Effect of Calcium Sulfate on Pod Rot of Peanut

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ABSTRACT

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Several experiments were conducted to assess the effectiveness of calcium sulfate ($CaSO_4$) in reducing the severity of pod rot of peanut cv. Early Bunch in Oklahoma. In the greenhouse, peanut pods were grown in soil naturally infested with *Pythium myriotylum* and *Rhizoctonia solani* (AG-4) or in steam-pasteurized soil artificially infested with *P. myriotylum*. In field microplots, peanut pods were grown in methyl bromide-fumigated soil artificially infested with *P. myriotylum*, *R. solani*, or both pathogens. Calcium sulfate as agricultural gypsum was applied before pegging at 0, 1,120, or 2,240 kg/ha. Plants in fields with histories of pod rot received up to 3,360 kg/ha $CaSO_4$. Hulls from $CaSO_4$-treated pods showed an increase ($P = 0.05$) in Ca content compared with hulls of nontreated pods. However, there was no decrease ($P = 0.05$) in pod rot severity in treated pods, nor were yields significantly ($P = 0.05$) increased in any experiment. There was no apparent relationship between Ca content in hulls and pod rot severity. Rot was induced in pods by adding *P. myriotylum* and/or *R. solani* (AG-4) to pasteurized or fumigated soils. These fungi were routinely recovered from $CaSO_4$-treated or nontreated pods grown in pathogen-infested soils, but rarely from pods grown in noninfested soils. Our results show the importance of specific fungal pathogens to pod rot etiology in Oklahoma and argue against a hypothesis suggesting Ca deficiency in hulls as the primary cause of peanut pod rot.

Peanut pod rot, a worldwide soilborne disease, can be a limiting factor in peanut (*Arachis hypogaea* L.) production. In Oklahoma, 43% of 37 peanut fields sampled in 1983 had pod rot, and disease incidence in these fields was 5.0–36.7% (4). Infected pods show various degrees of discoloration, from superficial russeting to complete blackening of the hulls, plus various stages of hull and kernel decay. Pegs can be infected and the junction between peg and pod weakened to the extent that substantial loss of pods occurs at digging.

The disease is most often considered to be of complex etiology. Biotic factors implicated in the disease include phytopathogenic fungi (5,6,8,10,16), plant parasitic nematodes (7), and soil mites (17). *Pythium myriotylum* Drechs. and *Rhizoctonia solani* Kühn (AG-4) are considered (5,15,16) to be the principal fungi in the disease complex, although *Fusarium solani* (Mart.) Appel. & Wr. emend Snyd. & Hans. (6) and other soil fungi (16) have been reported to rot pods.

Garren (9) reported that high rates of calcium added to soil in the form of gypsum ($CaSO_4 \cdot 2H_2O$) (up to 8,960 kg/ha) effectively reduced pod rot. Further study (11) suggested that the calcium content of peanut pods was important in suppression of pod rot caused by *P. myriotylum*. Pods containing >0.20% calcium had less disease than those containing < 0.15% calcium. Moore and Wills (15), however, found no correlation between calcium rates and pod rot incited by *P. myriotylum* and/or *R. solani*. Csinos and Gaines (1) and Csinos et al (2) suggested that peanut pod rot is primarily an abiotic disease involving a calcium imbalance in the pod and is similar to the blossom-end rot of other fruits. In this view, phytopathogenic fungi are considered secondary in the etiology of the disease.

In Oklahoma, *P. myriotylum*, other *Pythium* spp., and *R. solani* (AG-4) have been consistently isolated from rotted peanut pods (4). Also, application of up to 3,360 kg/ha of gypsum has not reduced pod rot in some Oklahoma peanut fields (Filonow, *unpublished*). Therefore, a study assessing the role of calcium in reducing pod rot in Oklahoma was conducted. Specific objectives of the study were 1) to assess the effectiveness of $CaSO_4$ applications in reducing the severity of pod rot in soil infested with *P. myriotylum* and/or *R. solani* (AG-4), and 2) to ascertain possible relationships between calcium content of pods and pod rot severity. Preliminary results of this study have been presented (4).

