Reaction of Peanut Cultivars to Pythium Pod Rot and Their Influence on Populations of *Pythium* spp. In Soil[1]

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ABSTRACT

In four field experiments the peanut cultivars Florigiant and NC 7 were generally more susceptible ($P = 0.05$) than Pronto and Spanco to pod rot and sometimes more susceptible ($P = 0.05$) than Florunner, GK 7, Langley or Okrun. The pod rot susceptibility of Florunner, GK 7, Langley, Okrun, Pronto and Spanco was usually similar. No consistent cultivar differences ($P = 0.05$) among pod yields were observed. *Pythium myriotylum* was the dominant species isolated from infected hull pieces plated on a medium selective for pythiaceous fungi. No cultivar significantly reduced populations of *Pythium* spp. in the soils of their pegging zones. In 1987, populations of *Pythium* spp. in soils at Ft. Cobb and Madill, Oklahoma increased at 67 days after planting (DAP) but declined at 89 DAP. in 1988 a similar population trend occurred at Ft. Cobb at 89 DAP and at Enos, Oklahoma at 127 DAP. The increase and decline of *Pythium* spp. were probably not directly influenced by soil temperature or matric potential. The involvement of the peanut plant in the fluctuation of *Pythium* spp. in soil is a plausible explanation for this trend.

Key Words: Peanut, *Arachis hypogaea* L., *Pythium* species, peanut pod rot

Pod rot of peanut (*Arachis hypogaea* L.) occurs in many peanut growing regions of the United States and in other countries (22). In Oklahoma, 43% of 37 peanut fields sampled in 1983 had pod rot, and disease incidence in these fields ranged from 5.0 - 36.7% (6). Pod rot cost Oklahoma peanut growers about $3.4 million in lost yield in 1985 (A. B. Filonow, personal communication). Symptoms of the disease include various degrees of discoloration, from superficial russetting to complete blackening of the hulls, usually accompanied by various stages of hull and kernel decay (22). The junction between pegs and pods can be weakened by the disease, resulting in a substantial loss of pods at harvest.

Pod rot is usually considered to be of complex etiology. Nutrient imbalances, particularly calcium deficiencies in some soils have been implicated in pod rot etiology (3). Pod rot can also be caused by one of several fungal pathogens acting alone or in combination. Fungi that have been reported to cause pod rot are *Pythium myriotylum* Drechs. (5, 8, 10, 12), *Rhizoctonia solani* Kühn (5, 10, 12), and *Fusarium solani* (Mart.) Appel. & Wr. Emend Synd. & Hans. (8). Nematodes (11) and mites (25) have been implicated in the epidemiology of the disease syndrome. *Pythium myriotylum* is considered a major pathogen of peanut in Oklahoma (6) and elsewhere (22). Other species of *Pythium* are pathogenic to peanut (22), but little is known of their ability to cause pod rot or of their prevalence in Oklahoma peanut soils.

Management of Pythium pod rot in Oklahoma has been difficult. The fungicide metalaxyl, which is specific for oomyceteous fungi such as Pythium spp. has been used with variable success in reducing pod rot and increasing pod yield (4). Although fungicides active against *Pythium* spp. will probably remain an important component of Pythium pod rot management programs for some time, they may be more effective in combination with peanut cultivars exhibiting some resistance to Pythium pod rot. Genotypes derived from parents of spanish market types are less susceptible to pod rot (7, 23). Pronto and Spanco are examples of cultivars with spanish type pedigree that are frequently planted in Oklahoma; however, the field performance of these cultivars in reducing pod rot has not been very high or consistent (4; A. B. Filonow, personal observation). Moreover, little is known as to how Pronto and Spanco compare with other peanut cultivars for Pythium pod rot susceptibility under Oklahoma growing conditions.

Peanut roots (24) and pods (17) leak energy-rich components that may be utilized by phytopathogenic fungi for growth in soil (16, 21). Peanut cultivars may differ in their capacities to harbor *Pythium* spp. on roots, pods, or in surrounding soil. Cultivars with traits that suppress *Pythium* spp. may be useful over time in reducing the disease potential in Oklahoma fields. The influence of peanut cultivars on populations of *Pythium* spp. has not been reported.

The objectives of this research were to: (1) compare several peanut cultivars adapted to Oklahoma for their susceptibility to pod rot in the field, and (2) to compare cultivars for their influence on populations of *Pythium* spp. in soil. The effects of soil moisture and temperature on these populations were also determined.

