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Management of peanut pod rot I: Disease dynamics and sampling

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ABSTRACT

Peanut fields are monitored for pod rot, which is typically caused by *Pythium* spp. and *Rhizoctonia solani*, in order to determine need, and the type and timing of fungicide applications. Pod rot can lead to damaged peanut kernels and when damage exceeds 2.49%, substantial price reductions occur. Nine fields or tests were sampled weekly for pod rot during the 2009 through 2012 growing seasons. The sampling was conducted on fields treated uniformly with fungicides for pod rot or within large research plots with various fungicide treatments. *Pythium myriotylum* was the most frequently identified pathogen species, although *Rhizoctonia* spp. were also recovered from diseased pods at all sites. Pod rot incidence was related to percent damaged kernels at harvest in 3 of 5 sites. Collection of 304 samples (sample unit = 46 cm of row) in a field was required to estimate 1% pod rot accurately (CV = 20%). There was a linear relationship between average % pod rot in a field, and the percentage of sampling units (absence/presence) with pod rot at low disease incidences. Scouting for pod rot of peanuts to make in-season fungicide applications will be hampered by high sample number, destructive sampling of plants, frequent sampling (due to rapid increase of disease), and the poor relationship between disease during the season and kernel damage at harvest. Making one preventative application at 60–70 days after planting may be a better practice than timing the initial fungicide application based on sampling for disease.

1. Introduction

Pod rot of peanut (*Arachis hypogaea* L.) can be caused by a number of different organisms including *Rhizoctonia solani* Kühn and *Pythium* spp. (Filonow et al., 1988; Garren, 1970; Sanogo and Puppala, 2012; Wheeler et al., 2005). Management of pod rot has been difficult in part because of the wide host range of the pathogens (Melouk and Backman, 1995) and limited cultivar resistance (Besler et al., 2003; Lewis and Filonow, 1990; Walker and Csinos, 1980; Woodward and Baughman, 2007). Pod rot can be partially managed by calcium sulfate in the southeastern U.S., particularly in soils that are low in calcium (Csinos et al., 1984; Walker and Csinos, 1980). This approach has generally been unsuccessful in the southwestern U.S. (Filonow et al., 1988), possibly due to higher soil concentrations of calcium. In this region, the fungicides metalaxyl, mefenoxam, and azoxystrobin are typically applied during the season for the management of pod rot (Besler et al., 2003; Filonow and Jackson, 1989; Grichar et al., 2000).

Peanut fields are often scouted to make decisions about which fungicide products to use and when to time applications. However, science-based decision rules have not been developed for pod rot. Furthermore, an appropriate sampling methodology is lacking. Sampling methodologies during the growing season to make management decisions for diseases caused by soilborne pathogens are rare. Pre-plant or fall sampling has been utilized in making management decisions for plant parasitic nematodes and *Verticillium dahliae*, because these densities provide an estimate of potential yield loss (Barker and Olthof, 1976; Rowe et al., 1987). However, decision rules for sampling in-season to make fungicide applications are limited to foliar diseases (Carisse and Jobin, 2012; Leiminger and Hasuladen, 2012; Vincelli and Lorbeer, 1987). A

Abbreviations: DK, damaged kernels.

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complication for sampling-based threshold decisions in pod rot is that peanuts have a very low threshold for damage. If the percentage of damaged kernels at harvest is above 2.49%, then the producer risks the crop being labeled as segregation 2, which may be rejected for sale or be valued at only 35% of non-damaged peanuts (Anonymous, 2014).

Crop consultants and producers monitor peanut fields for pod rot and use disease symptomology, amount of disease, as well as current and forecasted weather conditions to make recommendations for fungicide applications (Wheeler and Woodward's personal observations). There are no formal rules in place to sample for pod rot, or action thresholds developed for managing pod rot with fungicides. In a more traditional scouting program, there is a relationship between the pest/pathogen density and reduction in yield. Given knowledge of the pest density/yield loss relationship, value of the commodity, cost of pesticide application, and effectiveness of an application, then the economic injury level required for treatment can be calculated and a critical pest/pathogen density can be utilized in scouting fields (Binns et al., 2000).

Sampling for pod rot is destructive to the crop because the plant roots are pulled up so that pods and pegs, which form below ground, can be examined. There are no above ground symptoms associated with pod rot and no intuitive sampling unit can been defined. Peanuts exhibit a prostrate growth habit, which makes it difficult to identify individual plants; therefore, digging of a set number of plants is not feasible. Digging a certain length of row is the most typical method, but results in an uneven number of pods to evaluate per sampling unit. It is also not feasible to arbitrarily set a number of pods to evaluate because of the time it would take to count that number and also because it would result in excess destruction of plants and yield. A commercial sampling program therefore, should be based on 1) threshold of pod rot that reduces risk for segregation 2 kernel damage; 2) identifies the amount of row that must be sampled to estimate pod rot incidence; and 3) be cost effective of labor for the consultant and for the amount of crop lost to sampling for the producer.

