

VegNet Vol. 9, No. 25, November 1, 2002

Acid Soils, pH, Lime, and Liming

R. Precheur, The second article of a three part series on vegetable crop soil and plant nutrition follows the first news item.

Mid American Ag and Hort Services Launches www.midamservices.org for Employers

by John Wargowsky, Executive Director - Mid American Ag and Hort Services, Inc., labor@ofbf.org

Columbus, OH - October 31, 2002 - Agricultural, horticultural and other small business employers have a new web site (www.midamservices.org) to help them comply with the myriad of state and federal labor laws and regulations. This new employer tool is provided by Mid American Ag and Hort Services, Inc. (MAAHS) and was made possible by financial assistance from Indiana's Office of the Commissioner of Agriculture, USDA Block Grants on Specialty Crops and Promotion of Agriculture and Ohio State University Extension Ag and Hort Labor Education Program.

The site includes links to the portions of numerous state and federal government sites that tell employers what they need to know. Topics covered include temporary guestworker programs such as H-2A, H-2B and H-1B along with the Migrant and Seasonal Agricultural Worker Protection Act and social/language issues associated with the employment of foreign labor.

Additional topics include minor labor, wage-hour, OSHA, housing, posting, Family Medical Leave Act, immigration, Social Security and tax withholding issues, pesticide safety, Worker Protection Standard, harassment, discrimination, plant closing, transportation, drinking water, workers' compensation, new hire reporting, continuation of health care coverage, affirmative action and polygraph testing.

According to John Wargowsky, the organization's executive director, MAAHS is a consortium of associations, organizations and employers organized to meet the educational, regulatory compliance assistance and labor recruiting needs of agricultural and other employers in Ohio and Indiana. "This web site complements the member services provided by MAAHS," Wargowsky said. "We will continue to add content based upon member needs and requests."

This web site establishes the commitment of MAAHS and its Sponsor Members (Ohio Farm Bureau Federation, Indiana Farm Bureau, Ohio Nursery & Landscape Association, Ohio Florists' Association, Ohio Fruit Growers Society, Ohio Vegetable and Potato Growers Association, Ohio Landscapers Association and Nursery Growers of Lake County Ohio) to meeting the human resource needs of member employers.

As stated in the original grant proposal to the Indiana Office of Commissioner of Agriculture, Indiana and Ohio employers will 1) employ labor with more confidence, 2) avoid unneeded expense due to violations of labor laws and regulations, 3) save time and money spent dealing with government investigators/regulators, 4) save time in finding regulatory compliance information and 5) increase their capacity to hire employees to diversify or expand their production, processing and distribution capabilities as a result of this web site.

If you would like more information about MAAHS, contact Wargowsky at P.O. Box 182383, Columbus, Ohio, 43218-2383 or 614-246-8286 (voice) or 614-249-2200 (fax) or labor@ofbf.org.

Acid Soils, pH, Lime, and Liming Compiled by Robert J. Precheur

This is the second article of a three part series on basic soil and plant nutrition for vegetable crops. These articles will review some of the fundamental principles that produce high crop yields for the lowest possible costs.

What are acid soils?

Most people have heard of common acids such as citric, hydrochloric, sulphuric and nitric acid. To a certain extent and in small quantities, some of these acids may be found in the soil solution. Soil particles of clay and organic matter can adsorb calcium, magnesium, potassium and sodium increasing the base status. Hydrogen and aluminum ions can be adsorbed to the soil particle replacing these bases causing an increase in soil acidity.

How is soil acidity measured?

Soil tests show soil acidity as a pH measurement, which is a measure of the strength or degree of the acidity or alkalinity level in the soil. A pH value of 7.0 is neutral. Values above 7.0 are alkaline and below 7.0 are in the acid range. Vegetable growers should remember that the pH scale is a logarithmic scale. A soil with a pH value of 6.0 is 10 times more acid than a soil with a pH of 7.0 and a soil with a pH value of 5.0 is 100 times more acid than a soil with a value of 7.0. Soil pH is not a measure of total acidity and many soil tests will report a lime test index or buffer pH. This is a measure of active and reserve acidity and lime recommendations are based on this number.

Do vegetable crops vary in their response to soil pH?

Yes. Crops not tolerant of acid soils and require a pH range of 6.0 to 6.8 on mineral soils are: asparagus, beet, broccoli, cabbage, cauliflower, leek, lettuce, melons, onions, and spinach.

