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Paper Mill Lime and Lime Mud for Land Application

Pulp and paper mills use sodium hydroxide or caustic soda to digest wood chips into pulp for paper. During this process, sodium carbonate is formed. The mill then uses calcium oxide (also known as caustic lime, burned lime or quick lime) to convert the sodium carbonate back to sodium hydroxide. In the process, calcium carbonate is formed.



Dried paper mill lime wastes from 5 mills in Alabama.

This "precipitated" calcium carbonate is much more reactive than crystalline calcium carbonate found in ground limestone. Paper mill lime may also contain some hydrated lime (calcium hydroxide) but it also contains lots of water. Thus, many paper mills refer to this byproduct as "lime mud." It is very difficult to dry because of the tiny particle size of the suspended lime. Many paper mills have huge landfills full of this stuff. However, some mills have been successful in

removing much of the water and making their byproduct lime available as an alternative soil liming material.

Composition of paper mill lime

Average chemical composition of some Alabama paper mill lime samples are found in Table 1. The most important considerations for land application as a soil liming material are the total alkalinity (percent calcium carbonate equivalency) and the fineness. By state law, all ground agricultural limestone sold in Alabama must be no less than 90% calcium carbonate equivalent with 90% passing a 10-mesh screen (approximately 2 mm) and 50% passing a 60-mesh screen (approximately 0.5 mm). All but one of the samples in Table 1 exceed this minimum requirement. However, some products can be quite wet e.g., 49% moisture. These would present obvious problems in spreading. Also, most ground, Alabama limestone would contain significant magnesium even if it did not meet the minimum 6% Mg requirement for dolomitic limestone. Therefore, growers whose soils test low in Mg should not use paper mill lime or make sure that Mg is part of their fertilization program.

Low levels of metals and contaminants

Table 1 also indicates that paper mill lime is generally very low in metals that are often mentioned as a concern with other industrial and municipal byproducts. There are no sources of metal contamination in the pulping process. Alkaline materials such as those used in the pulping process also reduce the plant availability of most metals. A publication by the University of Georgia notes that metal content is usually about the same or lower than that of agricultural limestone (Gaskins et al., 2004). Organic contaminants such as dioxins are not present in this part of the pulping process.

Land Application

Because of the fine particle size of paper mill lime, it is more reactive than ground agricultural limestone. A field study in the early 1990s at the Black Belt Substation on a Vaiden clay compared paper mill lime with ground dolomitic limestone on a dallisgrass-fescue pasture. Both were surface applied based only on the calcium carbonate equivalency of each product. The paper mill lime raised the surface soil pH higher and faster than ground limestone (Fig. 1). It also maintained the pH for the 18-month study. Similar results were observed in an 84-day incubation study (Fig. 2). Therefore, if dry paper mill lime is applied at the recommended rate for ag. limestone, one should expect the paper mill lime to increase the soil pH higher and faster than would be expected from ag. limestone. This should not be a problem if the soil pH is monitored to avoid grossly over liming the land.

Problems have been reported by some growers who have spread wet or lumpy paper mill lime. Logically, large lumps cannot be uniformly spread over the soil. With lumpy lime, the tendency may be to over apply it in an attempt to get complete coverage of the land. On sandy, weakly buffered soils, over application could raise the pH above 7 and induce micronutrient deficiencies, mainly manganese, zinc, and iron deficiencies.

To improve the physical condition of paper mill lime, some companies have blended paper mill lime with boiler ashes to dry out the lime and make it more crumbly. Boiler wood ashes are also an effective soil liming material but ashes have a relatively lower calcium carbonate equivalency. Therefore, more of the ash-lime blend may be needed to achieve the desired soil pH. On the other hand, the addition of ash may increase the nutrient content of the resulting liming material.

Summary

Paper mill lime and lime mud may be a very effective, alternative soil liming material. For convenience, it may be applied at rates recommended for ground agricultural limestone but the soil pH must be monitored to avoid over liming. Paper mill lime and lime mud can be very difficult to dry and spread resulting in lumps. Some companies have managed to dry out this byproduct so it can be effectively land applied without any problems.

