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Effect of Gypsum on Yield, Grade and Incidence of Pod Rot in Five Peanut Cultivars[1]

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ABSTRACT

Five cultivars of peanuts, (*Arachis hypogaea* L.), Florunner, Tifrun, Florigiant, Ga. 194 Va. and Early Bunch, were grown at Tifton, Ga. on a Stilson loamy sand, low in calcium (356 kg/ha), and at Plains, Ga. on a Greenville sandy loam, relatively higher in calcium (752 kg/ha), for three years (1977-79) to study the response of yield, grade and incidence of pod rot with applications of gypsum. Plots were topdressed with 0, 560, 1120, or 1680 kg/ha of gypsum. Pod rot did not occur at Plains and no significant difference occurred among gypsum rates for yield, percentages of sound mature kernels (SMK), extra large kernels (ELK), and value/ha for any cultivar. However, significant differences were detected for these variables among cultivars. At Tifton, severe pod rot occurred on plots receiving no gypsum, but the severity decreased for all cultivars as the rate of gypsum applied was increased. Differences in yield, percentages of SMK, ELK, pod rot, value/ha and kernel calcium occurred among cultivars, grown at different gypsum rates. Florunner was significantly higher in yield, percent SMK, and value/ha than the other cultivars at all gypsum rates, and significantly lower in pod rot at 0 and 560 kg/ha gypsum. The amount of calcium in kernels increased for most cultivars as rates of gypsum increased. These data support previous work which indicated a suppression of pod rot and an increase in yield and kernel calcium with applications of gypsum.

Key Words: Quality, Value, *Arachis hypogaea* L., Calcium

Pod rot is a sporadic but common disease of peanut (*Arachis hypogaea* L.) which causes 12-30 million dollars of damage each year in Georgia (12). No effective control measures are available although several workers have investigated the disease (3, 5, 6, 7, 9, 10).

Garren (6) was the first to report that high rates of gypsum resulted in a reduction of rotted peanut pods. He indicated that applications of landplaster and elimination of organic matter from the fruiting zone contributed most to decreased pod rot, and suggested that Pentachloronitrobenzene (PCNB) may increase pod rot. Hallock and Garren (7) offered more support for the reduction in pod rot with high rates of gypsum and further reported that high rates of $MgSO_4$ (1345 kg/ha) and K_2SO_4 (1010-2020 kg/ha) increased pod rot incidence. These authors also suggested that pods containing 0.20% Ca or greater appeared to be less vulnerable to pod rot pathogens.

Porter *et al.* (10) evaluated 13 cultivars, 15 plant introductions, and 2 breeding lines for resistance to pod breakdown caused by ***Pythium myriotylum*** Drechs. and ***Rhizoctonia solani*** Kuehn. They indicated that resistance to these organisms seemed to have been derived from a cross between a small, white-seeded Spanish-type peanut, and a large-seeded Virginia-type peanut, Dixie Giant.

Since Ca plays an important role in peanut nutrition (1, 2, 11, 13), and gypsum is applied as a normal cultural practice by farmers, further investigation of calcium and its relation to peanut pod rot appeared to be warranted. Although, the authors are aware of the data generated in Virginia, (6, 7, 9, 10), it seemed desirable to learn the relationship of gypsum to peanut pod rot under Georgia's soil and climatic conditions on cultivars grown in this area. Therefore, several peanut cultivars were grown in soils with low and high indigenous soil Ca and topdressed with different gypsum rates for the purpose of studying the effect of gypsum on yield, grade and incidence of pod rot.

Materials and Methods

Experiments were conducted for three years (1977-79) at Tifton, Georgia on a Stilson loamy sand (Arenic Plinthic Paleudult; loamy, siliceous, thermic), and at Plains, Georgia on a Greenville sandy loam (Rhodic Paleudult; clayey, kaolinitic, thermic). Soil test values at the initiation of the experiment are shown in Table 1.

