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Lime as a Fluid

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Traditionally, lime has been applied in dry form. Now, a new concept in liming has emerged. Numerous dealers with fluid fertilizer facilities and equipment are selling fluid suspensions of fine lime to farmers.

Ordinary dry aglime is a mixture of particles including fine, intermediate and fairly coarse sizes. It is usually applied to fields at rates of two or more tons per acre. Fluid limes contain only the fine particle sizes (usually 100 to 200 mesh material) suspended in water or liquid fertilizer. Mixtures run from about 50 to 75 percent lime and 0.5 to 5 percent attapulgite clay as a suspending agent and may contain a very small quantity of dispersing agent, with the rest of the solution either fertilizer or water. Standard suspension fertilizer application equipment is used for field applications, at rates generally ranging from 300 to 700 pounds per acre of actual lime. For example, a suspension of 70 percent lime weighing 15 pounds per gallon, applied at 60 gallons per acre would provide 630 pounds per acre of lime, or 900 pounds per acre of suspension.

Lack of Research

Little research has been done to determine the agronomic and economic effects of applications of small quantities of fine lime over several years. Some short-term results have shown that in certain situations pH increases can occur during the first year of application, and that yield increases are possible. Research is underway at Kansas State University, but long-term results won't be known for a while.

At least two commercial firms have reported work with dealers in working out the mechanics of mixing, suspending and applying the materials, and this is the major source of information presently available. Agronomic research results, however, are quite scarce.

Liquid Fertilizer Carriers

Most agronomists agree that phosphorus-containing fertilizers should not be used with lime suspensions. Either ortho- or polyphosphates are likely to react and reduce the effectiveness of the phosphorus as a fertilizer in such a high calcium solution, and they may cause mechanical problems by forming precipitates in the equipment. Potash should present no problem, and elements such as magnesium and sulfur could feasibly be safely applied this way.

Nitrogen is another question, however, and may need further consideration, especially since dealers are interested in applying the lime in a suspension with nitrogen solution. Nitrogen solutions contain roughly one-half urea. Since we know that the potential for volatilization (evaporation) losses of nitrogen (as NH_3) from surface-applied, non-incorporated urea increases as pH increases from the acid range into the neutral and alkaline range, we must be cautious when using nitrogen solution as the liquid carrier. We recommend immediate soil incorporation of lime/nitrogen suspensions to help avoid the potential for NH_3 volatilization loss. Once the suspension is incorporated into the soil, there should be no problem. Those presently using the lime/nitrogen suspensions feel that such nitrogen loss is not a problem. At least no loss has been apparent in terms of obvious reduced nitrogen response. Detailed observations and measurements through research, however, are lacking. The work at Kansas State University will evaluate this situation.

The Chemistry

Basically, the chemistry of neutralizing soil acidity with lime is no different for fluids than for dry materials. This guide does not go into all the chemistry of soil acidity and liming nor the agronomic benefits of liming. There are, however, certain facts of chemistry that should be kept in mind when considering lime suspensions.

Soil acidity is due to hydrogen ions (H^+) in the soil solution, plus exchangeable H^+ on the soil colloids and exchangeable aluminum (Al^{+3}). The soil, in terms of acid-base chemistry, behaves like a buffered weak acid, and consequently resists sharp changes in pH. The quantity and type of clay and quantity of organic matter in soils determine their buffering capacity and thus the amount of liming material required for a given pH change. *The more clay and organic matter the more highly buffered the soil, and the more resistance to change in pH.* Sandy soils low in organic matter are poorly buffered and require smaller amounts of lime for a given pH change in comparison to soils higher in clay and organic matter.

In many of our acid soils, addition of small amounts of liming material is inadequate to overcome the buffering capacity, and little or no pH change will occur. Soil H^+ and calcium carbonate ($Ca\ CO_3$) react on a one-to-one equivalence basis, and large amounts of acidity require large amounts of liming materials.

The effectiveness of any liming material depends on its purity and fineness. Research has shown that finely sized lime particles react faster than coarser ones, within certain limits. We would expect the fine particles in fluid lime to react quickly and to produce pH changes with smaller quantities of lime as compared to coarser materials. Still, there has to be sufficient material applied to overcome the soils buffering capacity if a pH change is to occur.

Agronomic Effectiveness

An application of 2,000 pounds per acre of dry fine lime to an acid Missouri soil gave a quick, short-term boost to alfalfa.

However, in the fourth year after application, the effect was gone.

