Runner and Virginia Type Peanut Response to Gypsum in Relation to Soil Calcium Level[1]

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ABSTRACT

Research reports relating peanut (*Arachis hypogaea* L.) response to gypsum at varying soil Ca levels are limited for the runner types and non-existent for the virginia type NC-7. Twenty-nine gypsum experiments were conducted from 1982 to 1987 with Florunner on six soils. Seven gypsum experiments were conducted on four soils with virginia types, six with NC-7 and one with Early Bunch. Pod yields of Florunner peanuts were increased by gypsum in 4 of 10 experiments with Mehlich-1 soil Ca ranging from 221 to 538 kg/ha and in all 7 virginia type peanut experiments with soil Ca ranging from 168 to 1559 kg/ha. However, soil Ca concentration influenced the degree of response of the virginia types since pod yield response to gypsum declined with increased soil Ca concentration and reached 95% of maximum yield at 1544 kg soil Ca/ha. The percentage of sound mature kernels (SMK) of Florunner peanuts was not affected by gypsum, but the SMK and extra large kernels of the Virginia types were increased by gypsum up to 540 kg soil Ca/ha. Soil pH varied from 5.4 to 7.4 and there was a high correlation between soil pH and soil Ca, but there was no indication that soil pH, per se, was influencing the results. Data indicate that the critical soil Ca concentration was at least 538 kg/ha for Florunner peanuts and was near 1600 kg/ha for the NC-7 virginia type.

Key Words: *Arachis hypogaea* L., fertilizer, groundnut, soil Ca extractant, quality.

Research reports relating runner type peanuts to gypsum at varying soil Ca levels are limited except those from Alabama (AL) (1, 7, 8). Even though 63% of the runner type peanuts in the United States are produced in Georgia (GA) (10), results from only nine gypsum experiments on runner types in GA have been reported (16, 17, 19, 20, 21). These experiments were conducted from 1975 to 1981 on four soils with Mehlich-1 (9) extractable soil Ca ranging from 215 to 818 kg/ha. Significant (0.05) pod yield response to gypsum occurred in four experiments with soil Ca concentrations <356 kg/ha. Pod yield responses to gypsum in AL have occurred only with soil Ca <260 kg/ha (1).

Data relating virginia type peanut response to gypsum at varying soil Ca levels have been reported from 21 experiments in GA involving four soils (5, 16, 17, 18, 20, 21). In these experiments, conducted from 1975 to 1986, significant (P = 0.05) pod yield response occurred in 13 experiments with Mehlich-1 soil Ca concentrations ranging from 215 to 850 kg/ha. The percentages of sound mature kernels (SMK) and extra large kernels (ELK) were increased by gypsum up to the highest soil Ca concentration of 850 kg/ha. Other research has indicated a critical soil Ca level of about 560 kg/ha for the virginia type (4).

Further research is needed to determine the critical soil Ca level for both types of peanuts. The objective of this study was to investigate responses of runner and virginia type peanuts to gypsum application in soils with different Ca levels.

Materials and Methods

From 1982 to 1987 gypsum experiments were conducted on 29 sites with runner (Florunner) and on seven sites with virginia type (one with Early Bunch and six with NC-7) peanuts. All experiments were conducted at the Coastal Plain Station, Tifton, GA except for one on a Greenville soil at the Southwest Branch Station, Plains, GA. Runner types were grown on six and virginia types on four soils. Classification of these soils are: Tifton and Dothan - fine-loamy, siliceous, thermic Plinthic Paleudults; Fuquay and Stilson - loamy, siliceous, thermic arenic Plinthic Paleudults; Pelham - loamy, siliceous, thermic arenic Paleaquults; Ocilla - loamy, siliceous, thermic aquic arenic Paleudults; and Greenville - clayey, kaolinitic, thermic Rhodic Paleudults.

