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# Effects of a Lime Slurry on Soil pH, Exchangeable Calcium, and Peanut Yields

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### ABSTRACT

The effectiveness of a low rate of lime slurry for peanut (*Arachis hypogaea* L.) production was evaluated on four Coastal Plain soils of southeastern Alabama. The four experimental sites were selected on farmers' fields because of their low soil pH and low exchangeable Ca. Lime was applied just prior to planting at a 560-kg/ha rate and at the recommended rate; lime sources included a slurry, an equally-fine dry limestone, and an agricultural-grade limestone. Soil pH and exchangeable Ca of the Ap horizon were measured by depth increments when crop was harvested. Lime slurry and dry lime at equivalent rates had identical effects on soil pH and peanut yields. The 560-kg/ha rate was inadequate for maximum peanut yields on Ca-deficient soils. The recommended rate of agricultural-grade limestone was more reactive than the low rate of lime slurry, and it also produced higher peanut yields.


Key Words: peanut, lime, lime slurry, soil pH, exchangeable calcium.

A recent innovation in liming soils is the use of finely ground limestone suspended in water. The suspension usually consists of about 50% limestone in 48% water and is stabilized with 2% attapulgite clay. Commonly used terms to identify this material include: lime slurry, fluid lime, liquid lime, and lime suspensions. Several recent articles have appeared in the trade journal "Fertilizer Solutions", pointing out the adaptability of this material to the equipment of the fluid-fertilizer dealer and listing its advantages as (i) uniform spread, (ii) no dust, (iii) rapid increase in soil pH, and (iv) precise pH adjustment (3, 4, 7, 8, 9).

The so-called "advantages" of lime slurry appear to be particularly applicable to peanuts (*Arachis hypogaea* L.) growing on the acid, low-base, sandy soils of the southeastern USA. Peanuts are susceptible to Ca deficiency on these soils while being relatively tolerant to Al phytotoxicity and sensitive to overliming injury. Thus, low rates of highly reactive, uniformly spread lime might be a feasible practice for peanut fields.

Because agricultural-grade limestone usually contains a significant fraction of relatively coarse particles, the lime slurry, because of its fineness, should be more effective on a pound-for-pound basis of actual material. This has led commercial applicators in southeastern Alabama to use about 1,120 kg per hectare (560 kg of actual limestone) on the premise that this would be enough to supply Ca and raise soil pH in the pegging zone above critical levels. The objective of the field experiments reported here was to determine if a low rate of lime slurry would meet the Ca and pH requirement for maximum yield of 'Florunner' peanuts where either was deficient.

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## Materials and Methods

Experimental sites were chosen on four different farms in southeastern Alabama. Each site represented a different soil type and was selected because a yield response to lime was indicated by a relatively low pH and low extractable Ca (Table 1). Reasonably uniform areas were large enough in three fields to accomodate six treatments, four replications, with each plot measuring 5.5 x 30 m. Physical constraints at the fourth field allowed only three treatments.

Three liming materials were chosen from local dealers in the area: (i) a fine, calcitic limestone used by the "lime slurry" dealer, (ii) a bagged, fine, dolomitic limestone, and (iii) a bulk, ag-grade, dolomitic limestone (Table 2). The "lime slurry" was applied by the commercial applicator (Ashford Gin Company, Ashford, Ala.) after calibration of the equipment. The dry limestones were uniformly spread with a small tractor-drawn fertilizer spreader. Lime was spread in April 1978 on turned land and incorporated into the top 7 to 10 cm of soil with a disk and rototiller. Lime was deliberately concentrated in the pegging zone of peanuts, where it was thought to be most critical, in order to provide the most favorable comparison for the low lime rates.

**Table 1. Some chemical properties of Ap horizon (~22 cm) of experimental soil areas prior to establishment of liming experiments.**

| County | Soil type | Soil pH | Extractable nutrients† Ca | Mg | K | P |
|---|---|---|---|---|---|---|
| | | | ---pp2m--- | | | |
| Barbour | Dothan sl (Plinthic Paleudults) | 4.9 | 140 | 15 | 21 | 11 |
| Henry | Faceville sl (Typic Paleudults) | 4.8 | 130 | 8 | 47 | 21 |
| Henry | Esto ls (Typic Paleudults) | 5.0 | 260 | 11 | 63 | 64 |
| Henry | Bonifay ls (Grossarenic Plinthic Paleudults) | 5.3 | 150 | 14 | 29 | 10 |

†Measured by double-acid (0.05 N HCl + 0.025 N $H_2SO_4$) extract procedure (5).