Materials and Methods

Reaction of Cultivars to Pod Rot

In 1987, Pronto, Spanco, Florunner, Okrun, Langley and GK 7 were planted in fields at Ft. Cobb and Madill, Oklahoma. Soils in both fields were naturally infested with *P. myriotylum* and had histories of supporting pod rot. Soils at both locations had occasionally received over the years applications of N-P-K and gypsum and had soil fertility levels adequate for peanut growth. The Ft. Cobb field was located in the west-central region of Oklahoma. The soil was a fine sandy loam (62% sand, 24% silt and 14% clay). Soil analysis showed 78 kg/ha P, 405 kg/ha K, and 1055 kg/ha Ca at pH 6.9. The field at Madill was located in the southeastern region of Oklahoma within 10 miles of the Texas border. Soil at Madill was 65% sand, 19% silt and 16% clay with a pH of 6.6. Plots consisted of four rows, 6.0 meters long with 0.91 meter spacing, arranged in a randomized, complete block design. There were four replicates per cultivar. Two center rows were used for yield determinations and two outer rows were used for plant and soil sampling.

The peanut cultivars Pronto and Spanco (spanish market types); Florunner, Okrun, Langley and GK 7 (runner market types); and Florigiant (virginia market type) were treated with Granox PMF at 177.4 cc/45.36 kg of seed and planted at approximately 17 seeds per meter for the spanish types and 14 seeds per meter for the others. Cultivars were planted on May 12, 1987 at Madill and on May 13, 1987 at Ft. Cobb. Plots at Madill and Ft. Cobb were irrigated weekly with approximately 5 cm of water per irrigation.

Plant samples were collected at three random locations from the outside rows of plots at harvest and at two or three intervals prior to harvest to assess pod rot severity. Three plants were randomly dug from each border row of

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a plot, placed in large plastic bags and transferred to 5 C within 24 hours after collection. Pods were removed from the plants, washed under water and rated for pod rot severity using a disease assessment scale of 1-5, where 1 = no lesions on surface, 2 = 1-25% of surface with lesions, 3 = 26-50% of surface with lesions, 4 = 51-75% of surface with lesions and 5 = > 75% of surface with lesions. A weighted mean was used for the pod rot severity rating. The number of pods in each disease class was multiplied by the disease class and these values were summed. The sum was divided by the total number of pods rated. To determine the presence of *Pythium* spp. in infected pods, pieces of hulls from a randomly taken subsample of symptomatic pods were plated on a *Pythium* selective medium (PSM), containing 8 g Difco cornmeal agar, 12 g agar, 20 mg streptomycin sulfate, 20 mg penicillin G, and 10 mg pimaricin in one L of distilled water. For each replicate per cultivar there were 10-25 hull pieces placed on 2-5 plates of PSM. Plates were incubated at 25 C for 24-36 h. All isolates were subcultured on cornmeal agar and incubated at 37 C.

At Madill, Spanco and Pronto were harvested on October 2 and the other cultivars were harvested on October 16. At Ft. Cobb, Spanco and Pronto were harvested on October 5 and the other cultivars were harvested on October 26. At harvest, plots were dug with a peanut digger-inverter and threshed. Peanut pods were sacked, dried to approximately 10% moisture, cleaned, and weighed for pod yield.

Cultivars that were planted in 1987 plus NC 7, another virginia market type, were evaluated in 1988 at the Ft. Cobb location and in a grower's field in Enos, Oklahoma that had a history of supporting pod rot. The soil at the Enos location was a loamy sand (85% sand, 14% silt and 1% clay with a pH of 6.0). The experimental design and replication was the same as 1987. Plant samplings, isolations from pods for *P. myriotylum*, pod rot ratings and yield determinations were conducted as in 1987. At Ft. Cobb, the cultivars were planted on May 11. Spanish type cultivars were harvested on October 11, whereas the other cultivars were harvested on October 24. At Enos the cultivars were planted on June 6 and all eight cultivars were harvested on October 28.

Populations of *Pythium* spp. in Soil Planted to Cultivars

Soil from the pegging zones of three randomly chosen plants per row was collected with a garden trowel to a depth of 10-12 cm. The soil samples were composited in a plastic bag. All bags were temporarily kept in a styrofoam chest while in the field and transferred to 5 C within 24 hours. Populations of Pythium spp. in soil were estimated by plating 0.2 mL of a 1/10 dilution of soil in 0.1% (w/v) water agar on PSM. Dilutions of 1/50 were used when colonies per plate from a 1/10 dilution were 6-8 or more. There were five plates per dilution and plates were incubated at 24-26 C for 24 - 36 hours.

