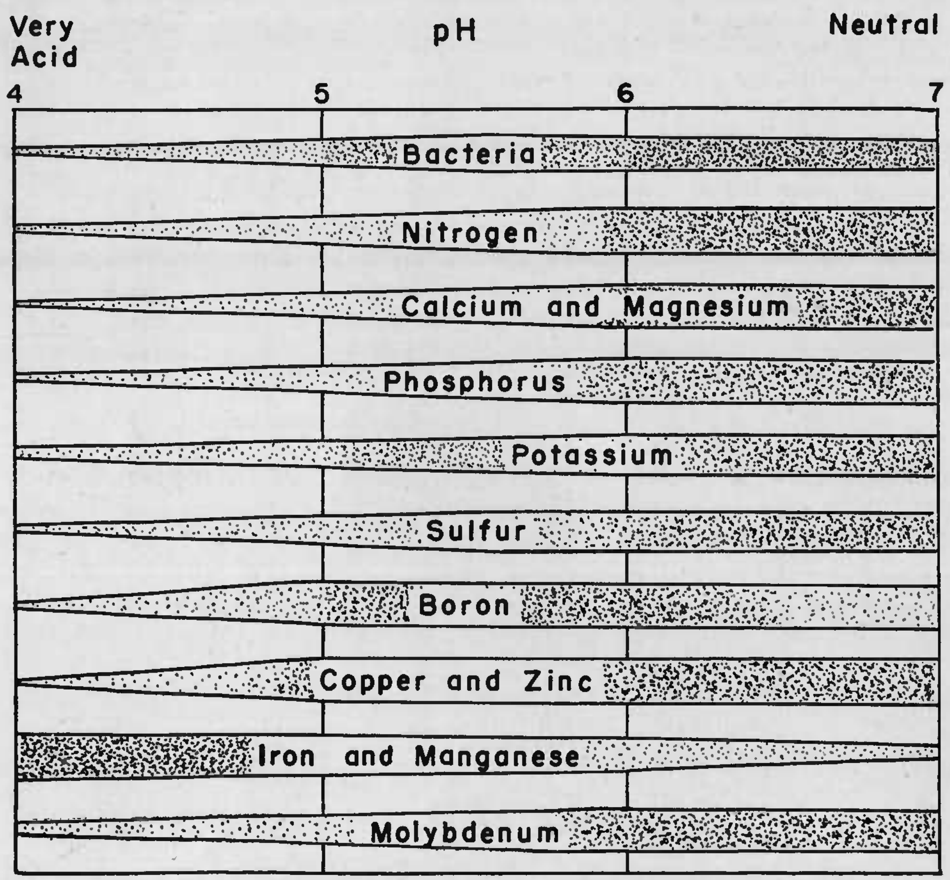
Soil Depth (Inches)	Lime Applied (tons/acre) 0	1.6	3.2	6.4
pH (0-5")	5.5	5.65	6.0	6.6
Calcium Recovered (as tons/acre of lime) 0-5"	1.43	.69	1.76	4.38
5-10"	1.43	.08	.69	1.52
10-20"	2.78	0	0	.33
20-30"	2.72	0	0	0
Total Recovered		.77	2.47	6.23

ASTORIA TRIALS

Soil Depth (Inches)	Lime Applied (tons/acre) 0	8	20
pH (0-5")	5.0	5.9	6.4
Calcium Recovered (as tons/acre of lime) 0-7"	.75	4.80	7.75
7-18"	.64	3.10	7.35
Total Recovered		7.90	15.10

LITTLE LIME leached in trials at Astoria and Oregon City. Figures in black area show the increase in calcium recovered in the soil, compared to unlimed plots, plus downward movement of calcium. Each ton of lime contains 800 pounds of calcium. Note that pH, calcium, increase with lime applications.

Soil pH Affects Availability of Plant Nutrients



¶ Decreases amount of soluble iron, aluminum, and manganese. These elements often are present in harmful amounts in highly acid soils.

¶ Increases the availability of inorganic phosphorus.

¶ Permits growing of a wider range of crops, especially legumes.

Lime alone, however, will not make your soil more productive if it does not have a good supply of other plant nutrients, such as nitrogen and phosphorus. You can't expect lime to benefit a crop when other essential nutrients aren't available.

