Severity, Distribution, and Losses from Taproot Cankers Caused by *Rhizoctonia solani* in Peanuts[1]

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ABSTRACT

Research on the ecology of peanut roots from fields in Georgia, Florida, and Alabama revealed a high frequency of sunken, dark cankers on the taproot which persisted to harvest. Isolations from these cankers resulted in recovery of *Rhizoctonia solani* anastomosis group 4 (AG-4) from more than 50% of the cankers. A survey of peanut fields being harvested during early September revealed that 28% of the fields had an average of more than 50% of the taproot surface area cankered. In contrast, for fields in the same area harvested one month later, 77% had disease severities of less than 25% and none were greater than 50%. In an experiment conducted in 1984, roots from 64 plots were examined and rated for root rot severity and yield. When taproot disease severity was regressed against yield, a highly significant negative correlation (r^2 - 0.60, $P<0.01$) was found.

Key Words: *Arachis hypogaea, yield loss, groundnut*

During investigations of the ecology of the peanut rhizosphere, it was observed that peanut plants grown in experimental field plots in Alabama often had cankers on their taproots which persisted throughout the growing season. These cankers were brown to black in color, variable in size, sunken, and occurred mostly on, but were not restricted to, the upper taproot. Root cankers of this description caused by *R. solani* have been reported previously (3), but their impact on peanut yield was not evaluated. Taber and Pettit (6) reported on the relative frequency of isolation of organisms in the *R. solani* group versus that of *Rhizoctonia*-like organisms in various peanut plant parts, but not from roots. Further, they did not report which *R. solani* anastamosis groups occurred on peanut. The objectives of this study were to study the occurrence, severity, and damage caused by taproot cankers on peanuts in the southeastern United States.

Materials and Methods

Taproot disease assessments. A subjective root disease rating scale of 1 = no taproot cankers, 2 = 25% of root surface cankered, 3 = 50% of root surface cankered, 4 = 75% of root surface cankered, and 5 = taproot entirely diseased, was developed and is depicted in Fig. 1. Decimal scores were used to indicate observable levels which fell between the whole numbers defined in the scale above. Similar assessments were performed for a Georgia, Alabama, and Florida disease survey of 1982, as well as field trials at Headland, AL in 1983 (described later in this section).

Root disease survey. Root samples were collected during the 1982 harvest from inverted plants in farmers fields located in southwest Georgia, southeastern Alabama, and the panhandle of Florida. The frequency and severity of cankers of the type found in our preliminary observations (Headland, Ala.) were determined using the subjective scale previously described. All plants were of the Florunner variety, but cultural practices may have varied. To provide a temporal comparison, roots were collected from 52 recently harvested fields in early September and from 60 different fields in the same three state region approximately one month later.

Field test. A field trial was conducted in 1983 to assess the impact of taproot cankers of Florunner peanuts on pod yield. The soil type of the trial was a Dothan sandy loam. All seeds were treated with the fungicide Pro-Ized II or Pro-Ized III and some with various preparations of *Bacillus subtilis* dust as described later. This bacterium has been shown to control peanut root cankers caused by *Rhizoctonia solani* (AG-4) (7), and was added to achieve varying levels of taproot disease. Seventeen such treatments were arranged into randomized complete blocks with 6 replications. Each plot consisted of two 6.1 m rows, spaced 91 cm apart. Each row contained 70 seeds planted 7.5 cm deep to insure contact with soil moisture. A cone-type planter (manufactured by K.E.M. Corp.) was used. The field had a crop history of continuous peanuts for the previous ten years. At inversion (142 days after planting), ten taproots (extending from the soil line to 20 cm deep) were taken from randomly chosen plants within each plot to assess taproot canker severity. Each root was thoroughly washed and rated while wet to enhance visualization of the dark, sunken cankers. Plots were then harvested using a combine and pod yield was recorded.