The experimental design was a split-plot with eight replications at Tifton and four replications at Plains. Whole plots (6.1 x 9.1m) consisted of four gypsum treatments, and sub-plots (1.8 x 6.1 m) were five peanut cultivars. The annual fertilization was 560 kg/ha of 5-10-15 fertilizer broadcast and incorporated. Vernolate (S-propyl dipropylthiocarbamate) and benefin (N-butyl-N-ethyl-∞, ∞, ∞-trifluoro-2,6-dinitro-p-toluidine) at 2.24 and 1.68 kg/ha respectively, were incorporated to 7.6 cm for weed control. Gypsum ($CaSO_4 \bullet 2H_2O$, approximately 72% $CaSO_4$ or 20% Ca) was applied in a 30 cm band centered over the row at early bloom at rates of 0, 560, 1120 and 1680 kg/ha. Seeding rates were Florunner and Tifrun at 132 kg/ha and Ga. 194 Va., Florigiant and Early Bunch at 128 kg/ha. Recommended cultural, insect, and disease control practices were followed and plots were irrigated as required. Peanuts were dug with a mechanical digger-shaker-inverter, allowed to dry in a windrow, and harvested with a peanut combine. Shortly after the peanuts were dug, each plot was evaluated for visual pod rot damage and given a rating of 0-5. Ratings were as follows: 0 = no damage; 1 = 1-20%; 2 = 21-40%; 3 = 41-60%; 4 = 61-80%; and 5 = 81-100% of pods rotted. Harvested peanuts were dried to 8.5% moisture. A 454 g sample of harvested peanuts was used for grade determination based on Federal-State inspection Service guidelines for determining percentages of sound mature kernels (SMK) and extra large kernels (ELK). The value (dollar) per hectare was based on yield, quality factors and federal support price for each year. Percent calcium in kernels was determined by the method of Gaines and Mitchell (4).

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Table 1. Initial soil pH values and extractable soil P, K, Ca, and Mg content of experimental plots at Tifton and Plains, Georgia.[1]

Location	Soil Type	pH[1]	P	K	Ca	Mg
			kg/ha			
Tifton, GA	Stilson loamy sand	5.6	136	84	356	52
Plains, GA	Greenville sandy loam	6.1	27	193	752	132

[1] Soil pH was determined with a 1:1 water:soil and P, K, Ca and Mg were extracted with double acid (0.05 $\underline{N}$ HCl + 0.025 $\underline{N}$ H_2SO_4) solution.

Results

The data collected over the three year test were similar each year, although statistically significant differences occurred among years for some of the dependent variables. The data presented are three year means for pod rot rating, yield and percentages of SMK, and ELK, and means of two years for value per hectare. Differences, where noted, are significant at $P = 0.05$.

Plains Location

Pod rot was not detected at the Plains location. No differences in grade or yield occurred among gypsum rates. However, significant differences in yield, value/ha and percentages of SMK, and ELK occurred among cultivars. Details are presented in Table 2.

Table 2. Three-year mean of yield, % sound mature kernels, % extra large kernels and value/ha for peanuts grown in Plains.[1]

Cultivar	Yield[2]	SMK	ELK	Value
	(kg/ha)	(%)	(%)	($/ha)
Florunner	4078 a	72.6 a	-	2400 a
Ga. 194 Va.	4080 a	63.5 cd	46.6 a	2514 a
Tifrun	3756 b	69.5 b	-	2183 b
Florigiant	3714 b	64.0 c	37.0 c	2110 bc
Early Bunch	3280 c	62.4 d	38.9 b	2043 c

[1] No significant difference ($\underline{P}$ = 0.5) was found among gypsum rates for cultivars. Means are a composite of all gypsum rates over three years, except for value, which is a mean of two years.

[2] Means followed by the same letter are not significantly different from each other according to Duncan's Multiple Range Test ($\underline{P}$ = 0.05).

Tifton Location

Yield

Application of gypsum increased yields for all cultivars (Table 3), but differences among rates were not significant except for Ga. 194 Va; yield increased significantly for plots receiving 1120 kg/ha and 1680 kg/ha gypsum over plots receiving 560 kg/ha. Florunner outyielded the other peanut cultivars at all gypsum rates. Generally the order from highest to lowest yield was Florunner, Florigiant, Tifrun, Early Bunch and Ga. 194 Va. The differences in yield among cultivars tended to decrease as the amount of gypsum applied increased.

Table 3. Three-year mean for yield for peanut cultivars topdressed with gypsum, Tifton location.[1]

Cultivar	Gypsum (kg/ha) 0	560	1120	1680
	Yield (kg/ha)			
Florunner	4765 a	5684 a	5621 a	5682 a
Tifrun	2935 b	4757 c	4763 c	5004 b
Ga. 194 Va.	2481 c	4583 c	5046 bc	5168 b
Florigiant	3062 b	5062 b	5126 b	5201 b
Early Bunch	2509 c	4677 c	4952 c	4945 b

[1] Means arranged vertically followed by the same letter and means arranged horizontally underscored by the same line are not significantly different according to Duncan's Multiple Range Test ($\underline{P}$ = 0.05).

Quality and Grade

The percentage of SMK increased with the addition of gypsum for all cultivars (Table 4). There were no differences among rates of gypsum for Florunner and Florigiant, but for Tifrun, Ga. 194 Va., and Early Bunch the addition of gypsum above the 560 kg/ha level further increased the percentage SMK (Table 4). Florigiant and Ga. 194 Va. had higher percentage ELK with the addition of gypsum (Table 5), but no differences occurred among rates. Early Bunch had a higher percentage ELK at 560 and 1120 kg/ha than at the 0 and 1680 kg/ha rates of gypsum. Ga. 194 Va. had higher percentage ELK than Florigiant and Early Bunch at the two highest rates of gypsum, but no differences occurred among cultivars at the two lowest rates. Early Bunch had a higher percentage ELK than Florigiant at only the 1120 kg/ha rate of gypsum.