Moderately tolerant crops for a pH range of 5.5 to 6.8 include: beans, carrot, collard, corn, cucumber, eggplant, kale, mustard, parsley, pea, pepper, pumpkin, radish, squash, tomato and turnip.

Very tolerant crops of a pH range of 5.0 to 6.8 include: chicory, endive, potato, rhubarb sweet potato and watermelon.

What causes acid soils?

(A) Leaching and erosion

Losses of calcium and magnesium from soils by leaching and erosion are much more rapid under row crop conditions than in natural forests or grasslands. As rain moves through the soil, it absorbs carbon dioxide, present in the soil atmosphere, forming weak carbonic acid. Weak organic acids are also formed when water moving through the soil comes in contact and reacts with humus. These acids remove calcium and magnesium and are replaced by hydrogen and aluminum making the soil more acid.

(B) Organic matter decomposition.

Decomposition of organic matter is an acidifying process. The rate of decomposition and hence acidification, is much higher in cultivated than in natural soils and more rapid under higher temperatures.

(C) Type of commercial fertilizer.

Fertilizers, particular those containing ammonium (NH_4^+), acidify soils. When NH_4 -nitrogen is converted to nitrate (NO_3) by nitrification, the net result is the release of free hydrogen into the soil solution lowering soil pH. For example, it requires 84 lbs of calcium carbonate (lime) to neutralize the acidity produced by 100 lbs of urea and 59 lbs of lime to neutralize acidity produced by 100 lbs of ammonium nitrate. The higher the rate of nitrogen fertilization, the greater the acidification.

(D) Crop Removal

Calcium and magnesium removed by crop plants contributes to depletion from the soil, and thereby promotes acidification. The higher the yields, the greater the removal of calcium and magnesium. Where the whole crop is removed from the ground up, more calcium and magnesium will be removed in comparison to a crop where just part is harvested. Multi-cropping the same field will also increase the removal of calcium and magnesium. Some vegetables have a higher percentage of calcium and magnesium than other vegetables. For example, Kale tops contain 1.8% calcium on a dry matter basis compared to potato tubers with 0.04% calcium. Spinach leaves contain 1.24% magnesium while beet roots only contain 0.013 % magnesium. A 10 ton yield of cabbage will remove 10 pounds of calcium and magnesium per acre. A 400 bushel yield of bulb onions will remove 10 lbs of calcium and 5 lbs of magnesium. A 30 ton/acre yield of tomatoes will remove 11 pounds of calcium and 16 lbs of magnesium per acre.

What about Liming?

Soil acidity is corrected by liming which neutralizes soil acidity. Liming puts the soil in the desirable pH range allowing for maximum availability of required nutrients for crop growth. Most mineral soils should be limed to around a pH of 6.5. How much lime to apply is determined by a soil test using the "lime index" or "buffer pH".

(A) Mineral soils

Soil pH is determined on mineral soils in a 1:1 soil:water suspension. Lime requirement is determined using a buffer to determine reserve acidity. Methods may vary by laboratory and growers should use laboratories that belong to the North American Proficiency Testing program for soil test labs?

(B) Organic soils

In OH, the lime recommendations should be made directly from the water pH test. The water pH test measures the H ions in the solution phase and not adsorbed H

ions. Lime muck soils only after a pH test. Do not lime unless the soil is below pH 5.3. Soil samples should be taken from the subsoil, below the plow layer, to provide a forewarning of potential pH changes. Sub-soiling or deep plowing may bring some of the subsoil to the surface.

Liming Materials and Solubility

In general, there are four types of liming materials available. Percentages of CaO and MgO may vary by definition.

1. Calcite - Ground Calcium Limestone (50-56% CaO, and 0.5- 4% MgO). This material is relatively more soluble than other types of ground limestone and corrects soil acidity most rapidly. It is particular useful when soil tests show that adequate amounts of magnesium are present in the soil.
2. High Mag or Magnesian Limestone (39-42% CaO, and 5-15% MgO). This material is intermediate in solubility between ground limestone and dolomitic limestone. High magnesium limestone supplies calcium and magnesium in approximately the same ratio as that removed from the soil by several crops.
3. Dolomitic Limestone (30% CaO, and 20% MgO). The high amounts of magnesium supplied in dolomite make it very useful when magnesium is very low. In most cases, high-mag limestone may be substituted for dolomite after soil magnesium levels are increased. Dolomite is not highly soluble and therefore corrects soil acidity more slowly than the other materials.
4. Hydrated Lime (60% CaO, and 12% MgO). Hydrated lime is made by adding water to burned lime (CaO). It reacts most rapidly but the effect is only temporary. Hydrated lime is caustic to both people and plants. Should be used only in emergency situations where a rapid change in pH is needed to grow a successful crop.

