Forage News

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Effects of Liming Materials on Soil pH

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Forage productivity and quality are related to soil pH and nutrient availability. Soil pH is the measure of acidity or alkalinity. In Mississippi, over 60% of the forage production acres are acidic with a pH of less than 5.8 in which remedial actions will be needed. Most nutrients are optimally available to plants within a pH range of 5.5 to 7.0, as this range is generally very compatible with healthy plant root growth. Soil pH of 6.5 is usually considered optimum for nutrient availability. Liming is commonly used to improve the productivity of acidic soils in pasture and hay systems by increasing the availability of nutrients and microbial activity that result in increased decomposition of soil organic matter decomposition to release mineral nitrogen, phosphorous, and carbon. Liming also increases root growth and reduces the elemental accumulation of aluminum (Al), manganese (Mn), and iron (Fe) which are toxic to plants in excess. At low soil pH nutrients such as calcium, phosphorus, and magnesium are less available to the plant.

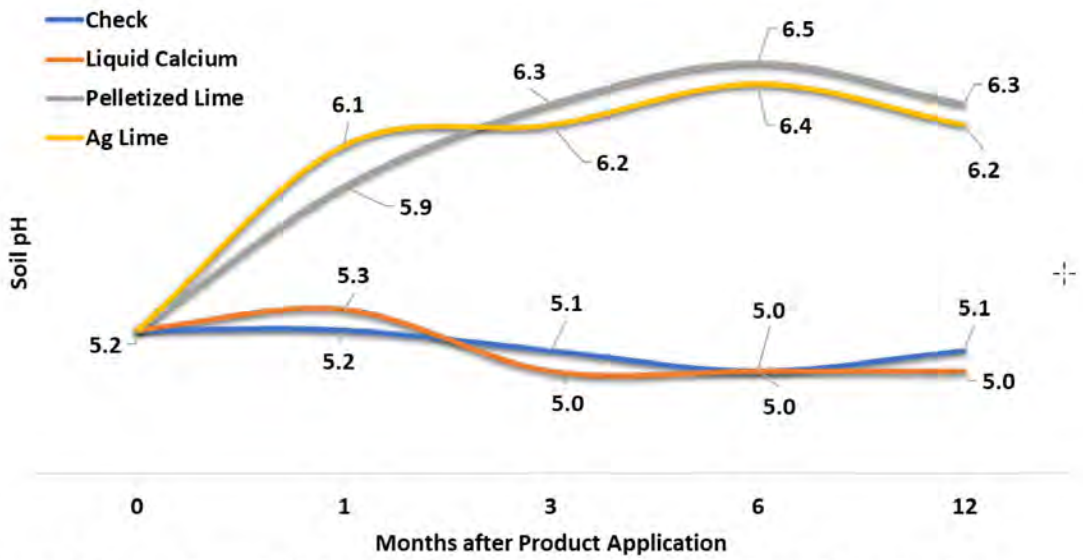

Figure 1. Comparative soil pH changes in a soil incubation study at 1, 3, 6, and 12 months after the application of four different liming materials. The initial soil pH before the application of the liming materials was 5.2. Source: Ritchey et al., 2023a. The University of Kentucky. Poster presented at the American Forage and Grassland Council Annual Meeting, Wiston-Salem, NC.

Soil acidification is a slow process, and the visible symptoms are not clear. Such a process can vary depending on the soil type, vegetation, fertilizer regimes, and other climatic factors. That is why taking a soil sample at least every two to three years is important. Untreated soil acidity in the upper six inches of the root zone of most forage systems can move deeper in the soil profile making liming more difficult and significantly more expensive. Some of the visible symptoms associated with soil acidity in forage systems include: (1) poor plant vigor (uneven growth, reduced growth, and low biomass production), (2) poor establishment of forage species (stunted growth), poor nodulation of legumes, (3) persistence of acid tolerant weed species such as broom sedge, and (4) increased susceptibility to diseases such as rust and leaf spot due to low potassium availability. Production practices based on guess and not on a nutrient management plan (soil testing) could gradually lower the soil pH. This is especially true where N fertilizers such as anhydrous ammonia, ammonium sulfate, and urea are applied in excessive quantities.

The effects of soil pH on nutrient availability – Nitrogen (N) is affected by soil pH because microbial activity affects N availability in the soil. Since microbial activities can occur at a wide range of soil pH, most of the nitrogen inhibition will happen when soil pH is less than 5. Most lime products are usually surface applied to pasture and hay fields. Although liming can be done at any time of the year, it is recommended to apply the liming material at least three to six months before the growing season and/or nitrogen fertilization. Significant amounts of nitrogen from ammonium and urea fertilizers could be lost by volatilization if fertilizer is applied immediately after the lime application. The availability of other nutrients such as phosphorous (P), potassium (K), and sulfur (S) can be increased with liming. Keep in mind that like N

application, the application of P immediately after liming could reduce its availability due to the reaction with calcium from the lime and forming insoluble compounds. On the other hand, liming can induce deficiencies of micronutrients such as zinc (Zn), Mn, and copper (Cu) in some crops, but very little is known in forage systems. In forage legumes, molybdenum (Mo) deficiencies have been reported when soil pH is above 6.0

Adjusting your soil pH – The pH in acidic soils is commonly raised by surface applying or incorporating a liming material. If your soil is alkaline, it is also possible to lower the soil pH by using a liquid acid solution or finely ground elemental sulfur, but this is rarely done because of the high cost, and we hardly see alkaline soils in the southern USA. Since natural limestone is relatively water-insoluble, agricultural limestone must be very finely ground so that it can mix with the soil particles and react with other nutrients to change soil acidity.