References

Gaskin, J., W. Miller, and L. Morris. 2004. Land application of pulp mill lime mud. Georgia Coop. Extension Service Bulletin #1249.

Muse, J.K., and C.C. Mitchell. 1995. Paper mill boiler ash and lime by-products as soil liming materials. *Agron. J.* 87:432-438.

Muse, J.K. 1993. Inventory and evaluation of paper mill by-products for land application. M.S. Thesis. Auburn University.

Table 1. Properties of six paper mill lime wastes from pulp and paper mills in Alabama (from Muse and Mitchell, 1995)

Property	Mean	Minimum	Maximum
pH	11.3	8.4	13.0
Bulk density (dry), g/cm ³	0.93	0.68	1.27
Total alkalinity, % calcium carbonate equivalency	102	91	109
Moisture, %	24	1	49
Particle size:	-----%-----		
>2.0 mm	5	1	13
>0.5 mm	24	5	54
>0.25	39	8	90
>0.106 mm	51	16	99
<0.106 mm	49	1	84
	-----mg/kg-----		
Aluminum (Al)	1280	630	2230
Arsenic* (As)	1.7	--	--
Boron (B)	8	5	10
Barium (Ba)	201	110	318
Cadmium (Cd)	0.3	0	0.6
Cobalt (Co)	6	5	9
Chromium (Cr)	67	50	95
Copper (Cu)	17	7	47
Iron (Fe)	1150	680	1920
Lead (Pb)	45	41	50
Magnesium (Mg)	7670	5680	10400
Manganese (Mn)	420	160	1070
Molybdenum (Mo)	5	4	5
Nickel (Ni)	35	4	158
Nitrate-N (NO ₃ -N)	8	1	20
Nitrogen (total N)	1780	1000	3000
Phosphorus (water soluble P)	2	0	24
Phosphorus (citrate insoluble P)	890	50	2520
Phosphorus (total P)	2040	1070	4970
Potassium (K)	470	130	920
Sodium (Na)	10800	3680	38000
Sulfur (S)	0.2	0.1	0.4
Zinc (Zn)	45	9	128
*Arsenic value from a single sample from Georgia reported by Gaskin et al., 2004.			

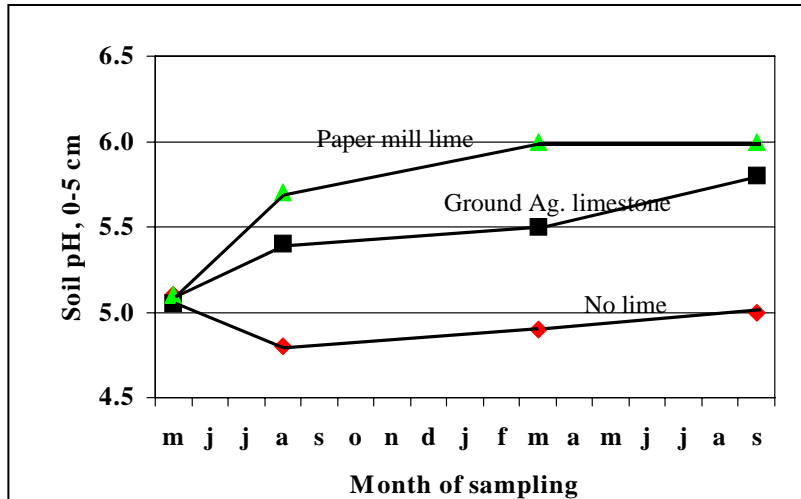


Fig. 1. Effect of ground agricultural limestone and paper mill lime on the surface pH of a pasture on a Vaiden clay when applied at comparable rates based only on the calcium carbonate equivalency of each product.