MATERIALS AND METHODS

Fungi. *Pythium myriotylum* and *R. solani* (AG-4) were isolated from peanut pods showing symptoms of pod rot. Isolations were made from diseased shells that were surface-disinfected in 0.05% sodium hypochoride (v/v) for 45 sec, followed by 70% ethanol for 45 sec, and plated on cornmeal agar (CMA). *Pythium myriotylum* and *R. solani* were maintained on CMA and potato-dextrose agar (PDA), respectively.

For infestation of soils in greenhouse or microplot experiments, fungi were grown in 250-ml flasks or aluminum oven pans (42 × 31 × 7 cm), respectively, containing 5% (w/w) cornmeal in coarse sand (CMS) medium. Flasks contained 100 g of CMS, whereas the pans contained 3 kg. Water containing cholesterol (10 mg dissolved in 50 ml of 95% ethanol/L of water) was mixed into the CMS (30 ml/100 g CMS), and the CMS was autoclaved for 1 hr on two successive days before inoculation with *P. myriotylum* or *R. solani*. Cultures were incubated in the dark at 24–26 C for 1–2 mo before use.

Greenhouse experiments. Single plants of *Arachis hypogaea* var. *hypogaea* 'Early Bunch' were grown in 17 × 18 cm diameter plastic pots. In two experiments, plants were grown in soil (76% sand, 12% silt, and 12% clay; pH 8.1) naturally infested with *R. solani* and *P. myriotylum*, collected from a field with a history of severe pod rot. In two other experiments, peanut plants were grown in pasteurized loam soil (45% sand, 34% silt, and 21% clay; pH 5.4) that was artificially infested with *P. myriotylum*. Fifty days after planting, about 500 g of soil was removed from the pegging zones of each of six plants and the soil was composited in a plastic tray. Three CMS flask cultures of *P. myriotylum* plus a little water were comminuted in a blender to produce a slurry. The slurry was thoroughly hand mixed into the soil, and about 500 g of *P. myriotylum*-infested soil was added back to the pegging zone in each pot. Inoculum densities of infested soils in pots were determined by plating dilutions of soil onto a selective medium (3). Densities ranged from 4.4 to 6.1 propagules (p)/g of soil.

Before pegging (about 50 days after planting), calcium sulfate in the form of agricultural gypsum (Calsul 78% $CaSO_4$; Farm and Range Supply Co., Tulsa, OK) was applied to plants in naturally infested soil at a rate of 1,120 and 2,240 kg/ha.

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Plants in artificially infested soils were treated with 1,120 kg/ha about 60 days after planting. Control plants were grown in noninfested (pasteurized) or pathogen-infested soils without $CaSO_4$. Treatments were completely randomized in all experiments, with 15 plants per treatment in most experiments. In one experiment using artificially infested soil, there were seven plants per treatment. Plants were watered daily and fertilized once every 2 wk with Hoagland's solution (13) containing 1 g/L $Ca(NO_3)_2$ to ensure pod formation in the controls. Temperature in the greenhouse was 33–37C. Pods were harvested 3–4 mo after $CaSO_4$ application. Pod rot severity of pods was assessed using the following disease classes based on percentage of discoloration of pod surface: 1 = no discoloration; 2 = < 10% discoloration; 3 = 10–75% discoloration, and 4 = >75% discoloration. The presence of *P. myriotylum* or *R. solani* in discolored pods was determined by plating pieces of surface-disinfested hulls on CMA or PDA. Pods were counted, oven-dried (60 C for 48 hr), and weighed.