Fertilizer was applied according to soil test recommendations (12) and areas were moldboard plowed to a depth of 25 cm. Plots were four rows spaced 0.92 m apart and 6.1 m long. Treatments were no gypsum and 560 kg of gypsum/ha and replicated four or five times in a randomized complete block design. Peanuts were seeded about 7.6 cm apart in May. Soil samples were collected at the 0 to 7.5 cm depth three weeks after planting. Granular gypsum (-4 + 20 mesh) containing 25% ≥ 20% Ca was applied in a 46 cm band over the row about 45 days after planting. Recommended cultural practices were employed including weed, insect, and leaf disease control. Yield was taken from the two-center rows of the four-row plot and pod weight was calculated at 8% moisture. Percent maximum yield was determined as yield mean without gypsum divided by yield mean with gypsum times 100. A 500 g pod sample was used to determine the SMK of runner and virginia types and the ELK of virginia types.

Soil pH was determined on a 1:1 soil:water ratio. Calcium was extracted from the soil on a 1:4 (weight:volume) ratio using Mehlich-1 (0.05 M HCl + 0.0125 M H_2SO_4) extractant and determined by atomic absorption spectroscopy.

The Statistical Analysis System was used in the analysis of variance and in developing regression equations (14).

Results

Runner type. Soil pH values ranged from 5.4 to 7.4 in 26 sites and soil Ca concentrations from 221 to 1559 kg/ha in 29 sites with Florunner peanuts (Table 1). Significant yield response to gypsum occurred in only four of 29 experiments and in those four sites soil Ca concentrations ranged from 221 to 538 kg/ha. However, gypsum did not elicit a yield response in 10 of 14 experiments within that soil Ca range.

Correlation coefficients indicated that there was no significant relationship between soil pH and pod yield of Florunner peanuts either for the no gypsum or gypsum treated plots since the r values were - 0.08 and - 0.09, respectively. However, soil pH was highly correlated (P = 0.01) with soil Ca (r = 0.85).

The percentage of SMK of Florunner peanuts was not affected by gypsum regardless of soil Ca concentrations in any of the 23 experiments in which this measurement was taken (Table 1).

There was no significant relationship (r = 0.06) between soil Ca concentration and percent maximum yield for the no gypsum treatment of Florunner peanuts, but significant yield response to gypsum did occur at certain soil Ca concentrations as indicated in the summary data (Table 2). Gypsum increased yields in one of two sites and in three of 10 sites where soil Ca concentrations were <250 and between 401-550 kg/ha, respectively. Yields were not increased by

[1]Contribution from the University of Georgia Agricultural Experiment Stations. Research was partially supported by a grant from the Georgia Agricultural Commodity Commission for Peanuts.

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Table 1. Influence of soil Ca on Florunner peanut response to gypsum in Georgia.

No.	Soil type	pH	Soil Ca	Pod yield control	Pod yield gypsum		Sound mature kernels control	Sound mature kernels gypsum	
			kg/ha				%		
1	—	—	221	6465	6689	*	—	—	
2	Pelham s	5.4	222	4768	4474	NS	73	74	NS
3	Ocilla s	6.0	273	3438	3608	NS	—	—	
4	Fuquay ls	5.9	296	3634	3616	NS	—	—	
5	Tifton ls	5.6	347	5163	4823	NS	75	75	NS
6	—	—	411	4735	4883	NS	—	—	
7	—	—	411	4527	4621	NS	—	—	
8	Pelham s	5.4	420	3964	4822	*	73	76	NS
9	Dothan ls	5.8	422	6101	6187	NS	75	75	NS
10	Tifton ls	5.8	428	5016	4577	NS	66	66	NS
11	Tifton ls	5.8	464	3275	3313	NS	—	—	
12	Tifton ls	6.0	507	2605	3122	*	77	78	NS
13	Ocilla ls	6.0	517	3951	4284	NS	74	73	NS
14	Fuquay s	6.4	538	4120	4320	*	64	65	NS
15	Pelham s	5.6	540	4891	4997	NS	76	75	NS
16	Tifton ls	6.0	568	4722	4452	NS	75	75	NS
17	Ocilla ls	6.5	584	3777	3942	NS	74	76	NS
18	Ocilla ls	6.2	591	2714	2939	NS	73	73	NS
19	Pelham s	6.2	606	4539	4573	NS	75	75	NS
20	Tifton ls	5.4	645	3516	3156	NS	76	76	NS
21	Pelham s	6.2	672	5126	5156	NS	73	73	NS
22	Tifton ls	6.4	760	4547	4590	NS	74	74	NS
23	Tifton ls	6.6	769	4257	4230	NS	73	73	NS
24	Greenville sl	6.4	902	5089	4995	NS	72	72	NS
25	Tifton ls	6.8	955	4219	4291	NS	74	75	NS
26	Tifton ls	6.4	1217	4133	4062	NS	74	75	NS
27	Pelham s	7.1	1239	4116	4287	NS	74	75	NS
28	Pelham s	7.0	1291	4077	4064	NS	76	75	NS
29	Pelham s	7.4	1559	4232	3989	NS	75	74	NS

