Effect of Soil pH on Sclerotial Germination and Pathogenicity of *Sclerotium rolfsii* [1]

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ABSTRACT

The effect of soil pH on sclerotial germination and pathogenicity of two isolates of *Sclerotium rolfsii* on peanut was examined. Sclerotial germination for both isolates was greater ($P \leq 0.05$) in acidic soil than at alkaline pHs. Similarly, percentage of peanut stems infected by *S. rolfsii* in greenhouse tests was greater at soil pH 5.6 than at alkaline soil pHs ($P \leq 0.05$), but disease did develop at soil pH 8.7 and 9.8. In contrast to a previous *in vitro* study, these data confirm that sclerotia of *S. rolfsii* will germinate and initiate disease at soil pH > 7.0.

Key Words: *Arachis hypogaea*, groundnut, peanut, stem rot, sclerotia.

Sclerotium rolfsii Sacc., the causal agent of stem rot, is one of the most important pathogens of peanut (*Arachis hypogaea* L.). Peanut sustains greater yield losses from infection by *S. rolfsii* than any other susceptible crop (Aycock, 1966). Reported annual peanut yield losses due to stem rot are 10% in the southeastern U.S. and up to 5% in the western states, despite extensive use of fungicides to control the disease (Melouk and Backman, 1995). In Texas and Oklahoma, *S. rolfsii* costs peanut producers approximately $15 million annually (Smith and Lee, 1986).

Although growth of *S. rolfsii* occurs over a broad range of pH values, growth is optimal at acidic pHs and is suppressed above pH 7.0 (Aycock, 1966; Punja and Grogan, 1982; Punja, 1985). There were minor differences in growth on potato dextrose agar (PDA) between pH 3.5 and 6.5, with no growth observed above pH 8.0. Both eruptive (Punja and Grogan, 1981) and hyphal germination of sclerotia are inhibited on agar medium above pH 7.0, with the optimum range for germination at pH 2-5 (Punga and Grogan, 1982). However, soil pH in many Texas peanut fields is alkaline (Godfrey *et al.*, 1973), and stem rot of peanut, for which sclerotia are the primary inoculum, is commonly observed in fields where soil pH exceeds 7.5 (R. Lemon, pers. commun., 1995). This suggests that sclerotial germination may occur at soil pH values above 7.0. The objectives of this study were to examine the effects of alkaline soil pHs on germination of sclerotia of *S. rolfsii* and on development of stem rot of peanut.

Materials and Methods

Sclerotium rolfsii isolates Sr1/1 and Sr1/9 used in this study were obtained from peanut and tomato, respectively. Nonsterile sclerotia were produced according to the protocol of Beute and Rodríguez-Kabána (1979, 1981). Mature sclerotia were collected from trays of soil and infested oat grains by wet sieving with sclerotia being caught on a 780-µm pore size sieve. Air-dried sclerotia were stored in polypropylene tubes at room temperature until used.

The effect of soil pH on germination was tested *in vitro*. The soil was a Lufkin fine sandy loam (vertic Albaqualfs; fine montorillic, thermic; pH 5.6; organic matter less than 2.0%). CaO was used to adjust the pH to values of 6.7, 7.7, and 8.7 because of its rapid action and small quantities needed to alter the pH. Soil pH was determined from a slurry of 2 parts distilled water and 1 part air-dried soil immediately before initiating the experiment. The pH adjusted soils were moistened (45 mL distilled water/500 g air-dried soil) and placed in separate 100 × 15-mm petri dishes. Five sclerotia of *S. rolfsii* were pressed into the soil surface of each petri dish, but not covered with soil, and incubated at 27 C in darkness. The number of germinated sclerotia per petri dish was counted at 24-hr intervals.

To determine the effect of soil pH on disease incidence, peanut (cv. Florunner) seeds were germinated on moist paper towels for 3 d at room temperature. Two germinated seeds each were planted into 15-cm-diameter plastic pots containing Lufkin sandy loam field soil (pH 5.6) and maintained in a greenhouse at 24-34 C. Six wk after planting, 200 g of soil, with pH levels adjusted to 7.7, 8.7, and 9.8 with CaO, were added separately to the surface of each pot, giving a surface layer of treated soil *ca.* 2 cm deep. Untreated soil (pH 5.6) was added to control pots. Fifty sclerotia were placed adjacent to stems of peanut plants in each pot. The percentages of stems infected by *S. rolfsii* per pot was determined each week after inoculation.