Microplot experiments. Microplots (2.4 × 2.4 × 0.23 m), located on the Plant Pathology Farm (Oklahoma State University), were constructed from railroad ties and filled with sandy loam soil (72% sand, 12% silt, and 16% clay; pH 6.6). Soil was fumigated with methyl bromide for 48 hr, then aerated for 10–14 days before planting. Seeds of Early Bunch were planted 10.2 cm apart in three rows 2.1 m long and spaced at 0.9 m per microplot. Soil from the pegging zone around the plants in some microplots was removed at flowering and replaced by soil artificially infested with *P. myriotylum* and/or *R. solani* that was prepared by mixing CMS pan cultures of a pathogen with pasteurized soil (1:4, w/w) in a cement mixer. Soil infested with both pathogens was prepared from equal weights of *Pythium*-infested and *Rhizoctonia*-infested soils. Infested soils were prepared 1 day before use and stored in a large plastic container that had been disinfected with 0.05% sodium hypochloride. Inoculum densities of *P. myriotylum* were determined as previously described (Greenhouse experiments). *Rhizoctonia solani* was determined by pelleting soil (12) on a selective medium (14). Inoculum densities of *P. myriotylum* or *R. solani* were 5.2–16.5 p/g of soil or 91–256 p/100 g of soil, respectively.

Before pegging (about 50 days after planting), $CaSO_4$ as agricultural gypsum was applied as a 30-cm band over plants in microplots at a rate of 2,240 kg/ha. The $CaSO_4$ was watered (about 2 cm) into the soil by sprinkler irrigation. Controls were plants grown in pathogen-infested microplots without $CaSO_4$ and in noninfested microplots with and without $CaSO_4$. Microplots were arranged in a randomized complete block design with four replications per treatment. Microplots were irrigated twice weekly (approximately 5 cm of water per week) from July to September, then as needed thereafter.

About 160–170 days after planting, plants in individual microplots were dug and threshed. Pods from each microplot were composited into a cloth bag, weighed, and stored at 5 C for 1–2 wk before disease rating. A 1,000-cm^3 subsample of each bag was taken and rated for pod rot severity as described. Isolations for fungi in hull pieces were made on PDA and CMA. The remaining intact pods were weighed before and after oven drying (60 C, 48 hr). The calculated percent of moisture was used to adjust the fresh weight to oven dry weight and yields were determined for each microplot.

Field experiments. Tests were conducted in fields naturally infested with *P. myriotylum* and *R. solani* and with histories of pod rot. The Wetumka, OK field was primarily a loamy fine sand (83% sand, 11% silt, and 6% clay; pH 6.7), whereas the Perkins, OK field was a loam (48% sand, 33% silt, and 19% clay). Plots consisted of two rows of Early Bunch, 12.2 m long and 0.91 m apart. Treatments were 1,120, 2,240, and 3,360 kg/ha agricultural gypsum applied as a 35-cm

Table 1. Pod rot severity of peanut cv. Early Bunch grown under greenhouse conditions in soil artificially infested with *Pythium myriotylum* with or without the addition of $CaSO_4$

	Mean fraction of pods[a]			
	Disease severity class			
Treatment	Clean	< 10%	> 10 to < 75%	> 75%
Noninfested	0.91a z[b]	0.08b z	0.01c y	0.00c y
P. myriotylum	0.08c y	0.15c z	0.50a z	0.28b z
P. myriotylum + $CaSO_4$ (1,120 kg/ha)	0.10c y	0.09c z	0.55a z	0.25b z

[a] Number of pods expressed as a fraction of the total assessed for pod rot severity. Values given are means of 15 replications. Means followed by the same letter are not different ($P = 0.05$), according to Duncan's multiple range test.
[b] Significance among disease severity classes for a treatment is indicated by a, b, and c. Significance among treatments for a disease severity class is indicated by y and z.