The matric potential of soil samples was determined from soil moisture release curves constructed from readings obtained with a soil moisture pressure plate apparatus (Soil Moisture Equipment Corporation, Santa Barbara, CA). Soil samples obtained during the population samplings were used. One sample per plot was assayed. Saturated soil samples were subjected to increasing nitrogen pressure from 10 KPa. (.1 bar) to 200 KPa for 48 hours. The soil moisture content of soils after equilibration was determined by weighing moist soil, drying at 80 C for 72 hours and reweighing. Soil temperatures were monitored with 10K ohm thermistors (Radio Shack) soldered to the ends of copper/constantan wire (Omega Engineering). Thermistors were placed 10 cm deep with one per plot, In 1987, temperature data were acquired at Ft. Cobb with a Campbell CR7 micrologger. Problems with the micrologger in 1987 prompted us to use an ohmmeter in 1988. Electrical resistance at both locations was measured during the early afternoon and converted into temperature with a resistance/temperature curve supplied with the thermistors.

Data from all experiments were subjected to an analysis of variance and differences between means determined by the Student-Newman-Keuls Test at P = 0.05.

Results

Reaction of Cultivars to Pod Rot

In 1987 at Ft. Cobb (Table 1), Florigiant was more suspectible (P = 0.05) to pod rot at all sampling dates than Pronto, Spanco, Okrun and GK 7. Florigiant was more susceptible than Langley at all sampling dates except at harvest, but was as susceptible as Florunner except at 96 DAP. Generally, there were no significant differences between Pronto, Spanco, Florunner, GK 7, Langley, or Okrun as to pod rot susceptibility. Only Pronto, the lowest yielding cultivar (2159 kg/ha) and GK 7, the highest (3100 kg/ha), were significantly different in yield. Mean pod yield for all cultivars at Ft. Cobb in 1987 was 2762 kg/ha.

Table 1. Pot rot severity and yield of peanut cultivars at Ft. Cobb, Oklahoma in 1987.

Cultivar	Pod rot severity at days after planting[x] 96	131	147[y]	167[z]	Yield kg/ha
Pronto	1.90b	1.68b	1.58b		2159a
Spanco	1.85b	1.75b	1.57b		2845ab
Florunner	1.96b	1.81ab	1.97ab	1.76ab	2744ab
GK 7	2.17b	1.62b	1.84b	1.57b	3100b
Langley	2.46b	1.75b	1.81b	1.82ab	2922ab
Okrun	2.26b	1.63b	1.73b	1.68b	2922ab
Florigiant	3.35a	1.99a	2.07a	1.97a	2642ab

[x] The mean pod rot severity of six plants per replicate and four replicates per sampling was determined. Pod rot severity was rated on a scale of 1-5, where 1 = no lesions on pod and 5 = >75% of pod surface with lesions. Means in columns with the same letter are not significantly (P = 0.05) different according to Student-Newman-Keuls test.

[y] Pronto and Spanco harvested.

[z] All other cultivars harvested.

In 1987, no significant (P = 0.05) differences were seen in pod rot susceptibility among cultivars grown at Madill (data not shown). Except for Pronto and Spanco which had significantly lower yields than other cultivars, no significant differences in yield among cultivars were found. Mean yield for all cultivars at Madill in 1987 was 4301 kg/ha.

In 1988 at Fort Cobb (Table 2), few significant (P = 0.05) differences in cultivar susceptibility to pod rot were seen at 89 DAP; however, at 146 DAP and at harvest Florigiant and NC 7 were more (P = 0.05) susceptible than all other cultivars. At harvest (146 DAP) Spanco and Pronto were less susceptible than other cultivars, whereas Florunner, GK 7, Langley and Okrun did not differ. There were no cultivar differences in pod yield. Mean pod yield for all cultivars at Ft. Cobb in 1988 was 3071kg/ha.

Table 2. Pod rot severity and yield of peanut cultivars at Ft. Cobb, Oklahoma in 1988.

Cultivar	Pod rot severity rating at days after planting[x] 89	118	146[y]	166[z]	Yield kg/ha
Pronto	1.59ab	1.61c	1.47c		3051a
Spanco	1.34c	1.49c	1.56c		3179a
Florunner	1.69ab	1.47c	1.55b	1.80b	2975a
GK 7	1.56b	1.69bc	1.69b	1.83b	3306a
Langley	1.63ab	1.69bc	1.63b	1.81b	2848a
Okrun	1.47b	1.57c	1.57b	1.89b	3306a
Florigiant	1.78ab	1.97a	1.98a	2.32a	2899a
NC 7	1.92a	1.88ab	2.02a	2.24a	3306a

[x] The mean pod rot severity of six plants per replicate and four replicates per cultivar per sampling was determined. Pod rot severity was rated on a scale of 1-5, where 1 = no lesions of pod and 5 = >75% of pod surface with lesions. Means in columns with the same letter are not significantly (P = 0.05) different according to the Student-Newman-Keuls test.