Soil acidity can be corrected by the application of different types of liming materials. Lime is a natural product made by finely grinding limestone (calcium carbonate). Before applying lime to a pasture or a hay field, it is recommended to collect a soil sample that is representative of the area. This is something that should be done yearly on hay production fields or every two to three years in pastures. The more finely ground the liming product is, the faster will react with the soil to neutralize acidity. When using any limestone product, it is important to apply the material at the correct rate. Producers also need to know the relative neutralizing value (RNV) of the liming material to effectively adjust the application rate and achieve the targeted neutralization of the soil acidity. The RNV is a chemical measurement of the lime materials' ability to neutralize acidity. The rate at which the lime should be applied depends on the pH of the soil, what target range is trying to be obtained, and soil type. Soil type comes into play when determining lime application rate. Certain soil types will be more resistant to change in pH than others. In general, it is more difficult to change pH in clay soil than it is in sandy soil. When liming clay soil, higher lime amounts will be necessary to have the same effect that a smaller amount would have on sandy soils.

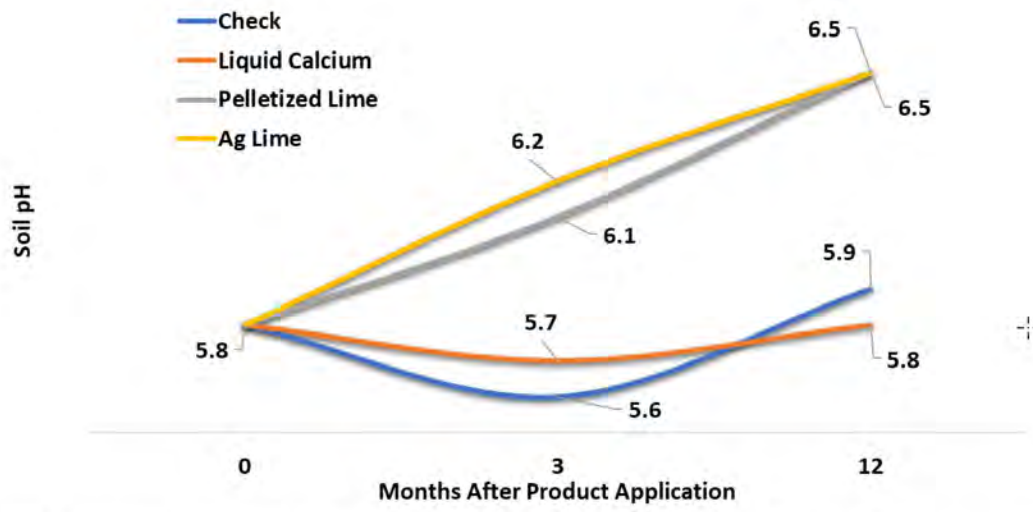

Figure 2. Comparative soil pH changes in a bermudagrass study at 3 and 12 months after the application of four different liming materials. The study was conducted across 16 locations in Kentucky. The initial soil pH before the application of the liming materials was 5.8. Source: Ritchey et al., 2023b. The University of Kentucky. Poster presented at the American Forage and Grassland Council Annual Meeting, Wiston-Salem, NC.

The most common liming materials include “ag lime” (crushed calcitic lime), dolomitic lime (calcitic lime high in magnesium), and slaked lime (quick or burnt lime). Other products being promoted in the market include industrial by-products such as wood ash. It is important to obtain a nutrient analysis of any by-product because some of them might contain heavy metals that could cause soil contamination. Ag lime is a lot coarser and therefore takes longer to affect soil pH. Pelletized lime also consists of very finely ground limestone particles held together by a soluble binding agent. Pelletized lime is usually used because of the ease of application, but it can be very expensive despite having a great initial response with your forages from its application. Ag lime coming from a water treatment plant can be a good source of ag lime but is a wet sludge with 40 to 50% moisture and it is more difficult to handle, apply, and distribute uniformly.