Seed Treatment. Florunner peanut seeds were treated with flowable fungicides sold under the trade names Pro-Ized II and Pro-Ized III (Gustafson, Inc., Dallas, TX) in various combinations with preparations of *B. subtilis* (Abbott Laboratories, of North Chicago, IL). Pro-Ized II contained 70 mg/mL of Botran (2,6-dichloro-4-nitroaniline) and 95 mg/mL thiram (tetramethyl thiuram disulfide). Pro-Ized III contains these fungicides and also Vitavax (carboxin) at 70 mg/mL. Four of the seventeen treatments consisted of various bacterial preparations applied with no fungicide. Ten of the treatments contained the fungicide Pro-Ized II applied at 9.8 or 7.8 mL/kg of seed in combination with *B. subtilis* bacterial preparations applied at 1011 spores/kg seed, and at 7.8 mL/kg of seed applied with no bacteria. Three of the treatments contained the fungicide Pro-Ized III which was added at either 9.8 mL/kg of seed or 7.8 mL/kg of seed with a bacterial preparation, or without bacteria at 7.8 mL/kg of seed with a bacterial preparation, or without a bacteria at 7.8 mL/kg of seed applied without bacteria. In all cases, the bacterial treatments were mixed with the flowable fungicides at a rate resulting in approximately 1011 spores/kg seed, however, inert ingredients of the bacterial preparations varied between treatments. The fungicide-bacterial spore mixture was sprayed on seeds using an air-gun sprayer, while seeds were rolled in a drum (Gustafson Batch Lab Treater, Gustafson, Inc., Dallas, TX).

Determination of causal organisms. Plants used for this experiment were from replicated field tests in 1983 and 1984. Fungi associated with root cankers were cultured by cutting roots longitudinally in sections approximately 2 cm long. These sections were cut so that mostly healthy tissues, immediately adjacent to necrotic tissues, were plated. Sections were surface sterilized in a 0.78% sodium hypochlorite solution for 4 min and then placed on sterile potato dextrose agar (PDA) plates (acidified to pH 4.5 with lactic acid). Two root sections were placed on each plate. Resulting fungal cultures were then identified using light microscopy, or were subcultured and examined later if necessary. After staining with 0.5% aqueous aniline blue, organisims were designated as *R. solani* or as a Rhizoctonia-like organism based on whether cells were multinucleate or binucleate, respectively. Anastamosis groups were determined by placing the isolates on oppo-

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site sides of PDA plates from organisms of known anastamosis groups. Multinucleate fungi are assumed to be *Thanatephorus cucumeris* (4). Designations of CAG represent binucleate isolates with a *Ceratobasidium* perfect stage (2). When the hyphae of the two organisms overlapped by 2-8 mm, the entire plate was placed on a microscope stand and hyphal fusion was examined in the overlapping area. Hyphal fusion indicated that the test isolate was of the same anastomosis group as the known isolate growing on the same plate.

Statistics. Statistical analyses used in establishing the relationship of taproot cankers to yield consisted of linear regression using the SAS least squares method (5) and utilized all of the 17 treatment means to reduce plot to plot variation and sampling error.

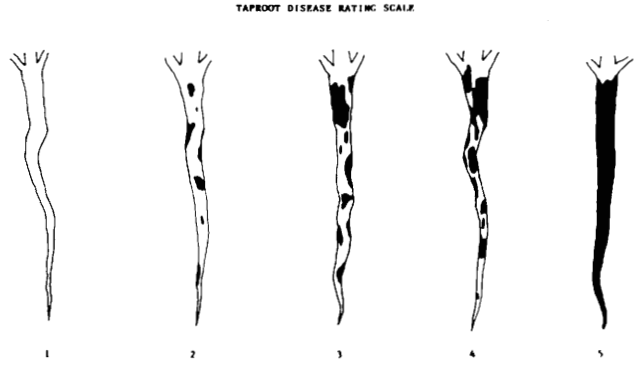

Fig. 1. Severity scale used for evaluation of peanut taproot canker disease severity. (1 = no disease, 2 = 25% of root area affected, 3 = 50% of root area affected, 4 = 75% of root area affected, 5 = root completely necrotic). Disease was rated to the 0.1 unit.

Results

Root disease survey. The incidence of peanut root cankers in the tri-state survey is shown in Fig. 2 and 3. Figure 2 illustrates the frequency distribution for 52 randomly selected fields harvested in early September. For the early sample, 28% of the fields had mean taproot disease severities exceeding 3.0 (50% of root surface cankered). Additionally, eight percent of the fields fell into the category of greatest disease severity which was 4.5-5.0 on the rating scale. Approximately one month later, when the survey was repeated for the same tri-state region (60 fields), disease severity was much lower (Fig. 3). There were no fields with roots in disease severity categories greater than three; only 25% of the fields evaluated in October had disease ratings of 2.0-3.0 (25%-50% of root surface cankered).