[y] Pronto and Spanco harvested.

[z] All other cultivars harvested.

At the Enos site no cultivar appeared to show a consistent and significant (P = 0.05) difference as to pod rot reaction. Only NC 7 at 90 DAP and Florigiant at 122 DAP were more susceptible compared to other cultivars. Pronto and Spanco did not have significantly less pod rot than the runner types. Langley and Florigiant had significantly lower pod yields than the other cultivars. The mean pod yield for all cultivars at Enos in 1988 was 2902 kg/ha.

Pythium spp. were commonly isolated from symptomatic pods. Sixty three percent of 328 isolates subcultured form PSM were identified as *P. myriotylum* on the basis of the following taxonomic criteria: rapid growth at 37 C, abundant appressoria in clusters, lobulate sporangia and typically 3-6 antheridia surrounding the oogonia (27).

Table 3. Pod rot severity and yield of peanut cultivars at Enos, Oklahoma in 1988.

Cultivar	Pod rot severity rating at days after planting[z] 90	122	140[y]	Yield kg/ha
Pronto	1.24bc	1.45c	1.65b	3255b
Spanco	1.16c	1.54c	1.69b	3051b
Florunner	1.24bc	1.58bc	1.77b	3026b
GK 7	1.23bc	1.56c	1.81ab	3382b
Langley	1.28b	1.61b	1.75b	2238a
Okrun	1.18c	1.51c	1.65b	2899b
Florigiant	1.53ab	1.93a	1.92a	2238a
NC 7	1.74a	1.82ab	1.82ab	3128b

[z] The mean pod rot severity of six plants per replicate and four replicates per cultivar per sampling was determined. Pod rot severity was rated on a scale of 1-5, where 1 = no lesions on pod and 5 = > 75% of pod surface with lesions. Means in columns with the same letter are not significantly (P = 0.05) different according to the Student-Newman-Keuls test.

[y] Harvest.

Population of Pythium spp. in Soil Planted with Cultivars

In 1987 at the Ft. Cobb location, the mean population of Pythium spp. for all cultivars (Fig. 1) was relatively stable at planting and 35 DAP with an average of 7 and 3 propagules (p)/g of soil, respectively. At 67 DAP the mean population proliferated to 657 p/g, followed by a decline at 96 DAP, with a population at harvest of 32 p/g. There were no significant (P = 0.05) differences in soil populations for any cultivar at any sampling period, except at 96 DAP when populations in soils planted to Langley and Florunner were greater (P = 0.05) than in those planted to Spanco and GK 7. In addition, when monthly populations for cultivars were averaged over the entire season, there were no differences among the cultivars.

At Madill (Fig 2.) population trends of *Pythium* spp. in 1987 increased and declined similarly to populations at Ft. Cobb. The mean populations for all cultivars at planting on May 12 and at 36 DAP were 12 and 44 p/g soil, respectively. At 67 DAP the population was 741 p/g and then declined for the remaining months, with a final population of 68 p/g at harvest. Generally, there were no significant differences in soil populations for any cultivar, except at 67 when the population in soil planted to Langley was greater (P = 0.05) than in soil with Spanco, and at 145 DAP when the population in soil with Spanco was greater than in soil with Okrun or Florigiant. When averaged over the season, population means for cultivars were not different.