Table 2. Pod rot severity of peanut cv. Early Bunch grown under greenhouse conditions in naturally infested soil with or without the addition of $CaSO_4$

	Mean fraction of pods[a]			
	Disease severity class			
Treatment	Clean	< 10%	> 10 to < 75%	> 75%
Steam-pasteurized	0.73a z[b]	0.23b yz	0.04c x	0.00c x
Infested	0.21bc y	0.35a z	0.30ab yz	0.14c y
Infested + $CaSO_4$ (1,120 kg/ha)	0.04b x	0.15b y	0.43a z	0.38a z
Infested + $CaSO_4$ (2,240 kg/ha)	0.09c x	0.20ab y	0.33a yz	0.38a z

[a] Number of pods expressed as a fraction of the total assessed for pod rot severity. Values given are means of 15 replications. Means followed by the same letter are not different ($P = 0.05$), according to Duncan's multiple range test.
[b] Significance among disease severity classes for a treatment is indicated by a, b, and c. Significance among treatments for a disease class is indicated by x, y, and z.

Table 3. Calcium content (percent) in hulls of pods (representing pod rot severity classes) obtained from peanut cv. Early Bunch grown under greenhouse conditions in soil artificially infested with *Pythium myriotylum* with or without the addition of $CaSO_4$

	Percent calcium in hulls[a]			
	Disease severity class			
Treatment	Clean	< 10%	> 10 to < 75%	> 75%
Noninfested	0.34b y[b]	0.37b y	0.50a y	ND[c]
P. myriotylum	0.42b y	0.45b y	0.38b x	0.61a y
P. myriotylum + $CaSO_4$ (1,120 kg/ha)	0.73a z	0.70a z	0.61b z	0.70b z

[a] Determined by atomic absorption spectrophotometry. Values are the means of three determinations of a 10–20 pod composited sample representing each disease class. Means followed by the same letter are not different ($P = 0.05$), according to Duncan's multiple range test.
[b] Significance among disease severity classes for a treatment is indicated by a and b. Significance among treatments for a disease severity class is indicated by x, y, and z.
[c] ND = Not determined; no pods in this class.

band over the plants at pegging. Plots without gypsum were the controls. Treatments were arranged in a latin square design with four replications per treatment. Balan and Dual were incorporated before planting. Bravo 500 (1.2 L/ha) was applied six times during the growing season to control leaf spot diseases. Plants were dug, inverted, air-dried in the field for 3 days, and threshed. Pods were weighed following threshing and three 1,000-cm^3 samples were rated for pod rot severity using the disease severity classes described earlier.

Elemental analysis. Pods from experiments were analyzed for Ca content. Random subsamples were taken from pods in the four disease classes for all treatments. Hulls of pods were sent in coded envelopes to a soil and plant analysis laboratory (Servi-Tech, Inc., Dodge City, KS) for determination of total Ca.

Statistical analysis. All experiments were done twice and data were analyzed with a two-way analysis of variance or regression analysis. Differences between means were compared by using Duncan's multiple range test.

RESULTS

Greenhouse experiments. Steam-pasteurized soil, artificially infested with *P. myriotylum* in the pegging zone, produced pod rot in Early Bunch peanut, whereas pods from noninfested soil showed very little or no pod rot (Table 1). Pods from *P. myriotylum*-infested soil exhibited severe pod rot, where 28% of the pods had surface discoloration of 75% or more. *Pythium myriotylum* was consistently isolated from infected pods, but not from noninfected pods. Pod rot severity was not reduced ($P = 0.05$) by the addition of 1,120 kg/ha $CaSO_4$ to soil artificially infested with *P. myriotylum*. For instance, the fraction of pods from *P. myriotylum*-infested soil and *P. myriotylum*-infested soil plus $CaSO_4$ in the > 10% to <75% disease severity class were 0.50 or 0.55, respectively. Also, for the >75% disease severity class there were no ($P = 0.05$) differences (Table 1).

There was significantly more ($P = 0.05$) pod rot produced in naturally infested soil than in the same soil that had been steam-pasteurized (Table 2). Addition of 1,120 or 2,240 kg $CaSO_4$/ha did not reduce ($P = 0.05$) disease severity of pods grown in naturally infested soil.