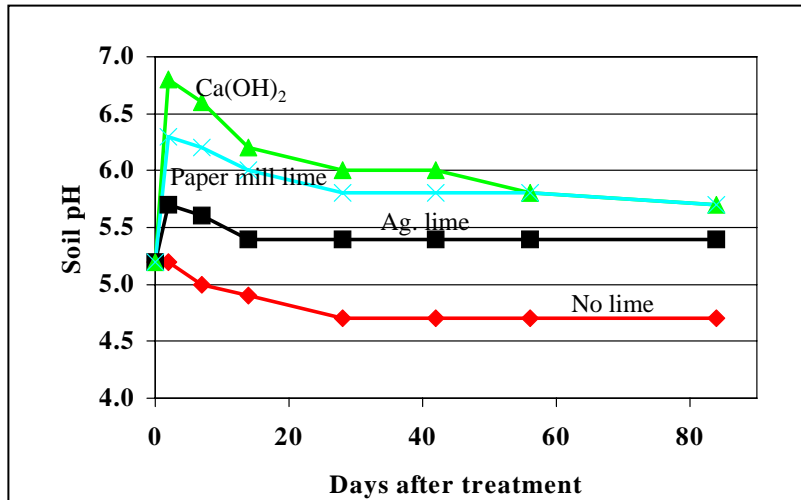
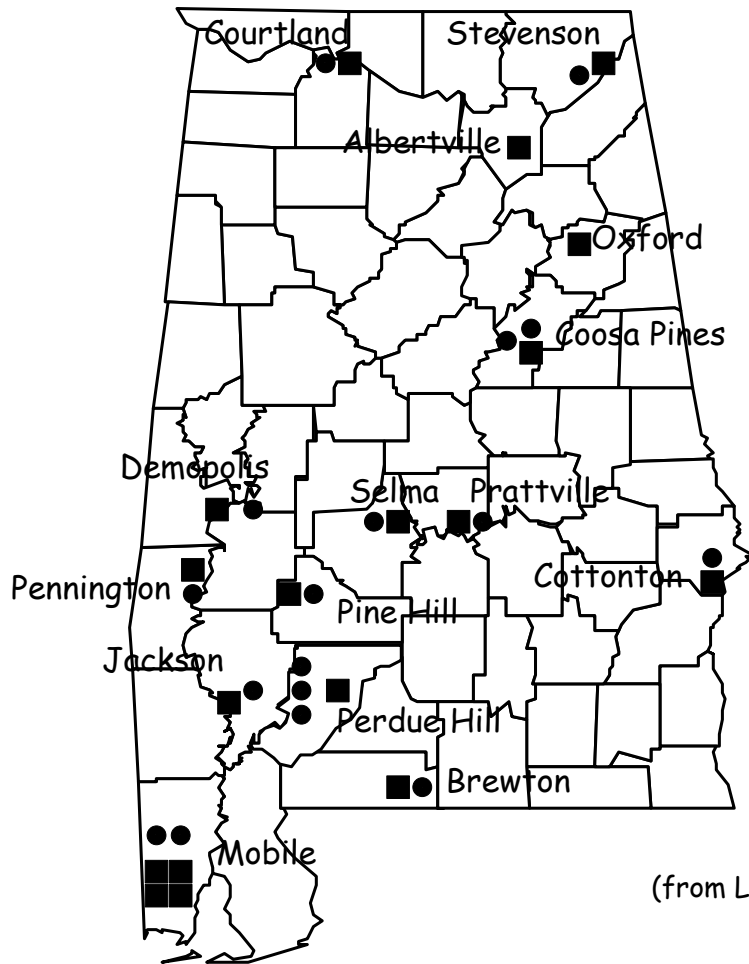


Fig. 2. Mean effect of 6 paper mill lime byproducts compared to reagent grade calcium hydroxide and ground dolomitic agricultural limestone applied to a sandy loam soil in an incubation study. All products were applied at comparable rates based only on each product's calcium carbonate equivalent (Muse and Mitchell, 1995).

Locations of Alabama Pulp and Paper Mills



- Paper Mill
- Pulp Mill

(from Lockwood-Post's Directory, 2003)

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