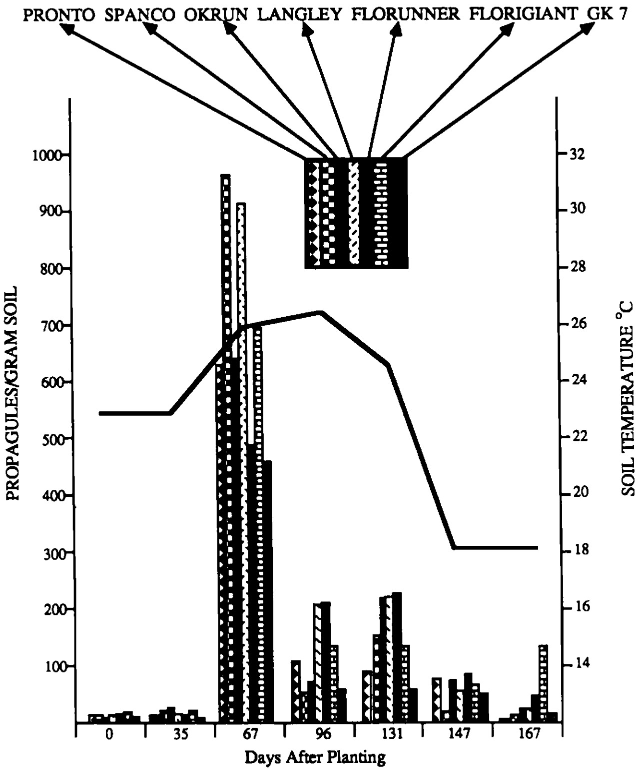

Fig. 1. Populations of *Pythium* spp. in soil planted to peanut cultivars and monthly mean soil temperatures at Ft. Cobb, Oklahoma in 1987.

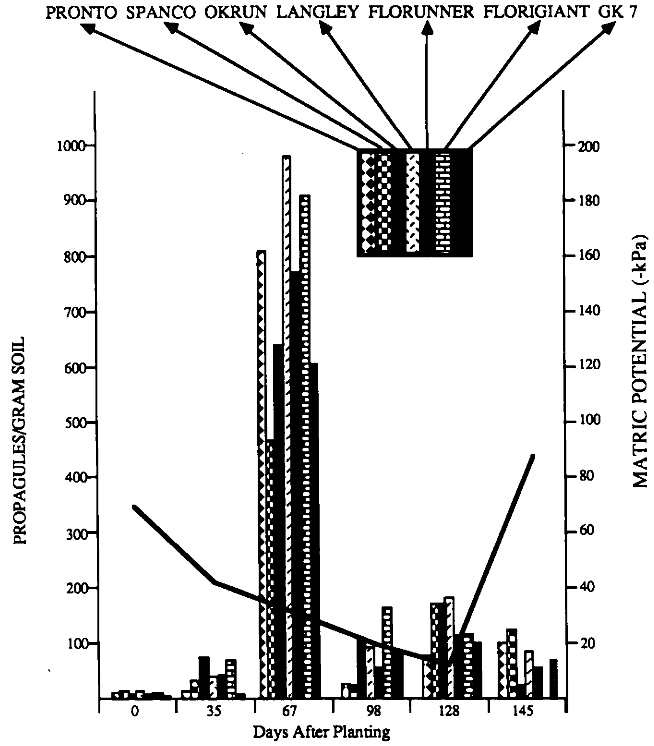

Fig. 2. Populations at *Pythium* spp. in soils planted to peanut cultivars and monthly mean matric potential of soil at Madill, Oklahoma in 1987.

In 1988 at Ft. Cobb (Fig. 3), mean populations of *Pythium* spp. for all cultivars were 8, 5, and 13 p/g soil at planting, 30 DAP, and 62 DAP, respectively. At 89 DAP the population was 346 p/g, and then declined the following sampling period. At harvest the population was 28 p/g soil. Cultivars generally had no effect on populations of *Pythium* in soil, except at 89 DAP when the population in soil planted to Florigiant was greater than in soil with Spanco, and at 166 DAP when the population in soil with Pronto was greater than in soil with Okrun. Averaged over the season population means for cultivars were not different (P = 0.05). Mean populations for all cultivars at Enos (Figure 4) averaged 1 p/g at planting and 31 DAP. At 62 DAP the populations began to increase, reaching a peak of 21 p/g soil at 127 DAP. Populations then declined to an average of 13 p/g at harvest. No significant (P = 0.05) differences occurred among the cultivars at any sampling period or when comparing averaged monthly populations of a cultivar for the growing season.