Addition of $CaSO_4$ to artificially (Table 3) or naturally infested (Table 4) soils resulted in peanut hulls with greater ($P = 0.05$) Ca concentrations than those from soils receiving no $CaSO_4$, regardless of disease class. Calcium concentrations in hulls of pods from naturally infested soils (Table 4) without added $CaSO_4$ ranged from 0.37% to 0.51%, whereas Ca concentrations in hulls from soils receiving 1,120 or 2,240 kg/ha $CaSO_4$ were 0.87–1.37% or 0.81–1.54%, respectively. Calcium concentration was generally not lower ($P = 0.05$) in diseased hulls compared with healthy hulls (Tables 3 and 4). In some cases, pods in the most severe disease class (Tables 3 and 4) had more Ca in their hulls than pods from less severe disease classes.

Microplot experiments. Pod rot developed in fumigated soil to which *P. myriotylum* and/or *R. solani* were added in the fruiting zone of plants (Table 5), whereas pods from noninfested microplots had little or no discoloration. Isolations for fungi confirmed the presence of *P. myriotylum* and/or *R. solani* in discolored pods. Generally, *P. myriotylum* produced as much disease as *R. solani*. Both pathogens together did not cause greater disease than either pathogen alone. In both experiments a smaller percentage of pods from soil containing both pathogens was present in the most severe disease class than pods from soil with one pathogen. Calcium sulfate (1,120 kg/ha) did not reduce pod rot. The disease class distributions of pods from $CaSO_4$-treated plots were similar to those from plots without $CaSO_4$. There was no increase ($P = 0.05$) in yield (data not given) from $CaSO_4$-treated plots compared with nontreated plots. Hulls of pods from treated plots had about twice the Ca concentration compared with those from nontreated plots (Table 6). There was no evidence of decreased pod rot with increasing Ca content in hulls.

Field experiments. Data shown in Tables 7 and 8 are from the Wetumka, OK field test. Results from this test agreed very well with results (data not shown) from the Perkins, OK test. Pod rot was less severe in pods harvested from field experiments than from pods obtained from greenhouse or microplot studies. A greater percentage of infected pods from field experiments were in the low (< 10%) and intermediate (> 10% to < 75%) disease classes than in the most severe class (>75%). Linear regression analysis showed no reduction ($P = 0.05$) in disease severity resulting from application of up to 3,360 kg/ha $CaSO_4$,

Table 4. Calcium content (percent) in hulls of pods (representing pod rot severity classes) obtained from peanut cv. Early Bunch grown under greenhouse conditions in soil naturally infested with *Pythium myriotylum* with or without the addition of $CaSO_4$

	Percent calcium in hulls[a]			
	Disease severity class			
Treatment	Clean	< 10%	> 10 to < 75%	> 75%
Steam-pasteurized	0.43a y[b]	0.49a x	ND[c]	ND
Infested soil	0.37b y	0.34b x	0.37b y	0.51a y
Infested + $CaSO_4$ (1,120 kg/ha)	ND	0.87b y	1.04a z	1.37a z
Infested + $CaSO_4$ (2,240 kg/ha)	0.81c z	1.07b z	1.16b z	1.54a z

[a] Determined by atomic absorption spectrophotometry. Values are the means of three determinations of a 10–20 pod composited sample representing each disease class. Means followed by the same letter are not different ($P = 0.05$), according to Duncan's multiple range test.
[b] Significance among disease severity classes for a treatment is indicated by a, b, and c. Significance among treatments for a disease severity class is indicated by x, y, and z.
[c] ND = Not determined; no pods in this class.

Table 5. Pod rot severity of peanut cv. Early Bunch grown in microplot soils artificially infested with *Pythium myriotylum* and/or *Rhizoctonia solani* with or without the addition of $CaSO_4$