How fine should lime be ground?

Fineness of grinding becomes a compromise between effectiveness and price. The finer the limestone until the 60-mesh size is reached the more quickly it will react with the soil and the higher pH will be raised. But, generally, the finer the limestone the higher the cost per ton. A study showed that the wisdom of using limestone containing less than 35% of 60 mesh material is questionable. The same study also indicated that 50-60 mesh limestone is practically as effective as 100 mesh material is raising the pH of the soil. When 8-20 mesh limestone was applied at the rate of 3 tons/acre to a soil with a pH of 5.0, there was little change in soil pH after 18 months (Meyer and Volk, Soil Science, Vol. 73, No. 1, 1952). In another study, only 2.3 tons/A of limestone (with 51-60% passing through a 60 mesh screen) was needed to get the desired crop response, By comparison, 3.8 tons/A (with only 20-30% passing through a 60 mesh screen) were required to get the same crop response (Stanley A. Barber, Purdue University).

Bottom Line: Find out what your dealer is supplying.

Is There An Upper Limit of Lime?

When the lime need is 4 tons or greater per acre, apply the lime in split applications, i.e., half before plowing, half after plowing.

How should lime be applied for maximum effectiveness?

Uniform application and thorough incorporation of agricultural lime in the soil are essential to a good lime program. Incorporation is not usually a problem where

conventional or deep tillage is regularly practiced. In no-tillage situations, pH changes may only occur in the upper 1-2 inch zone. Sub surface acidity may not be affected.

What is Fluid Lime?

The idea for fluid lime came in response to the need for a liming material capable of reacting with the soil. Finely ground lime applications cause severe dust problems and caused the development of fluid lime or liquid lime formulations. These materials all have similar characteristics:

1. One hundred percent of the material should pass through a 100 mesh screen and a minimum of 80 -90 percent through a 200 mesh screen.
2. Water is the liquid carrier. Sometime nitrogen solutions are used. Depending on the cropping situation, herbicides and potash may be added to the suspension.
3. Some sort of a suspension agent is added to the mixture.

Is this better than other materials? The effectiveness of agricultural limestone also applies to fine lime; in other words, the effective calcium carbonate equivalent of all fine lime materials, whether applied in suspension or dry form will be determined by the quality of the product used: fineness of grind, chemical purity and the rate at which it is applied.

Lime suspensions do not possess any special capabilities as compared with conventional lime which contains a high percentage of fast acting, 60 mesh or finer particle size. Fine lime breaks down and dissipates more rapidly in the soil. The residual effect on soil acidity tends to be of shorter duration than conventional lime. The use of lime suspensions may require more frequent applications to maintain desired soil pH.

What About Pelletized Lime?

(From: Michigan State University)

PELLITIZED LIME REACTS MORE SLOWLY

East Lansing, MI., Field tests conducted at Michigan State University show that agricultural lime raises the soil pH notably more quickly than pelletized lime, probably because of the binding agent used in making the pellets. The tests were conducted by MSU agronomists Darryl Warncke and Francis Pierce beginning in April of 1995 and continuing through fall of 1996. The lime application rates at the test sites were none, 1, 2, 4, or 8 tons per acre. Tests for pH were made at weeks 1, 2, 6, 8 and 16. The dolomitic limestone raised the soil pH more quickly than the pelletized lime (also made of dolomitic or calcitic lime) and the change in pH increased more rapidly and rose higher as the rate of application increased. By contrast, the change in pH with where pelletized lime was applied was less and occurred more slowly during the 16 weeks of equilibration. Pelletized lime materials are made by granulating finely ground lime. The lime particles are cemented together with ligno sulfonates, which comprise about 9 percent of the pellet content. In order that the lime become reactive, the lignosulfates have to be broken down by solubilization or microbial action, which, under the MSU field studies, retarded the breakdown or dissolution of the lime pellets. The pelletized lime also increased the extractable sulfur in the soil by a small amount.

References

Longnecker, E.D. Lime for Michigan Soils. Michigan State University. Cooperative Extension Service. E471.

Maynard, D and C. L. Thomson. 1970. Nutrition of Vegetable Crops in Massachusetts. Univ. Of Massachusetts, Cooperative Extension Service. Publication No. 63.