Interactions of either soil moisture or soil temperature and peanut cultivar on population of *Pythium* spp. were not significant. At Ft. Cobb in 1987 (Fig. 1), the mean monthly soil temperature reached a maximum of 27 C at 96 DAP

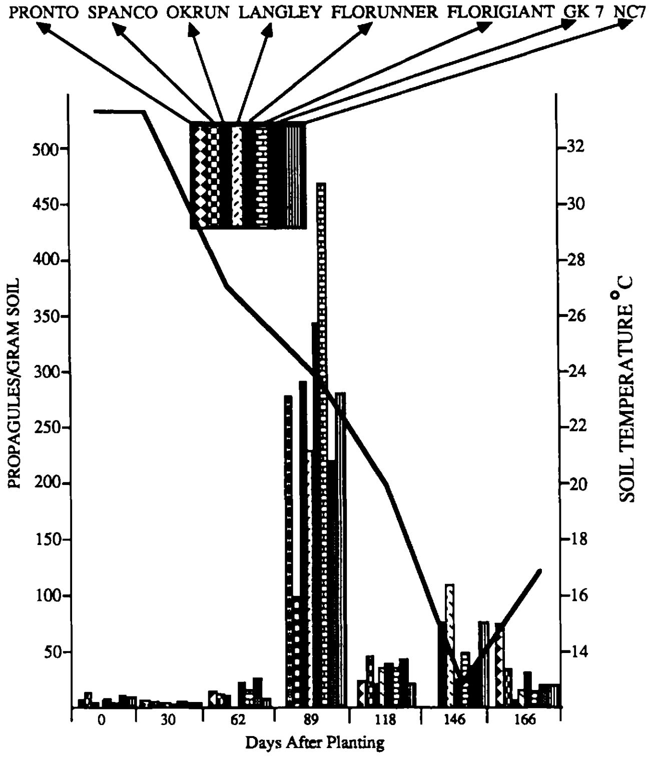

Fig. 3. Populations of *Pythium* spp. in soil planted to peanut cultivars and monthly mean soil temperatures at Ft. Cobb, Oklahoma in 1988.

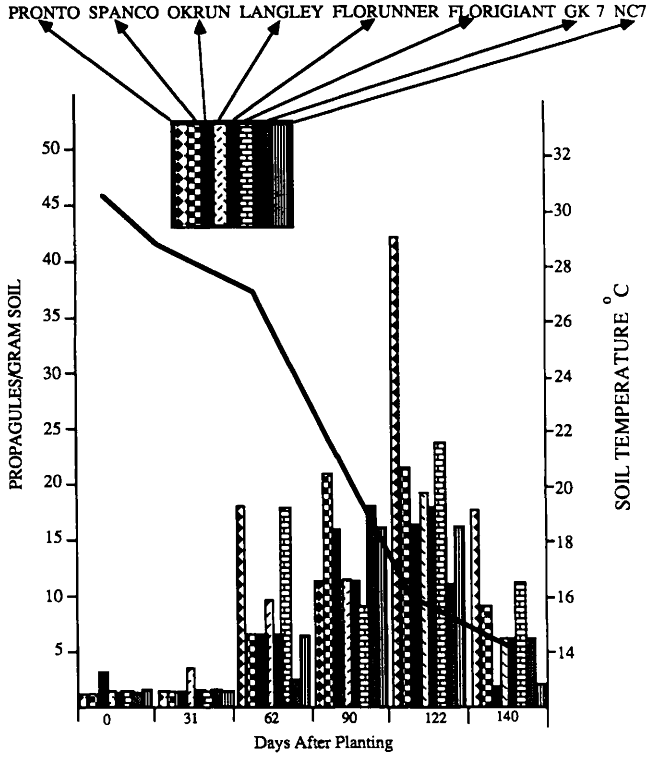

Fig. 4. Populations of *Pythium* spp. in soil planted to peanut cultivars and monthly mean soil temperatures at Enos, Oklahoma in 1988.

whereas the *Pythium* spp. population peak occurred at 67 DAP. In 1988, the mean monthly soil temperature (Fig. 3) was higher (34.3 C) at planting, but populations of *Pythium* spp. were highest at 89 DAP. At Enos in 1988, (Fig. 4) mean monthly soil temperature was highest at planting (30.9 C) whereas populations were greatest at 122 DAP. Soil matric potential fluctuated considerably from location to location and from year to year. Examples of these fluctuations are shown in Figs. 2 and 5. Correlations between soil matric potential (r = .19) or soil temperature (r = .24), and fluctuations in populations of *Pythium* spp. were not significant (P = 0.05).

Some fast growing colonies on PSM were subcultured on cornmeal agar at 37 C and microscopically examined for morphological characteristics (27). *Pythium myriotylum* was found in the soils from all fields.