**Table 2. Calcium carbonate equivalence (CCE), Mg content, and particle-size distribution of limestone.**

| Material | CCE | Mg | Particle size <10 mesh | Particle size <60 mesh |
|---|---|---|---|---|
| | % | % | % | % |
| Slurry (calcitic) | 98.4 | 0.4 | 100 | 99 |
| Dry, fine (dolomitic) | 101.7 | 11.7 | 100 | 94 |
| Dry, ag-grade (dolomitic) | 104.2 | 12.2 | 96 | 50 |

†Analyses were made by Chemical Laboratory, Alabama State Department of Agriculture and Industries, Auburn, Alabama.

Table 3. Effect of lime sources and rates on soil pH and exchangeable Ca at different depths in the Ap horizon of four soils.

| Lime source and rate | Dothan sl | | | Faceville sl | | | Esto ls | | | Bonifay ls | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0-7 cm | 7-15 cm | 15-22 cm | 0-7 cm | 7-15 cm | 15-22 cm | 0-7 cm | 7-15 cm | 15-22 cm | 0-7 cm | 7-15 cm | 15-22 cm |
| kg/ha | Soil pH† | | | | | | | | | | | |
| 0 | 5.2 | 4.8 | 4.7 | 5.2 | 4.9 | 4.8 | 5.3 | 5.2 | 5.1 | 5.4 | 5.0 | 4.9 |
| 560 slurry | 5.4 | 5.0 | 4.7 | 5.4 | 5.0 | 4.8 | 5.5 | 5.2 | 5.0 | 5.7 | 5.4 | 5.1 |
| 560 dry fine | 5.5 | 5.0 | 4.7 | -- | -- | -- | 5.7 | 5.3 | 5.0 | 5.7 | 5.4 | 5.2 |
| Rec.§ slurry | 5.8 | 5.1 | 5.0 | -- | -- | -- | 6.3 | 5.7 | 5.2 | 6.5 | 6.1 | 5.5 |
| Rec.§ dry fine | 6.1 | 5.7 | 4.8 | 6.7 | 5.7 | 5.0 | 6.7 | 6.1 | 5.5 | 6.6 | 6.2 | 5.6 |
| Rec.§ ag-grade | 5.8 | 5.2 | 4.7 | -- | -- | -- | 6.4 | 5.9 | 5.3 | 6.0 | 5.8 | 5.3 |
| | Extractable Ca (pp2m)‡ | | | | | | | | | | | |
| 0 | 158 | 120 | 105 | 110 | 110 | 113 | 217 | 198 | 193 | 153 | 123 | 135 |
| 560 slurry | 203 | 143 | 115 | 190 | 135 | 115 | 310 | 238 | 203 | 218 | 200 | 160 |
| 560 dry fine | 228 | 123 | 128 | -- | -- | -- | 300 | 238 | 208 | 220 | 195 | 173 |
| Rec.§ slurry | 428 | 125 | 178 | -- | -- | -- | 944 | 508 | 308 | 603 | 425 | 248 |
| Rec.§ dry fine | 425 | 248 | 128 | 590 | 208 | 125 | 703 | 358 | 208 | 438 | 363 | 188 |
| Rec.§ ag-grade | 338 | 165 | 93 | -- | -- | -- | 513 | 330 | 230 | 358 | 255 | 193 |

†Measured in 1:1 soil:water suspension

‡Measured by double-acid (0.05 N $HCl$ + 0.025 N $H_2SO_4$) extraction (5)

§Rate recommended by Auburn's Soil Testing Laboratory as follows: 2,240 kg/ha for Dothan sl and Bonifay ls; 3,360 kg/ha for Faceville sl and Esto ls.

