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The Nature Of Yield Responses Of Florunner Peanuts To Lime

Fred Adams* and D. L. Hartzog[1]

ABSTRACT

The effectiveness of spring-applied agricultural limestone and topdressed gypsum as Ca sources for Florunner peanut (*Arachis hypogaea* L.) production was determined in 78 on-farm experiments in southeastern Alabama during 1972-1979. Dolomitic and calcitic limestones were incorporated into the upper 10 cm of soil at a rate of 2.24 metric ton/ha, and gypsum ($CaSO_4 \bullet 2H_2O$) was topdressed at early bloom at 560 kg/ha. Limestone and gypsum were essentially equal sources of Ca except on a Bonifay sand where gypsum was inferior. Lime applied in this manner apparently increased yield and grade because of its Ca content and not because it increased soil pH. Limestone disked-in just prior to planting did not need a Ca supplement in the form of top-dressed gypsum. Only one instance of Mg deficiency was identified, and that was on a low-Mg soil with very little clay in its profile.

Key Words: peanut, *Arachis hypogaea*, soil pH, lime, calcium, acid soil.

Liming the acid soils of the southeastern USA has a long, sustained history of improving peanut (*Arachis hypogaea* L.) yields (1, 6, 7, 11, 12, 13). The major beneficial effects of liming are usually divided into the separate functions of (i) reducing Al toxicity, (ii) reducing Mn toxicity, (iii) increasing Ca availability, (iv) increasing Mg availability, and (v) increasing Mo availability (2).

The unique fruiting habit of the peanut makes it unusually susceptible to Ca deficiency (5), and Rogers (12) concluded that peanut yields were increased by liming because lime supplied needed Ca. Although lime is generally believed to benefit most crops by raising soil pH and precipitating soluble Al and Mn (2, 8), experimental proof that this is important in peanut production is lacking. Instead, there is evidence that the peanut has remarkable tolerance for both Mn (9) and Al (3).

As part of an on-farm soil fertility program with peanuts in southeastern Alabama, liming experiments were conducted with the objective of determining if spring-applied agricultural limestone incorporated to a depth of about 10 cm had benefits on peanut yields and grades beyond that caused by its Ca content.

Materials and Methods

The field experiments selected for this report cover the period of 1972-1979; all were planted to the Florunner cultivar to avoid possible differential responses caused by genetic differences. Each experiment was conducted for only 1 year at each site. Chosen sites were based on farmers' soil samples that indicated a possible yield response to lime or Ca according to the Auburn University Soil Testing Laboratory The individual farmers were responsible for all production procedures except lime application, gypsum application, and harvesting. Consequently, these data have resulted from a spectrum of growing conditions over an 8-year span that are representative of the peanut-producing area of Alabama.

[1]Professor of Soil Science and Agronomist-Peanuts, respectively, Department of Agronomy and Soils, Auburn University, Auburn, Alabama 36849.

Experimental sites were chosen that provided enough area for each plot to consist of six rows (0.9 m wide, 25 to 30 m long) and four replications. All experiments contained a check treatment and a liming treatment (2. 24 metric ton/ha of dolomitic limestone, 20% Ca) or a gypsum ($CaSO_4 \bullet 2H_2O$, 23% Ca) treatment (560 kg/ha); some contained both gypsum and liming treatments; some contained a lime-plus-gypsum treatment; some contained a calcitic limestone (36% Ca) treatment. Lime was broadcast on turned land and disked-in to a depth of about 10 cm just prior to planting; gypsum was broadcast over the row in a 30-cm band at early bloom.

After peanuts were harvested by plot with each farmer's combine, they were weighed, dried, and graded. Soil samples were taken fom the plow layer of the untreated plots and analyzed for pH and extractable bases by the double-acid method (0.05 *N* HC1 + 0.025 *N* H_2SO_4) (4).

Results and Discussion

For convenience of discussion, the experiments are grouped into the following categories: (i) lime versus gypsum, (ii) lime plus gypsum, (iii) calcitic versus dolomitic limestone, and (iv) yield response to soil Ca and pH.

Lime versus Gypsum. In an effort to determine if limestone and gypsum were equal sources of Ca or if limestone was beneficial beyond its Ca content, 16 experiments compared yield and sound-mature-kernel (SMK) percentage increases that resulted from applications of gypsum and dolomitic limestone (Table 1). The experiments were located on 10 different soil series, ranging in pH from 4.7 to 5.8 and from 82 to 680 pp2m in extractable Ca. Lime and gypsum increased yields in eight and seven experiments, respectively; both increased percentage SMK in nine experiments. Lime produced slightly more yield than gypsum in two experiments, considerably more in one, and slightly less in one. Gypsum produced slightly higher SMK values than lime in two experiments; lime and gypsum had the same effect on percentage SMK in all other experiments.