Discussion

In our study there was little statistical difference in pod rot reaction among most of the cultivars, except for Florigiant and NC 7. Florigiant and NC 7 sometimes had significantly more pod rot than most or all other cultivars at many sampling periods. Pronto and Spanco, however, did not appear to offer any advantage in pod rot resistance over Florunner, GK 7, Langley or Okrun. The overall level of pod rot found in our study was not as severe as normally observed, especially at Ft. Cobb (4; A. B. Filonow, personal observation). Higher disease pressure may have produced greater discrimination among cultivar susceptibilities. Our results, however, were generally consistent from location to location during the study. In addition, spanish market type cultivars are usually more resistant to pod rot than runner or virginia market types (7, 22, 23). The runner type cultivars in our study did have some spanish ancestry (18); however, their ancestry was more indirect than Pronto or Spanco (100% spanish pedigree). This may have contributed to the partial resistance exhibited by the runner market type cultivars in this study.

It appears that Florigiant or NC 7 may not be suitable for Oklahoma fields with a history of pod rot. These cultivars are certainly less desirable for use in Oklahoma than Pronto or Spanco which often were found to be more resistant than Florigiant or NC 7.

In this study Florunner was more resistant than Florigiant. This was in accordance with the observations of Walker and Csinos (28), but differed from those of Porter *et al.* (23). In Texas, Florunner was susceptible to pod rot in the field (26), but in greenhouse tests (14) Florunner did not differ in pod rot resistance from Starr (a spanish type cultivar), Toalson, Goldin I or PI 341885. These cultivar differences in pod rot susceptibility may be attributed to differences in field sites as to pathogenic fungi, inoculum potential and/or environmental factors that affect the onset and progress of disease.

Our study was not designed to elucidate the mechanism(s) of resistance to pod rot in the cultivars. Workers in Texas (15, 26) have suggested that pericarp cells of resistant genotypes are more compact and have a more uniform lignification than cells of less resistant genotypes. Calcium nutrition may also play a role in pod rot resistance, particularly in large seeded cultivars, such as Florigiant or Early Bunch that are more dependent on calcium fertilization than other cultivars (3, 28).

Cultivars did not markedly differ in their abilities to reduce populations of *Pythium* spp. in soil, especially at harvest. Although at some samplings, some significant effects

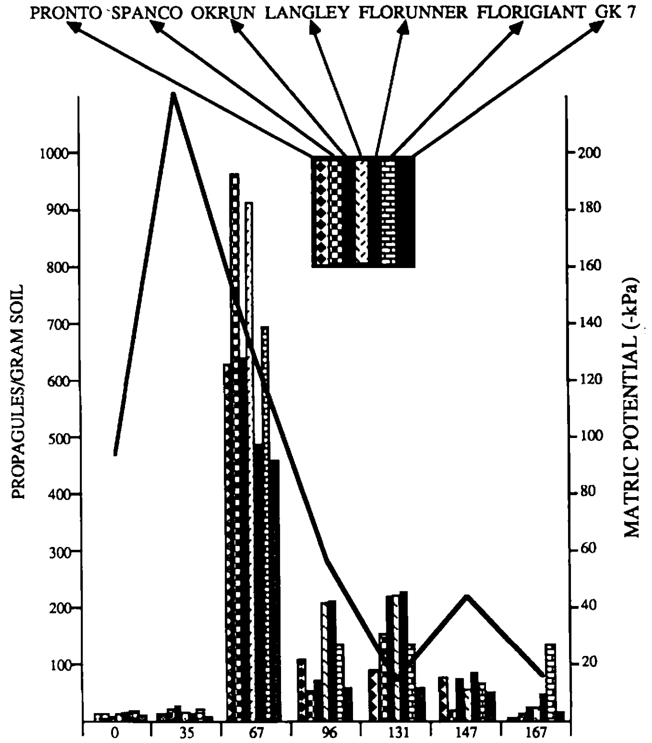

Fig. 5. Populations of Pythium spp. in soil planted to peanut cultivars and monthly mean matric potential of soil at Ft. Cobb in 1987.

among individual cultivars were observed, no cultivar effect was observed when mean populations over a whole season were compared.

In our study, *P. myriotylum* was the principal species of *Pythium* associated with rotted pods, and it has been commonly found in other Oklahoma fields with pod rot (6). In Georgia, however, soil populations of *Pythium* spp. were erratic in fields with pod rot and had no apparent relationship to pod rot incidence (3). In the study presented herein, fluctuations in populations of *Pythium* spp. also had no apparent influence on pod rot severity. For instance, severity ratings at sampling dates immediately following the population peaks at Ft. Cobb and Madill were not appreciably greater than ratings at later dates, even though the population peaks were 4 or more times greater than populations at the later dates. Our results and those of Csinos and Gaines (3) differ from those of Frank (9) who found a significant correlation between the recovery of *Pythium* spp. from sorghum baits incubated in a peanut soil and pod rot incidence.