Table 4. Effect of lime rates and sources on yield and percent sound mature kernels (SMK) of Florunner peanuts on four soil types.

| Lime source and rate | Dothan sl | | Faceville sl | | Esto ls | | Bonifay ls† | |
|---|---|---|---|---|---|---|---|---|
| | Yield | SMK | Yield | SMK | Yield | SMK | Yield | SMK |
| kg/ha | kg/ha | % | kg/ha | % | kg/ha | % | kg/ha | % |
| 0 | 3,660 | 71 | 2,410 | 67 | 3,570 | 69 | 3,630 | 74 |
| 560 slurry | 4,390 | 77 | 2,590 | 71 | 3,470 | 70 | 4,040 | 76 |
| 560 dry fine | 4,720 | 75 | -- | -- | 3,950 | 67 | 3,960 | 75 |
| Rec.‡ slurry | 4,970 | 76 | -- | -- | 3,950 | 73 | 4,100 | 74 |
| Rec.‡ dry fine | 5,070 | 75 | 3,320 | 75 | 3,930 | 70 | 4,160 | 75 |
| Rec.‡ ag-grade | 5,210 | 76 | -- | -- | 3,890 | 67 | 4,290 | 75 |
| Dunnett's test at 5% prob. | 1,070 | 2.8 | 890 | 5.8 | 1,140 | 5.2 | 980 | 3.1 |
| C.V. | 13.3% | 2.2% | 19.4% | 5.0% | 17.5% | 4.4% | 15.8% | 0.6% |

†Farmer topdressed all plots with 675 kg/ha of gypsum at blooming.

‡Rate recommended by Auburn's Soil Testing Laboratory; see Table 3 for rates.

'Florunner' peanuts were planted by the growers as part of a larger field, and each grower followed his usual cultural practices from preplant fertilizer and herbicide applications through digging. After peanuts were harvested by plot with each farmer's combine, they were weighed, dried, and graded. Soil samples were taken by 7½-cm increments to a depth of 22 cm from each plot as soon after harvest as soil moisture allowed (soil was too dry to sample at harvest). Soil samples were taken from the undisturbed areas between digger swaths. Each soil sample was analyzed for pH and extractable bases.

## Results and Discussion

The major effect of each lime source and rate was manifested in the pH and Ca content of the upper 7 cm of soil, although changes at the 7- to 15-cm depth were also apparent (Table 3). Soil pH and extractable Ca were slightly higher at the 15- to 22-cm depth with recommended lime rates but not with either low rate. The effects of the lime slurry and dry lime at the low rate were indistinguishable. Also, there were essentially no differences in soil pH among sources at the recommended lime rate. There were differences in exchangeable Ca, however, because the lime slurry was calcitic while both dry limestones were dolomitic.

Yield and percent sound-mature-kernels (SMK) of peanuts were increased by lime applications (Table 4). However, experimental precision was generally low because of the natural variability (particularly pH and Ca) of these Coastal Plain soils within the experimental areas and, possibly, because of the diverse genetic base of the Florunner variety. Nevertheless, the data are adequate to support general conclusions.

*Dothan sandy loam.* The experiment followed 10 years of Coastal bermudagrass (*Cynodon dactylon* L.). The crop was under moderate drought stresses during August and September, but yields exceeded 4 metric tons/ha. Each recommended lime rate (slurry, dry fine, ag-grade) increased yield about 40% while each 560-kg rate increased yield about 25%. Each lime source and rate increased percent sound mature kernels (SMK) about equally, suggesting that the 560-kg lime rate was adequate to supply Ca in the 0- to 7-cm soil zone for maximum podfill but was inadequate to raise soil pH enough for maximum production.

*Faceville sandy loam.* The experiment followed several years of continuous corn (*Zea mays* L.). The crop experienced drought stresses during August and September. Only three treatments were possible on this area because of physical restraints. The recommended rate of dry lime increased yield almost 40% and SMK by eight percentage points. In contrast, the 560-kg rate of slurry did not significantly affect yield and increased SMK only four percentage points. Thus, the 560-kg rate of lime slurry was inadequate to produce either maximum yield of maximum SMK.

*Esto loamy sand.* The experiment followed corn. The crop suffered moderate drought stresses during August and September, but yields approached 4 metric tons/ha, No lime source or rate increased yield or SMK significantly.