Causal organisms. An examination of the taproots revealed that many of the cankers affected large areas of epidermal tissue and often extended through the cortex to the vascular cylinder. When micro-organisms were cultured from cankers from field grown plants in 1983 and 1984, the primary genera of fungi recovered in order of frequency were *Rhizoctonia, Chaetomidium, Fusarium, Aspergillus* and *Rhizopus. Rhizoctonia solani* and bi-nucleate isolates with similar morphology referred to as Rhizoctonia-like fungi (1) were isolated from 51% of the cankers in 1983 and from 57% of the cankers in 1984. A member of the genus *Chaetomidium,* described as being closely related to the saprophytic genus *Chaetomium* (9), was recovered from 22% of the cankers in 1983, and 48% of the plants in 1984. A dark red to purple-colored diffusable pigment was associated with the growth of *Chaetomidium* on (PDA). The other genera collectively accounted for only 26% of all isolations.

Examinations of fungi having morphological characteristics of *Rhizoctonia* revealed that sixty-eight percent were multinucleate. The majority of these were identified as *R. solani* AG-4 with *R. solani* AG-2 being found only rarely. The binucleate group was found to contain mostly CAG-3.

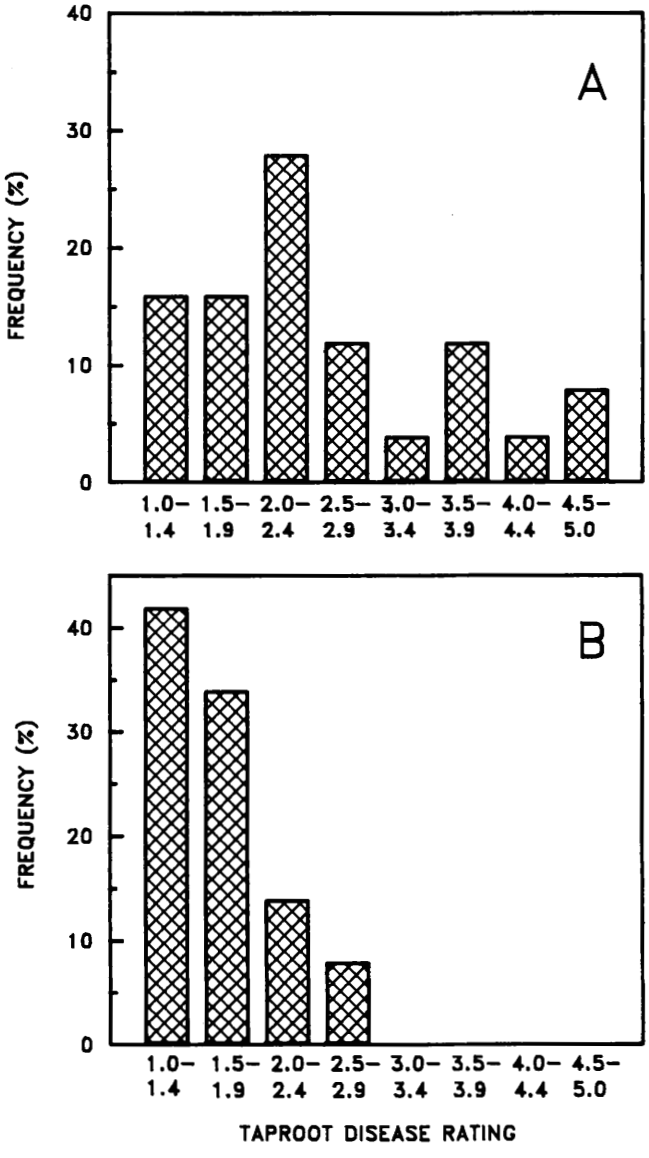

Fig. 2. Frequency of taproot canker disease severity determined from a survey of root disease from Georgia, Alabama and Florida. On September 9, 1982 (A), 52 fields were sampled and on October 3, 1982 (B), 60 fields were sampled.