	Mean fraction of pods[a]			
	Disease severity class			
Treatment	Clean	< 10%	> 10 to < 75%	> 75%
Noninfested	0.65a z[b]	0.35b z	0.00c y	0.00c x
Noninfested + $CaSO_4$ (1,120 kg/ha)	0.61a z	0.39b z	0.00c y	0.00c x
P. myriotylum	0.00c y	0.05c y	0.68a z	0.27b z
P. myriotylum + $CaSO_4$ (1,120 kg/ha)	0.04c y	0.08c y	0.63a z	0.24b z
R. solani	0.03c y	0.06c y	0.63a z	0.28b z
R. solani + $CaSO_4$ (1,120 kg/ha)	0.01c y	0.06c y	0.63a z	0.30b z
Both pathogens	0.01c y	0.04c y	0.77a z	0.18b y
Both pathogens + $CaSO_4$ (1,120 kg/ha)	0.01c y	0.08c y	0.72a z	0.19b y

[a] Number of pods expressed as a fraction of the total assessed for pod rot severity. Values given are means of four replications. Means followed by the same letter are not different ($P = 0.05$), according to Duncan's multiple range test.
[b] Significance among disease severity classes for a treatment is indicated by a, b, and c. Significance among treatments for a disease severity class is indicated by x, y, and z.

nor did increasing $CaSO_4$ applications result in decreasing pod rot severity in any of the disease classes (Table 7). Calcium concentration in hulls in all disease classes showed a positive increase ($P = 0.05$) with increasing $CaSO_4$ applied to soil (Table 8). There was no relationship between the distribution of pods in disease classes and the Ca content in their hulls. Yields were not increased ($P = 0.05$) compared with nontreated plots by the addition of $CaSO_4$ (data not shown).

DISCUSSION

High rates (1,120–3,360 kg/ha) of $CaSO_4$ applied to soil in these tests did not reduce the severity of peanut pod rot. Personal observations (Filonow, *unpublished*) from pod rot disease surveys in Oklahoma also indicate that $CaSO_4$ applications of 3,360 kg/ha did not control pod rot. Therefore, the effectiveness of high-rate $CaSO_4$ applications to peanut soils, at least in Oklahoma, for the control of pod rot is questionable.

Csinos et al (1984) and Csinos and Gaines (1986) suggested that pod rot in Georgia results from an imbalance of Ca^{++} and other cations (K^+, Mg^{++}, and NH_4^+) in the fruiting zone, leading to a diminished uptake of Ca^{++} by the pod. According to their hypothesis, "the peanut pod rot complex is initiated by the same conditions that cause blossom-end rot of fruits." These workers view the disease as primarily abiotic in etiology, with fungi playing a secondary role. Their hypothesis is based on the following observations in Georgia: 1) decreased pod rot and increased yields from use of calcium sulfate, 2) positive correlations between the concentration of most elements in fruits and pod rot except calcium, which showed an inverse correlation, 3) inconsistent recoveries of *P. myriotylum*, *R. solani*, or *Fusarium solani* from decayed pods and low, fluctuating populations of these pathogens in soil during the growing season, and 4) the failure of fungicides specific for *Pythium* and *Rhizoctonia* to reduce pod rot severity.

Our results showed the importance of fungal pathogens in the etiology of peanut pod rot in Oklahoma. We found no decrease in pod rot severity, nor were yields increased, from the use of up to 3,360 kg/ha $CaSO_4$ in soils artificially or naturally infested with *P. myriotylum* and/or *R. solani*. This amount of applied $CaSO_4$ was several times that reported by Csinos et al (1984) to reduce pod rot of Early Bunch peanut in Georgia soils. There was a demonstrated uptake of Ca by peanut hulls in soils to which $CaSO_4$ was applied. However, there was no evidence of decreased pod rot with increasing Ca content in hulls. In fact, disease severity was often greatest in hulls having the greater concentration of Ca. We were able to induce pod rot by adding a specific fungal pathogen (*P. myriotylum* or *R. solani*) in steam-pasteurized soil in the greenhouse and in methyl bromide-fumigated soil in microplots. These fungi were easily recovered from infected pods, but rarely from noninfected pods. In addition, species of *Fusarium*, *Rhizopus*, *Penicillium*, and *Aspergillus* were encountered on infected hulls, particularly from microplots and larger field plots, but these showed no consistent association with infection.