Although lime was superior to gypsum at three sites, these sites were not on the most acid soils as expected. Instead, it appeared to be at random (pH 5.0, 5.2, and 5.4), the greatest difference being on a Bonifay sand at pH 5.2. Furthermore, the one site in which lime appeared to be slightly inferior to gypsum for both yield and SMK was on a Red Bay sandy loam at pH 4.9 (only one soil had a lower pHo. Neither was dolomite's superiority de-

Table 1. A comparison of the effect of topdressed gypsum and pre-plant liming on yield and grade of Florunner peanuts in on-farm experiments in Alabama, 1972-1977.

Soil Series	Soil† pH	Extr. cations† Ca	Mg	K	Yield‡ No treat.	Gypsum	Lime	SMK‡ No treat.	Gypsum	Lime
		-------pp2m-----			----------kg/ha----------			---------%---------		
Bonifay s (Grossarenic Plinthic Paleudult)	5.2	82	8	26	360 a	1280 b	2730 c	61 a	73 b	74 b
Dothan ls (Plinthic Paleudult)	5.2	296	12	50	4010 a	3830 a	4310 a	72 a	74 a	73 a
Dothan sl (Plinthic Paleudult)	5.4	200	32	68	2360 a	2760 b	3140 c	68 a	77 b	76 b
Faceville sl (Typic Paleudult)	5.3	254	33	71	1920 a	1890 a	1980 a	67 a	67 a	68 a
Lucy ls (Arenic Paleudult)	5.2	121	9	50	1620 a	2070 b	2130 b	65 a	71 b	71 b
Lucy ls (Arenic Paleudult)	5.3	174	24	44	1400 a	2220 b	1940 b	61 a	69 b	66 b
Norfolk sl (Typic Paleudult)	5.8	680	142	181	2800 a	2640 a	2710 a	76 a	75 a	76 a
Orangeburg ls (Typic Paleudult)	5.2	163	11	34	2320 a	2810 ab	3430 b	69 a	75 b	72 b
Orangeburg ls (Typic Paleudult)	5.8	450	85	116	2910 a	2970 a	2800 a	66 a	65 a	65 a
Red Bay sl (Rhodic Paleudult)	4.9	128	15	81	1990 a	3170 c	2890 b	62 a	75 c	71 b
Red Bay sl (Rhodic Paleudult)	4.9	269	38	154	3850 a	3140 a	3280 a	75 a	77 a	76 a
Red Bay sl (Rhodic Paleudult)	5.2	254	12	70	3380 a	3200 a	3410 a	73 a	73 a	73 a
Red Bay sl (Rhodic Paleudult)	5.5	238	32	95	2960 a	3110 a	3070 a	64 a	70 c	67 b
Smithdale sl (Typic Paleudult)	4.7	195	28	99	2490 a	2630 a	2400 a	72 a	74 a	75 a
Sunsweet sl (Plinthic Paleudult)	5.0	213	27	109	860 a	1200 b	1510 c	68 a	72 b	72 b
Varina sl (Plinthic Paleudult)	5.4	160	27	60	1200 a	1770 b	1680 b	63 a	68 b	68 b

†From untreated plots after harvest.

‡Yields and SMK's of the same experiment followed by the same letter are not different at the 10% probability level.

pendent upon soil Mg. On soils were lime was superior to gypsum, extractable Mg ranged between 8 and 32 pp2m; nine other soils where lime was not superior also fell within this range of available Mg. Considering the overall data of these 16 experiments, lime appeared to do little more than serve as a source of Ca.

Lime plus Gypsum. Because it is frequently assumed that several months are required for lime to react with acid soils, gypsum is often recommended as a supplemental source of Ca the first year that a peanut field is limed. To determine the probable need of supplemental gypsum on limed soils, 12 experiments compared the effects of spring-applied lime with and without supplemental gypsum on yield and percentage SMK. The experiments were located on nine different soil series, varying in pH from 4.7 to 5.7 and in extractable Ca from 55 to 403 pp2m. (Table 2.). Yield and percentage SMK were increased by liming in seven experiments. In no case, however, did supplemental gypsum increase yield; SMK may have been increased by extra Ca in one experiment (Orangeburg sl). These data show that spring-applied lime provided all the Ca needed for maximum yield and grade when it was properly incorporated into the pegging zone.