Research by Kansas State University included 500 and 1,000 pounds per acre of fine lime in three locations. In the first year, there was only a slight soil pH increase at one location. After repeating the treatments the second year, again, there was no pH change in two of three locations. Yield differences in corn, soybeans and grain sorghum due to lime rates were not significant, but there was a trend for corn yields to be higher where lime was used.

Even though pH changes were minimal, the presence of the added lime was detectable to a certain extent in that the *lime requirement* measurement was generally lower. Also in these studies, rates higher than 1,000 pounds of lime per acre were included, and the effects were more pronounced in those cases.

These limited results do not build a strong case for small applications of lime. The fact remains that small amounts of lime can neutralize only small amounts of soil acidity.

Economics

In most areas, cost of fluid lime will have to be weighed against the cost of ordinary dry aglime. Suspendable liming materials will vary widely in cost from nothing when certain waste products are available to around $10 per ton for high quality fine limestone. Hauling costs must be added and will vary widely depending on distances from sources of material. Costs of $5 to $7 per ton are likely. Add to that mixing and spreading costs of $4 to $5 per acre and a reasonable profit margin. Cost per acre for 1,000 pounds of fine lime can run $10 to $12, applied, and we have reports of costs up to $17 per acre.

Comparing fine lime suspension directly to dry aglime is difficult. Dry aglime ordinarily runs $5 to $8 per ton per acre applied in this area. In other words, 2 to 3 tons per acre of dry aglime could be applied for roughly the same cost as ½ ton per acre of fine lime suspension. Since we usually assume normal dry aglime contains roughly 25 percent of "fine" lime (minus 100 mesh), then, for example, two tons would contain 1000 pounds of "fine" lime—In other words, just as much "fine" lime as in the suspension of the same cost. Presumably, then, the dry aglime should do everything the fine lime suspension does, plus have the long-term benefits of the remaining coarser 3,000 pounds of material.

These figures may not apply to many individual situations, which will have to be determined locally. However, they do point out that the economics may be impractical for fine lime suspensions in areas where dry aglime is available. In those areas where dry aglime and dealers are not available, fluid lime could conceivably be more economical than aglime because of freight costs.

Different Materials

In addition to fine grades of calcitic and dolomitic limestones, other materials can be used in suspension as liming materials. Calcium carbonate sludges from municipal water treatment plants, cement plant stack dust, carbonate sludges from certain paper mills and other by-product or waste materials high in calcium and magnesium carbonates can be used for liming materials. The concept of fine lime suspensions offers a potentially good way to use waste and by-product materials which have liming value.

Possibilities for Fluid Lime

We have already covered combining lime in suspension with liquid fertilizers. Another possibility in the mixture is herbicides and perhaps other pesticides. The increased activity of atrazine in higher vs. lower pH is well known. The enhancement of herbicidal activity is an interesting possibility, particularly for no-till situations where surface acidity can otherwise potentially reduce herbicide effectiveness. On the other hand, phytotoxicity (injured plants) could possibly be a problem in certain situations, so be cautious with this idea.

In the western Corn Belt and other areas where aglime may be unavailable, fluid lime may offer more promise than in more eastern areas where plenty of aglime is available. The need for lime in course textured soils producing corn under irrigation might be economically met with frequent, modest quantities of fine lime. Also in areas such as the southeastern United States, where certain crops respond to calcium (for example, peanuts), modest applications of fine lime in suspensions may prove quite feasible.

Maintenance application of fine lime in suspension seems to be a viable approach to consider. Frequent applications of fine lime in combination with other materials could conceivably prevent soil pH decline due to nitrogen fertilizer and other cropping and soil factors. The acidity produced by nitrification of ammoniacal fertilizer unquestionably contributes to reduction in soil pH. If lime is applied in a nitrogen solution, a portion of that lime will conteract the acidity produced from the nitrogen and the rest (if any) will be left to neutralize acidity from other sources in the soil.

Advantages of Fine Lime Suspensions

- Fast reaction
- Less required for a given pH change
- Can combine with nitrogen, potassium and sulfur fertilizer solutions
- No dust during application
- Uniformity of application easier
- May use floatation equipment
- Renters may prefer for fast reaction
- May be more economical in areas where aglime is unavailable

Disadvantages

- May have to apply every year—longevity unknown
- Cost may be greater, especially long-term
- Cannot be used with phosphorus fertilizer
- Advantage of use with nitrogen not applicable in areas where other nitrogen forms prevail
- Large pH changes not possible with small quantities

Conclusion

Suspension lime may have a place in some areas and situations, both agronomically and economically. The answers, however, are not all available at this time. Further research and development work by both institutional researchers and commercial firms will undoubtedly define the place of suspension lime over the next several years.

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