Maynard, D., John Howell Jr. and Robert J. Precheur. 1979. Vegetable Crops Newsletter. University of Massachusetts at Amherst. No. 77.

McCart, G. D., G. W. Hawkins, G. R. Epperson and D. C. Martens. 1972. Soil Acidity: Nature, Causes, Effects, Remedy. Cooperative Extension Service, Virginia Polytechnic Institute. Publication 490.

Michigan State University Extension Field Crop CAT Alerts 1997-2002 - 12049802 08/22/02. Dolomitic Lime Versus Calcitic Lime. [http ...](http://www.msue.msu.edu/msue/imp/modc2/12049802.html)
www.msue.msu.edu/msue/imp/modc2/12049802.html - 3k - Cached

Michigan State University Extension Bulletin. Sampling Soils for Fertilizer & Lime Recommendations. E498.

National Crushed Stone Association (NCSA). 1981. NCSA Aglime Fact Book

Warncke, D. R., D. R. Christenson, L. W. Jacobs, M. L. Vitosh and B. H. Zandstra. 1992. Fertilizer Recommendations for Vegetable Crops in Michigan. Michigan State University. Cooperative Extension Service. Extension Bulletin E550B.

What's New At The VegNet Web Site

Problem Of The Week

A pictorial comparison of Squash Vine borer damage and Bacterial Wilt in pumpkins. While the symptoms are similar, there are some key differences. Check it out. Click on the 'Problem of the Week' button of the left side.

Highlights From the Pumpkin and Muck Crops Field Days

Couldn't make it to Celeryville on July 25th or forgot about The Pumpkin Field Day on August 7th, then take a look at just a few of the highlights from these two field days.

Click on the 'Talk Between The Rows' button on the VegNet homepage.

2001 Slide Presentations

Pepper Variety Slides 2001 | [HTML Slide Show](#)

Pumpkin Variety Slides 2001 | [HTML Slide Show](#)

Go to the Library Section under Research Reports.

VegNet Vegetable Schools

A series of slide presentations are now available in order to update you on the latest pumpkin and sweet corn research. We begin with 6 pumpkin topics in Pumpkins 101 and have 10 slide presentations available in Sweet Corn 101. In sweet corn. Powerpoint presentations and html online slide shows are available now. Go to the VegNet homepage.

Pumpkins 101

The use of trap crops and Admire for cucumber beetle control and New varieties for 2001. We have presentations on cover crops for disease control and pumpkin fungicide use.

Perimeter Trap Cropping. Online html slide show | Perimeter Trap Cropping. PPT, 7 Mbytes

See also the Research Results section on the home page for text version of the report.

Pumpkin Variety Slides 2001 | HTML Slide Show

Sweet Corn 101

Presently only Powerpoint presentations available. Coming Soon: Online HTML slide shows. Check back often Nine topics including:

Aspects of Variety Selection based on Disease Control [ppt 40 KB]

Internet Link To "Reactions of Sweet Corn Hybrids to Prevalent Diseases" Dr. Jerald Pataky www.sweetcorn.uiuc.edu

Producing Early Sweet Corn [ppt 3.5 Mbytes]

Managing Weeds in Sweet Corn [ppt, 9 Mbytes]

Sweet Corn Herbicides & Variety Sensitivity. [ppt 2Mbytes]

Sweet Corn Development and Critical Periods for Irrigation Management [ppt 1.6 Mbytes]

Flea Beetle Management in Sweet Corn [ppt 510 KB]

How To Keep Worms Out of Sweet Corn Ears [ppt 8.3 Mbytes]

Role of Bt Transgenic Hybrids in Sweet Corn Pest Management. [ppt 21.2 Mbytes]

Bt Sweet Corn Efficacy in OH, 1999-2000 [ppt, 208 KB]

[Return to Vegetable Crops Homepage | Ohio State University Extension](#)

We appreciate very much the financial support for this series of vegetable reports which we have received from the board of growers responsible for the Ohio Vegetable and Small Fruit research and Development Program. This is an example of use of Funds from the "Assessment Program".

Where trade names are used, no discrimination is intended and no endorsement by Ohio State University Extension is implied. Although every attempt is made to produce information that is complete, timely and accurate, the pesticide user bears the responsibility of consulting the pesticide label and adhering to those directions.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Keith L. Smith, Director, Ohio State University Extension.

All educational programs and activities conducted by Ohio State University Extension are available to all potential clientele on a nondiscriminatory basis without regard to race, color, creed, religion, sexual orientation, national origin, sex, age, handicap or Vietnam-era veteran status.