Delaware researcher says

Fertilizer recommendation theory doesn't work on light soils

DETROIT, Mich. — Much of the cost of growing food crops comes from altering the soil in order to improve its productivity. Amounts of lime, fertilizer or waste products needed to do the job are usually determined by a soil test.

The recommendations made by many soil testing laboratories today are based on the idea that a specific ratio of calcium, magnesium and potassium is required for maximum soil productivity.

Delaware soil specialist William C. Liebhardt challenged this concept during a recent national meeting of agricultural scientists in Detroit, Michigan.

Reporting to members of the American Society of Agronomy, Crop Science Society of American and Soil Science Society of America, he said that, based on a 10-year study at the University of Delaware Agricultural Experiment Station, the theory doesn't hold up in actual practice – at least not on poorly buffered, sandy coastal plain soils.

Farmers following recommendations based on this theory may add more calcium, magnesium and potassium than is needed for maximum production, he said These extra nutrients sometimes have no significant effect on crop yield, but in other cases they actually reduce yields.

In either instance, the farmer is spending more money than he needs to on lime or fertilizer. With a smaller harvest, his profit is down even further and there's less food for the consumer.

Specifically, Liebhardt challenged the idea of trying to achieve a basic cation saturation ration (BCSR) between nutrients in soil for crop production as presently used. (Potassium, calcium and magnesium are all cations.)

The concept, widely used today, is based largely on greenhouse soil studies on alfalfa by soil scientists in New Jersey during the 1940's. They proposed that the ideal soil have 65 percent calcium saturation, 10 percent magnesium saturation and five percent potassium saturation.

In the late 50's a Midwestern agronomist combined this data with information from a Dutch research report and used it to generate figures for what he considered to be the optimum ratios between these three basic plant nutrients. His BCSR philosophy calls for saturations of 65 to 85 percent calcium, 6 to 12 percent magnesium, and 2 to 5 percent potassium.

Commercial laboratories adopted this philosophy, with some using 75 percent calcium saturation, 10 to 15 percent magnesium saturation, and 2 to 5 percent potassium saturation.

Since the concept hasn't been questioned in 30 years, Liebhardt assumes it's worked on the highly buffered soils of the Midwest which can tolerate a pH of 6.5 or 6.7. It may not have caused yield decreases, he said, but it probably has resulted in the addition of unnecessary nutrients just to balance up these ratios.

On the poorly buffered, low organic, sandy soils of the Atlantic Coastal Plain, these saturation levels result in excessive soil pH and drastically reduce yields. In its present form, Liebhardt said, the theory simply doesn't work on these soils.

The soil scientist based his comments on results of a 10-year study at the university Substation farm near Georgetown, Delaware. Soil in the research field was a typical, sandy coastal soil with a low cation exchange and very little organic matter.

Plots in the test received one and four tons of calcitic lime and dolomitic lime, and a one to one mixture of the two, twice during the study period – in 1970 and again in 1973. No lime has been added since then.

Potassium was also added at the rates of zero, 60, and 120 pounds per acre annually.

The calcitic lime had a calcium-magnesium ratio of 18 to 1. The dolomitic lime had a one to one ratio which resulted in wide variations in soil calcium and magnesium. The BCSR concept calls for a ratio of about six to one and a precise saturation level for each of these elements.

"Trying to achieve this ratio and saturation level on our sandy soils results in overliming and reduced yields," said Liebhardt. "If we go beyond a pH of 6 we run into a manganese deficiency and yields drop. The highest corn yield in the study was 195 bushels at a pH of 5.6. At a pH of 6.4, yield declined between 20 and 35 bushels an acre. (All plots in the study were irrigated.)

"When we looked at the correlation between manganese concentrations in earl leaves at silking and various other plant and soil factors," he continued, "we found that it really boils down to one thing. Manganese deficiency is a soil-related factor. When the pH is too high, the manganese is tied up and the corn plant can't use it."

When soybeans were grown on the same plot, there was no significant difference in yield between treatments, even though pH ranged all the way from 5.3 to 6.4. However, there was a trend toward lower yields as pH increased. Calcium and magnesium saturation levels in the soil also varied widely but had no statistical effect on yield.

These research results were supported by findings on commercially grown corn around the state.

Last summer Liebhardt compared results of soil tests and leaf tissue analysis from fields of farmers participating in a statewide extension irrigation program.

The theory calls for potassium cation saturation levels between 2 to 5 percent. Eighty-eight percent of soils tested in the program had potassium cation levels well above this.

Most Delaware fields also had much higher magnesium saturation levels than the 6 to 12 percent called for. Ninety-nine percent of the growers' soils were above the 6 to 12 percent soil magnesium considered optimal by the BCSR concept. Levels of this nutrient ranged anywhere from seven percent to greater than 30 percent, with all the low readings coming from one farm.

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