Table 2. The effects of pre-plant liming with and without supplemental Ca as gypsum topdressing on yield and grade of Florunner peanuts in on-farm experiments in Alabama, 1974-1979.

Soil Series	Soil pH†	Extr. cations† Ca	Mg	K	Yield‡ No treat.	Lime	Lime & Gypsum	SMK‡ No Treat.	Lime	Lime & Gypsum
		------pp2m------			----------kg/ha----------			---------%---------		
Bonifay s (Grossarenic Plinthic Paleudult)	5.2	82	8	26	360 a	2730 b	2520 b	61 a	74 b	76 b
Bonifay ls (Grossarenic Plinthic Paleudult)	5.2	97	13	40	2650 a	3660 b	3830 b	63 a	70 b	70 b
Cowarts ls (Typic Hapludult)	5.1	102	11	30	2800 a	4020 b	4360 b	65 a	71 b	71 b
Dothan sl (Plinthic Paleudult)	5.2	296	12	50	4000 a	4310 a	4140 a	72 a	73 a	72 a
Dothan sl (Plinthic Paleudult)	5.4	200	32	68	2360 a	3140 b	2920 b	68 a	76 b	78 b
Lucy ls (Arenic Paleudult)	5.2	121	9	50	1620 a	2130 b	2460 b	65 a	71 b	73 b
Orangeburg ls (Typic Paleudult)	5.2	163	11	34	2320 a	3430 b	3520 b	69 a	72 b	72 b
Orangeburg sl (Typic Paleudult)	5.1	220	40	90	2480 a	2950 a	2820 a	68 a	71 ab	75 b
Red Bay sl (Rhodic Paleudult)	4.9	269	38	154	3850 a	3280 a	3190 a	75 a	76 a	75 a
Rumford ls (Typic Hapludult)	5.7	403	85	75	3900 a	3630 a	3530 a	69 a	69 a	69 a
Smithdale sl (Typic Paleudult)	4.7	195	28	99	2490 a	2400 a	2280 a	72 a	75 a	73 a
Troup ls (Grossarenic Paleudult)	4.8	55	4	14	710 a	2390 b	2430 b	66 a	70 b	73 b

†From untreated plots after harvest.

‡Yields and SMKs of the same experiment followed by the same letter are not different at the 10% probability level.

Calcitic versus Dolomitic Lime. There is almost no experimental evidence that Mg is needed as a fertilizer supplement for peanut production in the southeastern USA. Yet, the sandy surface soils on which peanuts are grown are generally relatively low in exchangeable Mg. To ascertain the probable need for Mg on such soils, six experiments compared the effects of calcitic and dolomitic limestones on yields. The experiments were located on five soil series, varying in pH from 4.7 to 5.3 and in exchangeable Mg from 7 to 28 pp2m (Table 3). Yields were increased by liming in two experiments; in one of these, dolomitic limestone outyielded calcitic by 560 kg/ha. The apparently Mg-deficient soil was a Troup loamy sand, a soil with 7 pp2m extractable Mg in the plow layer and only minor clay accumulation in its profile. All other soils in these experiments had clayey subsoil horizons within the normal rooting zone. These clayey horizons provide a zone for available Mg accumulation, analogous to that reported for K by Woodruff and Parks (14). These data show that surface-soil exchangeable Mg can be quite low without affecting peanut yields, and the suggestion is made that Mg sufficiency may well be determined by the level found in subsoil horizons.

Data in the "lime versus gypsum" section above (see Table 1) also show that differences in responses to dolomitic limestone and gypsum could not be explained consistently on the basis of exchangeable Mg. For example, dolomite was far superior to gypsum on a Bonifay sand with 8 pp2m Mg, but it was only equal to gypsum on other soils at similar Mg levels (9-12 pp2m).

Yield Response to Soil Ca and Soil pH. In addition to the above experiments, there were 44 other experiments on farmers' fields in which the effect of either gypsum or a liming material on yield and SMK was determined. Instead of tabulating the results from these separate experiments, the results of all 78 experiments, which include responses to both gypsum and lime, are graphed in Fig. 1. The relative yield of each check treatment (Ca-treatment yield = 1.00) is graphed as a function of the check-treatment soil-Ca level. Although data points scatter appreciably about the drawn lines, the critical Ca level, as determined by the intersection of the two lines, is 0.62 meq/100 g (250 pp2m), a value that corresponds closely to earlier values obtained in Alabama for other runner-type peanuts (7,12).