Lack of a simple inoculum density/disease relationship under field conditions is plausible. Nonpathogenic organisms that are frequent colonists of pods such as *Penicillium, Chaetomium,* bacteria, etc. may influence the microbial succession on pods and subsequent ingress by pathogens (13, 21). Several such organisms have been isolated from pods from the Ft. Cobb location in other studies (4, 5). Nematodes (11) and mites (25) may interact with *P. myriotylum* to alter pod rot severity. *Meloidgyne hapla* and other plant parasitic nematodes are inhabitants of many Oklahoma peanut soils, including those at Ft. Cobb (6). Finally, the parasitic aggressiveness of *P. myriotylum* isolates can differ (20), and a weakly aggressive isolate may require a substantial density to cause noticeable pod rot. Little is known, however, about the parasitic aggressiveness of *P. myriotylum* isolates to peanut pods. Perhaps, as Garren suggested, fungal attack on pods should be studied in gnotobiotic conditions (13) or possibly genetically marked isolates could be introduced into a field and tracked.

The increase and decline in *Pythium spp.* in the soils of our study occurred regardless of the cultivar planted. Filonow and Jackson (4) reported similar proliferations of *Pythium spp.* in soil planted with Florunner or Spanco peanut at Ft. Cobb in 1986 and 1987. Therefore, observations over several years and at three different locations in Oklahoma suggest that this phenomenon may be a natural occurrence in soil planted to peanut.

Corroboration of the phenomenon is needed for other peanut production areas in Oklahoma and other states to test this hypothesis.

Little is known about the dynamics of *Pythium* spp. in soil planted with peanut. In general, populations of *Pythium* spp. in soil are influenced by temperature and moisture, microbial antagonism, and the presence and traits of a host. Warmer soil temperatures in the peanut soils of the southern United States probably influence the growth of *P. myriotylum* and other species, such as *P. aphanidermatum*, that are favored by warm temperatures. In Israel, populations of *P. aphanidermatum* in field soils showed peaks during January and February and in late August, with the peak in August attributed to higher soil temperatures at that time (1). On the other hand, Lumsden *et al.* (19) reported that populations of *P. aphanidermatum* and *P. myriotylum* in a Maryland vegetable field were highest in winter at the beginning of the study and declined to lower populations in the spring. Populations remained at low levels for two years, regardless of bean and rye rotation or incorporation of plant residue. It was suggested that germination of oospores followed by microbial lysis may have accounted for the decline.

In our study, soil temperature and matric potential did not directly drive fluctuations in *Pythium* spp. populations, because no significant correlations between each of these factors and population fluctuations were observed. It is possible soil temperature and moisture, through their effects on peanut development, may have influenced population dynamics. Higher populations of fungi and other microbes have been found in the geocarposphere of peanut plants than in the bulk soil (16, 21). Our results are somewhat supported by McDonald (21) who observed that as peanut fruit developed, numbers of fungal propagules in dilution platings of soil adhering to the fruit fluctuated. By 9-12 weeks after planting, the fungal population in geocarposphere soil was relatively low and stable, but thereafter the population increased. At week 15 the population peaked and then declined until week 17 when it peaked and declined again. Bimodal population peaks in the present study of *Pythium* spp. were not observed; however, biomodal peaks in *Pythium* spp. populations have been observed in another study (Soufi and Filonow, unpublished).

It is suggested as a hypothesis that the proliferation and decline of *Pythium* spp. in soils observed in this study may have responded to the development and maturation of pods. At Ft. Cobb and Madill, the timing of the population peaks, (July and August) was similar to the R4 - R6 reproductive growth stages for peanut (2) during which plants have added significant pod numbers and weight. At Enos, cultivars were planted four weeks later than the other locations because of an unusually dry and cool spring in 1988. Peanut plants at this site pegged later and produced pods slowly and later into the season. As suggested by work of Hale (17), nutrients released by pods forming in soil may be greatest during early development and decrease considerably as pods mature. Growth of microbial populations, including *Pythium* spp., may have proliferated in response to nutrients from developing pods. Following subsidence of nutrient exudation as pods mature, nutrient-starved microbes may have fed on hyphae of *Pythium* spp. in soil causing a decline in population. Alternatively, hyphae of *Pythium* spp. may have moved from the bulk soil to colonize geocarposphere soil and the surfaces of pods as they matured. Whatever the mechanism for the decline phase observed in our study, our results suggest the involvement of the peanut plant in the fluctuation of *Pythium* spp. in field soil.

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