Soil test shows lime needs

Your soil's lime needs can be figured from a soil test available through your County Extension Agent. The Oregon State College soil testing laboratory will measure the soil acidity and the amount of lime required to neutralize enough of these acids.

Results of 3,300 soil samples from the Willamette Valley the past 2 years show some lime is needed on most western Oregon soils. For example, about 80 per cent of these soils needed lime for best legume growth, and high soil acidity would have made it impractical to establish stands of legumes on 40 per cent of these soils. Coast county farmers were worse off. Out of 500 samples, about 90 per cent needed lime for good legume growth, and 60 per cent were too acid for growth of the most acid-tolerant legumes.

Lime—even finely ground, high quality material—stays in the usable root zone a long time. Coarse ground lime takes years to react with soil acids and become effective.

Lime remains in soil

But how much lime stays where it can be used? Research begun in 1918 at the Astor branch station and in 1941 at the Red Hills experimental area near Oregon City shows much of it was still present in the top 20 inches of soil when tested last year. (See graphs.)

At Astoria, 2 tons of lime were applied to test plots every 4 years since 1918. A second test began in 1938 with the same rate of lime applied. In 1954, then, 20 tons of lime per acre had been applied to the 1918 plot, 8 tons to the 1938 plot. Every winter about 6½ feet—77 inches—of rain falls at the Astoria branch station and much of it leaches through the ground.

All but 5 tons was still there in the 1918 plots; only 200 pounds were missing from the 1938 plots. Missing lime leached out or was crop-used.

Plots located near Oregon City show similar results. Here lime was applied in 1941, 1947, 1950, and 1953, totaling 1, 2, 4, and 8 tons per acre. Thus, researchers could measure the leaching effect on each rate, plus finding the effects of this application on crop yield.

Again, little had leached. Most of that not in the soil was used by the crop.

Lime affects yields

Another chart shows the effect of lime on yields. No other fertilizers were added—but phosphorus and sulfur probably would have upped yields. Corn and oat yields following clover were more where the soil had been limed, compared to grain yields that followed clover that had not been limed. Lime increased the legume's ability to fix nitrogen and left a larger supply for the grain. Also, availability of other nutrients increased.

The experiment shows another important fact, says Jackson: light lime applications every 3 or 4 years do little good. Enough lime must be added to neutralize enough soil acids to cause a real change in soil acidity.

Thus, farmers face two jobs in a liming program. First, put on enough lime to do some good; second, add enough lime regularly to hold down accumulating soil acids. A soil test will tell how much lime you need for the first application. Further tests every 5 years or so will show how much is being used.

The soil scientist cites two other reasons besides leaching that will affect maintenance application rates. One is crop removal. The other, acids left by some commercial fertilizers.

In general, legumes will remove more lime than will grain or grasses. For example, 1½ tons of barley per acre will remove about 40 pounds of lime, while 5 tons of alfalfa hay per acre will remove about 500 pounds.

Any fertilizer supplying the ammonia form of nitrogen will leave residual acidity. But this is not a serious problem if you lime to neutralize these acids.

How to Determine Limestone Quality

Limestone neutralizes a portion of your soil's acids. Its effectiveness depends on fineness of grind (particle size) and the amount of calcium carbonate (purity).

Purity

Purity means the total neutralizing value of the material. Limestone often is mixed with other rocks. The purity of a sample is given as the calcium carbonate equivalent (C.C.E.) and shows the amount of calcium carbonate or its equivalent. Pure calcium carbonate has a C.C.E. of 100. Some limestone contains mixtures of magnesium carbonate and calcium carbonate. These mixtures are commonly known as "dolomitic" limestone. Pure magnesium carbonate has a C.C.E. of 120. The calcium carbonate equivalent of a dolomitic limestone would depend upon the percentage of the two materials in the sample.

Fineness

Limestone must react with the soil acids before it becomes effective. It must be ground fine before it can come in contact with the soil acids, reacting with them fast enough to pay. Thus, the finer the grind the faster the lime goes to work. Our present lime and fertilizer law was amended by the 1955 legislature to require guarantees on percentage of material passing a 10, 20, 40, and 100 mesh sieve. For example, a 10 mesh sieve has holes 1/10 of an inch on each side.