Table 4. Three-year mean of percentage of sound mature kernels in peanut cultivars topdressed with gypsum, Tifton location.[1]

Cultivar	Gypsum (kg/ha) 0	560	1120	1680
	SMK (%)			
Florunner	71.1 a	75.7 a	76.3 a	76.0 a
Tifrun	61.2 b	70.2 b	71.1 b	72.5 b
Ga. 194 Va.	48.0 e	60.0 e	63.2 d	63.8 d
Florigiant	55.3 c	65.3 c	65.5 c	66.5 c
Early Bunch	52.0 d	63.3 d	65.5 c	65.8 c

[1] Means arranged vertically followed by the same letter and means arranged horizontally underscored by the same line are not significantly different according to Duncan's Multiple Range Test ($\underline{P}$ = 0.05).

Table 5. Three-year mean for percentage of extra large kernels in peanut cultivars topdressed with gypsum, Tifton location.

Cultivar	Gypsum (kg/ha) 0	560	1120	1680
	- - - - - - - - ELK (%)	- - -	- - -	- - -
Ga. 194 Va.	32.8 a	41.7 a	51.0 a	51.3 a
Florigiant	29.5 a	44.6 a	42.5 c	43.3 b
Early Bunch	31.8 a	44.5 a	46.4 b	39.5 b

[1] Means arranged vertically followed by the same letter and means arranged horizontally underscored by the same line are not significantly different according to Duncans Multiple Range Test (P = 0.05).

Pod Rot

Rotted pods sampled in 1977 were found to have a variety of fungi associated with them. *Pythium myriotylum* Drechs., *Rhizoctonia solani* Kuehn and *Fusarium solani* (Mart.) App. & Wr. emend Snyd & Hans. were found most frequently, and in several cases all three of the fungi could be isolated from a single rotted pod. These fungi were reported to be the microorganisms most frequently associated with peanut pod rot, (3, 5, 6, 8, 9) and the symptoms matched those occurring in the plots. For these reasons no further fungal isolations were made and only disease ratings were recorded.

The addition of gypsum decreased pod rot in all cultivars (Table 6). In Florunner, pod rot was decreased at all rates of gypsum, although no differences were detected among rates. In Tifrun, Florigiant and Early Bunch, pod rot was significantly decreased for treatments receiving 560 kg/ha gypsum and decreased again for treatments receiving 1120 and 1680 kg/ha. A significant reduction in pod rot occurred for Ga. 194 Va. treatments receiving 1680 kg/ha over 560 and 1120 kg/ha gypsum. Florunner had less pod rot than all other cultivars at the lowest rates of gypsum (0 and 560 kg/ha), but the differences in the amount of pod rot among cultivars decreased as the rates of gypsum increased.

Table 6. Three year mean for pod rot of peanut cultivars topdressed with gypsum, Tifton location.[1]

Cultivar	Gypsum (kg/ha) 0	560	1120	1680
	- - - - - - Pod rot index[2]	- - -	- - -	- - -
Florunner	1.7 a	1.0 a	0.6 a	0.6 a
Tifrun	3.5 cd	2.5 d	1.2 b	1.3 c
Ga. 194 Va.	3.0 b	2.0 c	1.6 b	1.1 bc
Florigiant	3.3 bc	1.6 b	0.8 a	0.9 ab
Early Bunch	3.7 d	2.2 cd	1.3 b	1.0 abc

[1] Means arranged vertically followed by the same letter and means arranged horizontally underscored by the same line are not significantly different according to Duncan's Multiple Range Test (P = 0.05).

[2] Pod rot index was as follows: 0 = 0%; 1 = 1-20%; 2 = 21-40%; 3 = 41-60%; 4 = 61-80%; 5 = 81-100% rotted pods.

Value

Value per hectare for all peanut cultivars was significantly increased with the addition of gypsum (Table 7). The value per hectare increased for Early Bunch and Ga. 194 Va. as the gypsum rates increased, but no differences were detected among rates for Florunner, Tifrun and Florigiant (Table 7).

Table 7. Two-year mean for dollar value per hectare of peanut cultivars topdressed with gypsum, Tifton location.[1]

Cultivar	Gypsum (kg/ha) 0	560	1120	1680
	- - - - - - Value ($/ha)	- - -	- - -	- - -
Florunner	2290 a	2735 a	2734 a	2791 a
Tifrun	1281 b	2028 c	2164 c	2209 c
Ga. 194 Va.	1040 c	2003 c	2259 bc	2393 bc
Florigiant	1305 b	2324 b	2442 b	2493 b
Early Bunch	995 c	2149 bc	2337 bc	2408 bc

[1] Means arranged vertically followed by the same letter and means arranged horizontally underscored by the same line are not significantly different according to Duncan's Multiple Range Test (P = 0.05).