*Bonifay loamy sand.* The experiment was located in a field that was in planted pines (*Pinus taeda* L.) between 1960 and 1976; it was planted to corn in 1977. The crop was largely free of drought stresses, and yields topped 4 metric tons/ha. The farmer inadvertently added 675 kg/ha of gypsum in a band over the rows to all plots at blooming, which appeared to largely negate a potential response to lime sources. However, it should not have affected the pH data nor the relative soil Ca data among liming treatments, particularly since the final soil samples were taken between the digger swaths.

Because of the variability in soil pH, extractable soil Ca, and peanut yields found with these experiments, practical considerations dictate that some interpretations be made outside purely statistical evaluations. For example, extractable Ca of several "check plots" was below the critical value of about 200 pp2m for soils of this area (2, 6). Yet, only two of the four experiments showed a statistically significant yield increase due to liming. Unless all four "check" plots of a particular experiment had less than the "critical" Ca level, then no statistical yield increase was obtained. For example, "check plot" Ca in the Esto soil ranged between 150 and 300 pp2m, and Dunnett's test showed no significant response to liming.

In order to utilize more effectively the relationship between extractable Ca and yield, the relative yield of individual check plots ("yield of check" ÷ "average yield of recommended lime rate" for that replication) was plotted against its extractable soil Ca (Fig. 1). For those "check plots" with <190 pp2m extractable Ca, there was a highly significant correlation between soil Ca and yield. (The solid line in Fig. 1 fits data points with Ca at <190 pp2m; the dashed line fits data points with Ca at 190 pp2m or more). These "low Ca" check plots included four from the Faceville soil, three each from the Dothan and Bonifay soils, and one from the Esto soil. Whereas analysis of variance data for individual experiments showed no statistical significance between yields of limed and unlimed plots on Bonifay and Esto soils, the graphed data in Fig. 1 show that three replications on Bonifay soil and two replications on Esto soil showed a yield response to lime.

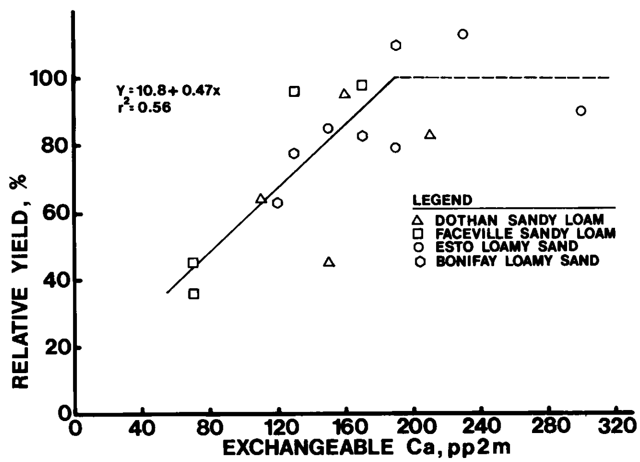


**Fig. 1. The relationship between relative yield of peanuts and the exchangeable Ca level of the uppermost 7 cm of soil of unlimed plots (equation describes solid line).**

# Summary and Conclusions

The reactivity rate of calcitic limestone is generally greater than that of dolomitic limestone (1), and, consequently, the calcitic lime slurry could have been expected to increase soil pH more than the dry dolomitic material. However, there was no difference in the effects of lime slurry and dry lime at equal rates of material on soil pH or on peanut yield and quality. The low rate of lime (560 kg/ha) was inadequate for maximum yield in these experiments where there was a clear need for additional Ca and an increase in soil pH. Even if the low lime rate had produced maximum yield, it is likely that it would have to be repeated annually. The reaction rate of agricultaral-grade limestone at recommended rates was adequate to meet the needs of peanuts for maximum yields. There was no evidence from the soil data or the yield data to suggest that lime slurry reacted with the soil significantly quicker than agricultural-grade material. As long as the lime reacted quickly enough to supply adequate Ca during the pod-filling stage, there seems to be no advantage for a material that might react sooner. Furthermore, it is probable that the agricultural-grade limestone (50% was <60 mesh) at the recommended rate actually contained more fine lime particles than did the low rate of slurry.

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