Scorecard described

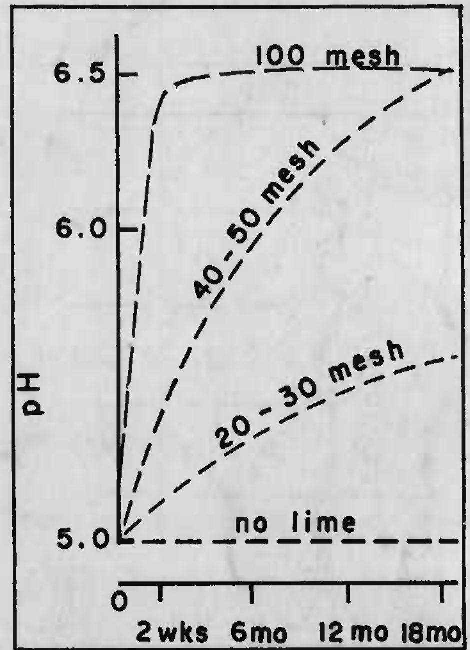
Oregon State College developed a score card evaluating both fineness of grind and calcium carbonate equivalent (C.C.E.). This score card has been changed to evaluate the particle sizes required in the labeling guarantee by the 1955 state fertilizer law.

Percentages of the samples reacting with the soil acids *within a one to three year period* after the lime has been mixed with the soil are given.

This score card *does not* tell how much lime will react with soil acids within a single growing season.

Rate of reaction

Rate of reaction is important for many liming jobs. Coarser ground limestone (a high percentage not passing 100-mesh sieve) should be applied a year ahead of planting such crops as legumes or vegetables. This will allow time for the limestone to react with the soil acids.



Rate of reaction of different mesh sizes of lime. Three tons per acre of each mesh size applied.

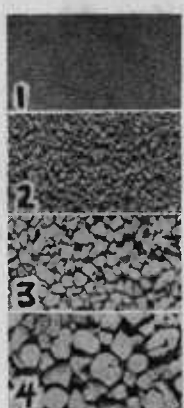
Limestone passing a 100-mesh sieve will react with the soil acids within a four to six week period if the lime is well mixed with the soil.

Figures in the above chart were taken from greenhouse experiments. Rate of reactions shown are faster than for average field conditions.

By-product liming materials

Many liming materials are produced as a by-product of industries in Oregon. Acetylene manufacturers, the pulp industry, and sugar beet refining are three sources of a sizable amount of by-product lime. Some of these materials are not a ground rock product, but are the result of chemical reactions. Particle size of the products is no longer a problem, but physical condition is. Some of these materials have considerable moisture and will end up in a glob or lump when spread on the field. This makes it hard to mix satisfactorily with the soil. When buying these materials, be sure they are delivered in a condition that will permit satisfactory spreading and mixing.

Sample Scorecard for Calculating Availability of Limestone Sold in Oregon



Particle Size*	Percentage of each particle size in sample	×	Percentage limestone available within 3 years	=	Pounds lime available per 100 pounds
1. Passing 40 mesh	58.3		100		58.3
2. 20 to 40 mesh	24.3		60		14.6
3. 10 to 20 mesh	16.6		30		5
4. Held on 10 mesh	.8		0		0

Total pounds available based on sieve analysis................77.9

Fineness score (77.9) × Calcium Carbonate Equivalent (97.7)* = 76.1 "Available" C.C.E.

Now here's an example of how this scorecard works:

Suppose a soil test shows your soil needs two tons of lime per acre. The lime you plan to apply has a score of 76. How much must you apply to put on two tons of available lime? Answer: 2.63 tons per acre—and here's how to figure it:

$$\frac{\text{Lime requirement (2 T/A)} \times 100}{\text{"Available" C.C.E. Score (76)}} = 2.63 \text{ tons per acre.}$$

*The Calcium Carbonate Equivalent (C.C.E.) and fineness guarantee must appear on lime sack labels.

Material in this circular was prepared by Tom Jackson, extension soils specialist and associate soil scientist at Oregon State College.