*Significant at 0.05.

gypsum on three sites with soil Ca concentrations of 273-347 kg/ha and on 14 sites with Ca concentrations >550 kg/ha.

Table 2. Summary of the influence of gypsum on Florunner peanut yields in soils with varying levels of soil Ca.

Number Sites	Number Soils	Soil Ca range	Average pod yield with gypsum	Average increase or decrease over control	Number of significant sites (0.05)
		kg/ha			
			< 250 kg Ca/ha		
2	1	221-222	5582	35	1
			250-400 kg Ca/ha		
3	3	273-347	4016	-62	0
			401-550 kg Ca/ha		
10	5	411-540	4513	195	3
			> 550 kg Ca/ha		
14	4	568-1559	4195	-24	0

Virginia type. Soil Ca ranged from 168 to 1559 kg/ha and soil pH from 5.5 to 7.4 in seven experiments with virginia types (Table 3). Pod yields were increased (P = 0.05) by gypsum even at the highest soil Ca concentration. However, the percentage of SMK and ELK was increased by gypsum only up to a soil test level of 540 kg Ca/ha.

The yield increase of virginia type peanuts from gypsum declined with increased soil Ca concentrations (Table 3).

Table 3. Influence of soil Ca on virginia-type peanut response to gypsum in Georgia.

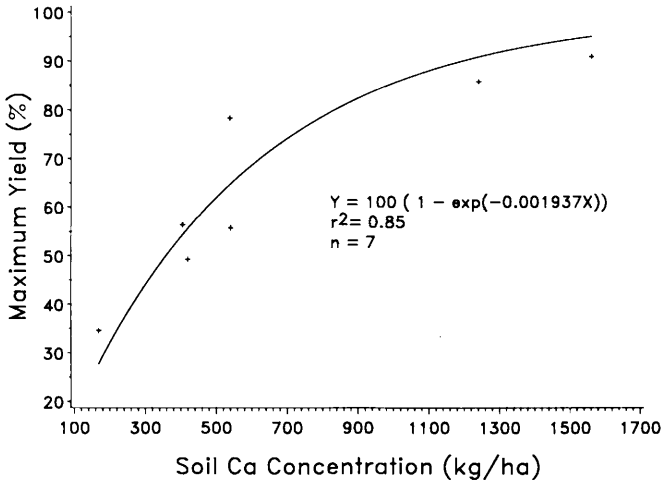
No.	Soil type	pH	Soil Ca	Pod yield control	Pod yield gypsum		Sound mature kernels control	Sound mature kernels gypsum		Extra large kernels control	Extra large kernels gypsum	
			kg/ha				%			%		
1.	Stilson fs[a]	5.5	168	1408	4063	*	33	66	*	—	—	
2.	Tifton ls	5.8	405	2550	4524	*	53	63	*	35	47	*
3.	Pelham s	5.4	420	2290	4641	*	63	70	*	44	53	*
4.	Fuquay ls	6.4	538	2785	3551	*	59	66	*	35	46	*
5.	Pelham s	5.6	540	2811	5042	*	65	71	*	44	54	*
6.	Pelham s	7.1	1239	4424	5159	*	69	69	NS	52	53	NS
7.	Pelham s	7.4	1559	4453	4891	*	70	70	NS	53	53	NS

*Significant at 0.05.

[a]Early Bunch was grown on the Stilson soil and NC-7 on the others.