There is little published information on the dynamics and distribution of peanut pod rot, and the goal of this work is to provide information to assess the practical aspects of sampling for pod rot to make in-season management decisions. The objectives of this project were to 1) characterize pod rot incidence during the growing season; 2) determine the relative proportion of *Pythium* spp. and *Rhizoctonia* spp. associated with rotted pods in fields during the season; 3) characterize the distribution of peanut pod rot as it relates to sampling number decisions; 4) determine whether pod rot incidence at low levels can be adequately described by pod rot presence or absence in a sampling unit; and 5) determine the relationship between pod rot incidence, kernel damage, and yield loss. This research was conducted in commercial peanut fields, which were either treated uniformly with fungicides for pod rot, or within research plots in commercial production fields containing several different fungicide treatments for pod rot management.

2. Materials and methods

2.1. Sampling procedures

Nine data sets were collected in six peanut fields over a four-year period (2009–2012). Each field or subset of a field was randomly sampled at approximately weekly intervals during the pod forming and maturing periods of R3–R7 (Boote, 1982), which typically occurs mid-July through September. If pod or peg rot was present, then healthy and diseased pegs/pods were counted and all diseased pegs/pods were placed in a plastic bag and brought to the laboratory for isolation. A sampling unit consisted of 46 cm of row in which the plant pegs and pods were examined for rot symptoms. The number of pegs and pods in a sampling unit were variable and ranged from 14 to 428. At each field or subset of a field sampled, 80 to 160 sample units were observed weekly, depending on the field and year (Table 1). The total pod number was only obtained for sample units positive for pod rot. The sampling procedures for the fields are described below. However, each sampling field was either part of a large plot fungicide test (labeled T), or was in a field that was treated uniformly by the producer with fungicides (labeled P). All fields had a history of pod rot and producers followed local commercial production practices.

2.1.1. Test fields

Six of the sampled fields were used for large plot fungicide tests, where azoxystrobin (0.447 kg ai/ha; Abound FL, Syngenta Crop Protection, Greensboro, NC) or mefenoxam (0.14 kg ai/ha, Ridomil Gold EC or SL formulation, Syngenta Crop Protection) plus prothioconazole (0.113 kg ai/ha) and tebuconazole (0.225 kg ai/ha) (Provost 433 SC, Bayer CropScience, Research Triangle Park, NC) were applied at various times in July–September. Plot length ranged from 170 to 648 m by 4–8 rows wide. Each plot was divided into enough grids to be sufficient for all projected sampling units. A random number generator, PROC PLAN (SAS version 9.3, SAS Institute, Cary, NC, USA) was used to order the total number of grids in a plot at random and they were sampled in that random order. A different set of random numbers was generated for each plot and each grid was only sampled once.

2.1.2. Sampling producer fields

Producer fields (P1 = entire field), or the remainder of the field outside of the fungicide test plots (P3, P6) were sampled weekly. Each producer field was divided into approximately 500 numbered grids and between 80 and 101 numbers were drawn at random each week and GPS coordinates were located within a selected grid for sampling. Replacement of grid numbers was permitted, since the grid size was large relative to the sample unit size. Producer fields were treated uniformly with azoxystrobin and/or mefenoxam by the producers.

2.2. Isolations

All pods exhibiting rot symptoms were washed thoroughly in running tap water and a sub-sample of at least four pods were selected for isolation (unless there were fewer than four pods with disease). Pods were dried for 2 ½–3 h in a laminar flow hood. In mid-August, pod symptomology changed with the development of some superficial lesions. Prior to that time, all lesions penetrated into the pods and resulted in total loss of the kernels. If there was a combination of superficial lesions and rotted pods, then eight pods were selected, four with superficial lesions, and four with substantial rots. The edge of the lesion was removed and placed on water agar. When hyphal growth was observed, a plug of mycelia was transferred to potato dextrose agar. The organism was identified to the genus level based on morphological characteristics on potato dextrose agar. A select number of *Pythium* spp. isolates were stored on cornmeal agar for species identification. For most field/sampling weeks, the organisms isolated from rotted pods were not recorded separately from those isolated from superficial lesions. In only four cases was this information recorded.

2.3. Species identification

A subset of *Pythium* isolates were identified to species based on morphology (Van der Plaats-Niterink, 1981) using a grass leaf