Effects of taproot cankers on pod yields. Figure 4 shows the relationship between taproot disease rating and yield (r^2 = 0.60) in Field 1 at Headland, Ala., in 1983. Though individual roots from various treatments were often found to be virtually free of cankers or completely covered (ratings of 1 and 5, respectively), treat-

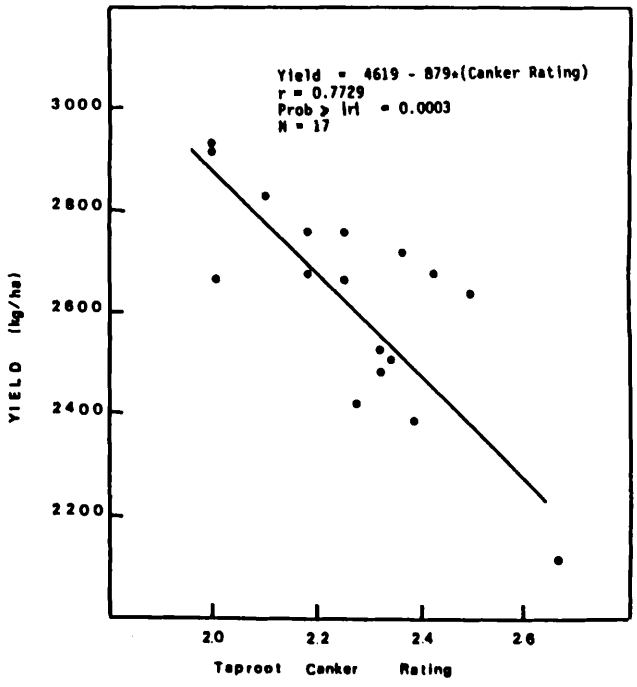

Fig. 3. The relationship of taproot disease severity at harvest to yield from Field 1 in Headland, Ala., 1983. Co-ordinates represent mean yields and taproot disease ratings of various *B. subtilis* seed treatments applied in conjunction with seed treatment fungicides.

ment means all fell between 2.0 and 2.7. This regression line demonstrates how relatively small differences in taproot disease can cause major changes in peanut yields. Stand counts between the treatments were not significantly different between treatments in 1983, while root disease ratings were still negatively correlated ($P \leq 0.05$) with yield.

Discussion

The survey of peanuts in the Georgia, Alabama, and Florida peanut production areas (Fig. 2 and 3) indicates that taproot cankers are common in these regions. Fields harvested in early September were more severely affected than those harvested one month later. One possible explanation for this increased severity is that those fields harvested early were also planted early (though planting date and field history were not known) and that the stress of early planting in cooler soils may have predisposed the plants to root infections. However, it is also possible that the fields had high levels of root cankers due to factors other than early planting and that the decline caused by these cankers resulted in earlier harvesting. In either case, the occurrence of the dry sunken cankers was widespread in the tri-state area.

The results of the isolation studies performed on sunken cankers from a single field in 1983 and a second field in 1984 indicate that the major fungal species associated with taproot cankers of peanuts is *Rhizoctonia solani* AG-4. Other pathogens such as *Sclerotium rolfsii* and *Cylindrocladium crotalariae* may have caused some of the cankers observed regionally in 1982. However, based on similarities in symptomology and some preliminary isolations on roots from the 1982 tri-state survey (M. A. Crawford and P. A. Backman, unpublished), we believe that *R. solani* is the most important cause of this type of root canker in this area. No comparisons were performed on the relative virulence of AG-4 versus other anastomosis groups isolated, but AG-4 appears most important due to its frequency of association with taproot cankers. The importance of isolating the genus *Chaetomidium* in high frequency is not known, but it seems likely that it is a saprophyte growing on the dead tissue, this being characteristic of the Chaetomiaceae family (9).

The importance of taproot cankers on peanuts which occur in or persist into the middle and latter part of the growing season has been largely unappreciated. Much attention has been given to *R. solani* with respect to seedling disease and pod and limb rot (1) but it also appears that cankers on the roots of peanut plants, which may appear quite healthy with respect to above ground growth, can cause significant yield losses. As shown in Fig. 3, small differences in levels of disease can be related to large yield differences. Further, the magnitude of disease severity used to establish the regression equation was not nearly as severe as that observed in our early disease survey. Losses in fields with average canker scores of >3.0 (50% of taproot surface diseased) could be very substantial. More research is needed to determine the practicality of controlling this disease. One method for reducing peanut taproot lesions is rotation with nonleguminous crops (8). In addition, the biological seed treatment *B. subtilis* has shown potential for reducing severity of Rhizoctonia- induced cankers on peanuts (7).

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