Kernel Calcium

The percent calcium in the peanut kernels increased as the amount of gypsum increased for all cultivars except Florigiant (Table 8). No differences in the percent of calcium in the kernels occurred among the cultivars at 0 and 560 kg/ha rate of gypsum, but differences occurred at the two highest rates.

Table 8. Percent calcium in peanut kernels of five peanut cultivars topdressed with gypsum, Tifton location.[1]

Cultivar	Gypsum (kg/ha) 0	560	1120	1680
	- - - - - - - - - - Calcium (%)[2]	- - -	- - -	- - -
Florunner	0.037	0.040	0.057 a	0.060 a
Tifrun	0.040	0.047	0.057 a	0.063 a
Ga. 194 Va.	0.040	0.043	0.043 b	0.063 a
Florigiant	0.040	0.037	0.043 b	0.043 b
Early Bunch	0.030	0.040	0.043 b	0.047 b

[1] Data is mean of 1979 results.

[2] Means arranged vertically followed by the same letter and means arranged horizontally underscored by the same line are not significantly different according to Duncan's Multiple Range Test (P = 0.05).

Simple correlation coefficients and probabilities between any two of the variables measured were determined for the Tifton location (Table 9). In general, there was a significant negative correlation between pod rot and each of the other variables, and a significant positive correlation between any pair of variables, excluding pod rot.

Table 9. Correlation coefficients for relationships between variables averaged over three years (P = 0.0001), Tifton location.

	Yield (kg/ha)	Pod Rot (Index)	SMK (%)	ELK[1] (%)	Value[2] ($/ha)	Calcium[3] (%)
Yield (kg/ha)	-	-0.62	0.76	0.58	0.98	0.40
Pod rot (Index)	-	-	-0.60	-0.40	-0.74	-0.49
SMK (%)	-	-	-	0.48	0.78	0.43
ELK (%)	-	-	-	-	0.81	0.42
Value ($/ha)	-	-	-	-	-	0.40
Calcium (%)	-	-	-	-	-	-

[1] Values from only three Virginia-type cultivars.

[2] Value per hectare averaged over two years.

[3] Probability of percent calcium in kernels was 0.01. Means of 1979 data.

Discussion

Florunner consistently yielded higher and gave greater value per hectare than all other cultivars at Tifton under low soil calcium. Florunner appeared to be less dependent on gypsum fertilization than any of the other cultivars tested. Our data also suggests that cultivars having a high calcium requirement are more susceptible to pod rot.

The data presented here supports conclusions made by other workers (6, 7) that the incidence of pod rot is less as rates of gypsum applied to peanuts is increased. At Plains, where the soil calcium was relatively high, and the soil is well drained, no pod rot developed. At Tifton on a soil relatively low in calcium, differences in susceptibility to pod rot among cultivars and responses to gypsum application occurred. At the Tifton location the soil tended to remain wet for long periods of time after rainfall or irrigation which indicated that the soil was poorly drained. This may have been an additional factor favoring the high incidence of pod rot at that location. Populations of *Pythium myriotylum* are difficult to estimate because an adequate media for isolating the fungus from soil does not exist. Under a soil situation as found at the Tifton location we would expect the conditons for supporting high populations to be favorable. The effect of this soil condition on other fungi associated with pod rot is not known.

Porter *et al.* (10) indicated that Florunner and Florigiant were relatively resistant to pod rot compared to other cultivars tested, and that little difference occurred in susceptibility between the two cultivars. Our study at Tifton indicates there is a significant (P = 0.05) difference between the two cultivars in pod rot incidence at 0 and 560 kg/ha gypsum and a difference in yield, percentage of SMK and value/ha at all gypsum levels. Porter *et al.* (10) did not indicate the soil Ca level, but as suggested by our data, their study may have been in an area having a relatively high Ca level, thus explaining the differences between the two sets of data.

Our data do not give additional information to the cause of peanut pod rot, but support previous evidence that the disease may be reduced with gypsum. Garren (6) has suggested that calcium may be affecting the host or the pathogens. Moore and Wills (9) have indicated that in vitro gypsum does not prevent or reduce rotted pods caused by *Pythium myriotylum* or *Rhizoctonia solani*, the major fungal contributors of peanut pod rot. In our test, percent calcium in kernels increased with gypsum rate and correlated negatively with incidence of pod rot. These data are consistent with the hypothesis that calcium is acting directly on the host (7), perhaps strengthening cell walls or in vivo an unknown factor exists which under low calcium may be the incitant of peanut pod rot.

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