There has been an increase in liquid lime products in the market. These products contain a very finely ground limestone along with a small amount of clay and a dispersing agent. Although they might provide a fast soil reaction and the ability to combine with fertilizers, they might need to be applied annually and might cause blockage in your spray tank. This could generate a potential for a higher cost than conventional liming and difficulty in getting large pH changes with relatively light applications of lime. Liquid calcium is not a form of lime. Some commercial forms of liquid calcium want to compare to ag lime, which is not the same type of product. Products that contain just calcium do not make them a good liming material because these products are a form of calcium chloride and not calcium carbonate. Lime needs to be able to effectively remove the hydrogen ions to change the pH in the soil and this only happens with the carbonate molecule reacts with the hydrogen ($CaCO_3 + H^+ = H_2O + CO_2 + Ca$). This means that liquid calcium might show a good response in a hay field because calcium is a nutrient that the plant needs and can help with soil structure. Although the price might sound attractive for the product, a yearly application without a response to correcting soil pH can become an expensive proposition.

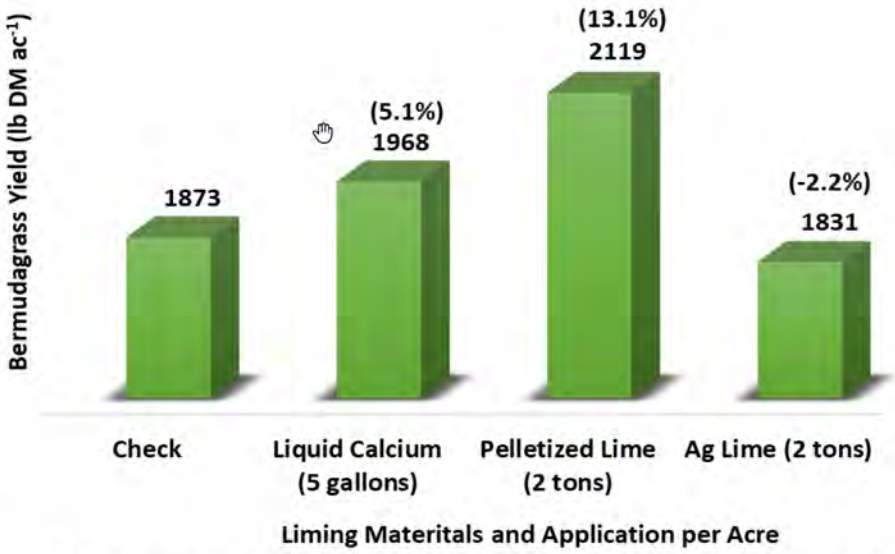

Figure 3. Bermudagrass biomass response three months after the application of four liming materials across 16 locations in Kentucky. Numbers in parentheses represent the percent yield increase/decrease compared to the check. Source: Ritchey et al., 2023b. The University of Kentucky. Poster presented at the American Forage and Grassland Council Annual Meeting, Wiston-Salem, NC.

Let's do the math on the liquid calcium products. A gallon of liquid calcium containing calcium chloride has a density of approximately 11 pounds per gallon and a calcium analysis of 10% by weight. That means that a gallon of product contains about 1.1 pounds of calcium. With the manufacturer's recommended applications of 1 to 5 gallons per acre, you will be applying 1.1 to 5.5 pounds of calcium per acre. A soil in Mississippi could contain from 2,000 to 2,500 pounds per acre of exchangeable calcium on the upper six inches. If there were a need for lime application, a ton of ag lime contains approximately 800 lbs of calcium and the cost of liquid lime is very expensive. Where practical options are available, make your choice of liming material based on solid, research-based information. A preliminary study conducted at the University of Kentucky indicated no benefit from the application of liquid calcium compared to Ag or pelletized lime in a soil incubation study (Figure 1). The treatments were no lime (check), liquid calcium at 5 gallons per acre, and ag and pelletized lime applied at two tons per acre. All treatments were adjusted for RNV. There was no change in pH when soil samples were taken over twelve months. A similar response was also observed in a field study conducted on bermudagrass across 16 locations (Fig. 2). There were yield benefits in bermudagrass with liquid calcium just because of the calcium utilization by the grass (Figure 3). Based on the calcium content, soil chemistry, and cost, liquid calcium products cannot be used to replace the calcium content and the soil-neutralizing ability of lime.

Summary – The objective in managing soil acidity is to reach a target pH range that optimizes forage production and nutrient availability. A good approach to having an effective nutrient management plan is testing your soil at regular intervals and if required, applying the correct rate and type of lime product to increase the soil pH to acceptable levels for forage growth. It is important to collect a soil sample and send it to a soil testing laboratory for a more accurate recommendation. Although portable soil test kits might be indicated a range of acidity in your soil, they do not provide the necessary accuracy to determine the rate of lime that needs to be applied. It is also important to take a soil sample that is representative of the pasture or hay field to determine other nutrient recommendations. Collecting a soil sample during the same time frame every two to three years will allow comparing values to previous soil tests and determining if there is a trend in soil pH change and the cause of such change. If you need further assistance with proper soil sampling of your pastures and hay fields, and interpretation of soil test results and recommendations, contact your local county Extension agent or the Mississippi State Forage Program.

Upcoming Events

Beef Cattle Field Day—March 30, 2023 | Newton, MS

For upcoming forage related events visit: ***http://forages.pss.msstate.edu/events.html***

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