In summary, our results contradict those of others (1,2) who showed significant reductions in pod rot severity or incidence resulting from $CaSO_4$ applications to peanut soils. The disparity in results obtained by different workers may be due to differences in soils, with some soils retaining more Ca^{++} under irrigation, or perhaps to factors related to inoculum potential of soils,

Table 6. Calcium content (percent) in hulls of pods (representing pod rot severity classes) obtained from peanut cv. Early Bunch grown in microplot soils artificially infested with *Pythium myriotylum* and/or *Rhizoctonia solani* with or without the addition of $CaSO_4$

	Percent calcium in hulls[a]			
	Disease severity class			
Treatment	Clean	< 10%	> 10 to < 75%	> 75%
Noninfested	0.17a y[b]	0.21a y	0.21a y	0.23a y
Noninfested + $CaSO_4$ (1,120 kg/ha)	0.38b z	0.48a z	0.42ab z	0.45ab z
P. myriotylum	0.17b y	0.21a y	0.16b x	0.25a y
P. myriotylum + $CaSO_4$ (1,120 kg/ha)	0.44a z	0.44a z	0.44a z	0.42a z
R. solani	0.18b y	0.25a y	0.27a y	0.22ab y
R. solani + $CaSO_4$ (1,120 kg/ha)	0.40a z	0.45a z	0.41a z	0.40a z
Both pathogens	0.15b y	0.20b y	0.26a y	0.28a y
Both pathogens + $CaSO_4$ (1,120 kg/ha)	0.36b z	0.40ab z	0.44a z	0.41ab z

[a] Determined by atomic absorption spectrophotometry. Values are the means of three determinations of a 10–20 pod composited sample representing each disease class. Means followed by the same letter are not different ($P = 0.05$), according to Duncan's multiple range test.
[b] Significance among disease severity classes for a treatment is indicated by a and b. Significance among treatments for a disease severity class is indicated by x, y, and z.

Table 7. Pod rot severity in peanut cv. Early Bunch grown in naturally infested field soil with and without the addition of $CaSO_4$

	Mean fraction of pods[a]			
	Disease severity class			
Treatment	Clean	< 10%	> 10 to < 75%	> 75%
No $CaSO_4$	0.33	0.48	0.15	0.04
$CaSO_4$ (1,120 kg/ha)	0.29	0.51	0.16	0.04
$CaSO_4$ (2,240 kg/ha)	0.29	0.52	0.14	0.05
$CaSO_4$ (3,360 kg/ha)	0.29	0.49	0.19	0.03
R^{2b}	0.01	0.00	0.02	0.01

[a] Number of pods expressed as a fraction of the total assessed for pod rot severity. Values given are means of four replications.
[b] Linear regression was performed on data for each disease severity class. R^2 = Coefficient of determination with N = 48.

Table 8. Calcium content (percent) in hulls of pods (representing pod rot severity classes) obtained from peanut cv. Early Bunch grown in naturally infested field soil with and without the addition of $CaSO_4$

	Percent calcium in hulls[a]			
	Disease severity class			
Treatment	Clean	< 10%	> 10 to < 75%	> 75%
No $CaSO_4$	0.26	0.20	0.26	0.38
$CaSO_4$ (1,120 kg/ha)	0.24	0.27	0.35	0.42
$CaSO_4$ (2,240 kg/ha)	0.30	0.41	0.39	0.62
$CaSO_4$ (3,360 kg/ha)	0.39	0.39	0.52	0.55
R^{2b}	0.71	0.82	0.94	0.64

[a] Determined by atomic absorption spectrophotometry. Values are the means of three determinations of a 10–20 pod composited sample representing each disease class.
[b] Linear regression was performed on data for each disease severity class. R^2 = Coefficient of determination with N = 48.

such as pathogen species or virulence, inoculum density, and environmental (abiotic or biotic) constraints on pathogen activity. Although pod rot may be caused by a single pathogen, e.g., *P. myriotylum* in this study, in natural field soils several pod-rotting fungi (5,8,10,16) and soil fauna (7,17) may be involved in a disease complex.

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