To determine the effect of soil pH on yield, the relative yield of check treatments in all experiments containing a liming treatment was graphed as a function of the check-treatment soil pH (Fig. 2). In spite of the generally positive correlation between Ca saturation and soil pH and the rather good correlation between soil Ca and yield, the data points appear to scatter randomly. The three data points of very low relative yield were on soils of very low Ca levels and indicate no positive

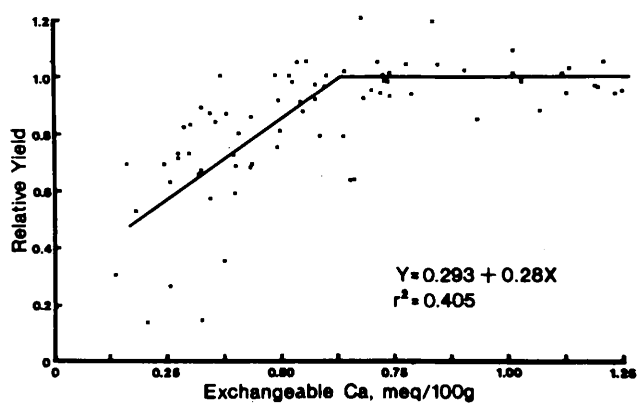

Fig. 1. Effect of extractable soil Ca on yield of Florunner peanuts (yield of Ca-amended plots assigned value of 1.0). Equation does not apply to horizontal line.

Table 3. A comparison of the effects of calcitic and dolomitic limestone on yield of Florunner peanuts in on-farm experiments in Alabama, 1975-1976.

Soil Series	Soil† pH	Extr. cations† Ca	Mg	K	Yield‡ None	Calcite	Dolomite
		--------pp2m------			------------kg/ha------------		
Dothan ls (Plinthic Paleudult)	5.0	214	10	70	2990 a	3000 a	2720 a
Dothan sl (Plinthic Paleudult)	5.3	237	18	68	4180 a	4050 a	4050 a
Iuka ls (Aquic Udifluvent)	5.1	148	14	55	3580 a	3650 a	3480 a
Red Bay sl (Rhodic Paleudult)	4.8	128	16	156	2600 a	3960 b	3890 b
Smithdale sl (Typic Paleudult)	4.7	195	28	99	2490 a	2440 a	2400 a
Troup ls (Grosarenic Paleudult)	5.1	138	7	16	3450 a	3750 b	4300 c

†From untreated plots after harvest.

‡Yields of the same experiment followed by the same letter are not different at the 10% probability level.

correlation with soil pH. The data graphed in Fig. 1 and 2 strongly suggest that the role of lime in peanut production is to serve primarily as a Ca source. There is little indication in these data that liming increased yields by increasing soil pH and thereby reducing soluble Al levels, which agrees with earlier findings of Al tolerances by the plant (3) and of low-pH tolerance by their rhizobia (10).

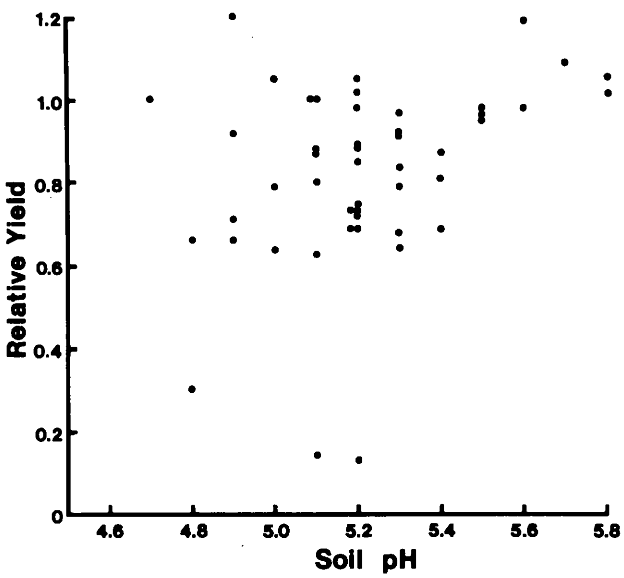

Fig. 2. Effect of soil pH on yield of Florunner peanuts (yield of limed plots assigned value of 1.0).

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