This relationship is shown in Fig. 1. where there is a curvilinear effect ($r^2 = 0.85$) between soil Ca concentration and percent maximum yield without gypsum. Ninety-five percent of maximum pod yield without gypsum is projected at 1544 kg Ca/ha.

Fig. 1. The relationship between Mehlich-1 soil Ca concentrations (without gypsum) and maximum yield of virginia type peanuts.



There was a significant (P = 0.01) relationship between soil pH and soil Ca concentration (r = 0.94) which was very similar to that between soil pH and pod yield of virginia types without gypsum (r = 0.91). However, the relationship between soil pH and pod yield of virginia types with gypsum (r = 0.27) was not significant, indicating that soil pH, per se, had only a minor effect, if any, on pod yield.

Discussion

Data from 29 gypsum experiments with Florunner peanuts and seven experiments with virginia types show that the Ca requirement for large-seeded virginia types is greater than that for the smaller seeded Florunner. These data support earlier findings (16, 17, 20, 21). In a recent review, Cox *et al* (4) reported critical soil Ca concentrations for peanut types. The critical level for Florunner based on 78 experiments in AL (1) was 260 kg/ha. Similarly, the level for large-seeded virginia types was about 560 kg/ha based on research over several decades from sources in New Zealand (6), GA (18, 21), and North Carolina (3, 13, 15).

In this study the critical soil Ca concentration for Florunner peanuts was at least 538 kg/ha since yields were increased by gypsum in three of 10 experiments with soil Ca concentrations ranging from 420-538 kg/ha (Table 1), which is considerably higher than the 260 kg/ha reported from AL (1). The critical soil Ca concentration for virginia types was not reached even with soil Ca concentrations of 1559 kg/ha since significant yield response to gypsum occurred at this soil Ca level. However, soil Ca is influencing the degree of response since peanut response to gypsum declined with increased soil Ca concentrations (Fig. 1).

In some instances, gypsum has increased yields of Florunner peanuts in GA experiments on Fuquay (16, Table 1), Lakeland (19), Stilson (17), Pelham and Tifton (Table 1) soils when soil Ca concentrations ranged from 221 to 538 kg/ha and of virginia types on Fuquay (18, 19, 20, Table 3), Stilson (5, 17, Table 3), Pelham and Tifton (Table 3) soils when soil Ca concentrations ranged from 215 to 1559 kg/ha.

However, gypsum has not affected yield or quality of runner or virginia type peanuts grown on the Greenville soil where seven gypsum experiments were conducted with virginia and four with runner types with soil Ca concentrations ranging from 561-818 (17, 18, 20) and 641-902 (17, 19, 20, Table 1) kg/ha, respectively. In comparison with other soils, peanut response to gypsum on the Greenville soil would be expected for virginia types but not for runner types. The dark reddish-brown Greenville soil generally has a higher clay content than the dark gray or dark grayish brown Fuquay, Pelham, Stilson, and Tifton soils. Clay content in the A horizon generally ranges from 2-10% in the gray soils (2) and from 22-24% in the red Greenville soils (11) where the gypsum experiments on peanuts were conducted.

Soil Ca concentrations of 561-818 kg/ha were sufficient without gypsum for maximum yield of virginia type peanuts on the clayey, Greenville soils (17, 18, 20), but gypsum increased yield of virginia type on the sandier soils even at soil Ca concentrations > 1500 kg/ha (Fig. 1). Therefore, there is some indication that the relationship shown in Fig. 1 may not be applicable for virginia types grown on soils with greater clay content such as the Greenville soil.

Data from 13 gypsum experiments in AL show that gypsum increased yields of virginia types on three of four loamy sands with soil Ca concentration of 146 to 470 kg/ha but not on nine sandy loams with soil Ca concentration of 381 to 1154 kg/ha (8). Soil texture may be influencing peanut response to gypsum at varying soil Ca levels.

Further research is needed to determine the role of soil particle size in availability of soil Ca in soils varying in texture.

Acknowledgments

The authors are grateful for the cooperative effort of A. S. Csinos, C. S. Kvien, N. A. Minton, and A. C. Mixon, Coastal Plain Station, Tifton, GA 31793.

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Accepted November 11, 1989