Experiments were conducted twice with four replications of each treatment. Data from the separate experiments were combined for analysis. Analysis of variance using the SAS (1985) general linear models procedure was used to

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determine treatment effects with mean separation using least significant differences.

Results and Discussion

Germination of sclerotia of isolate Sr1/1 was greater than that of isolate Sr1/9 ($P \leq 0.05$). Mean sclerotial germination after 4 d at pH 5.6 was 95 and 65% for isolates Sr1/1 and Sr1/9, respectively. For both isolates, germination of sclerotia was greater in acidic soil than in alkaline soil pHs ($P \leq 0.05$) (Fig. 1). At pH 8.7, mean germination after 4 d was 40% for isolate Sr1/1 and 10% for isolate Sr1/9.

In the pathogenicity tests, infected stems were first observed 14 d after inoculation. The percentage of infected stems at all assessment times was greater at soil pH 5.6 than in alkaline soils ($P \leq 0.05$) (Fig. 2). The percentages of stems infected by Sr1/1 at soil pH 7.7, 8.7, and 9.8 were only 16.9, 13.1, and 14.3%, respectively, of those at soil pH 5.6. Similarly, the percentage of stems

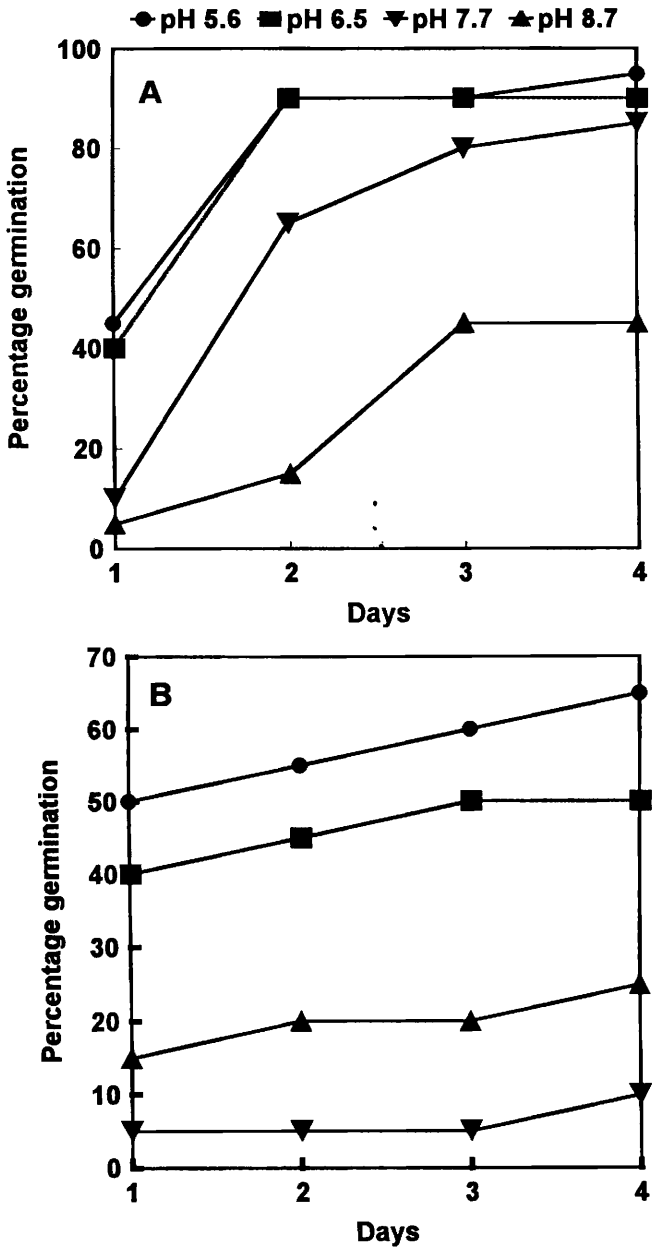

Fig. 1. Percentage germination of sclerotia of *Sclerotium rolfsii* at different soil pHs. A. Isolate Sr1/1 from peanut, $LSD_{0.05}$ = 31.4 for day 4. B. Isolate Sr1/9 from tomato, $LSD_{0.05}$ = 35.0 for day 4. Data are combined means from two experiments.

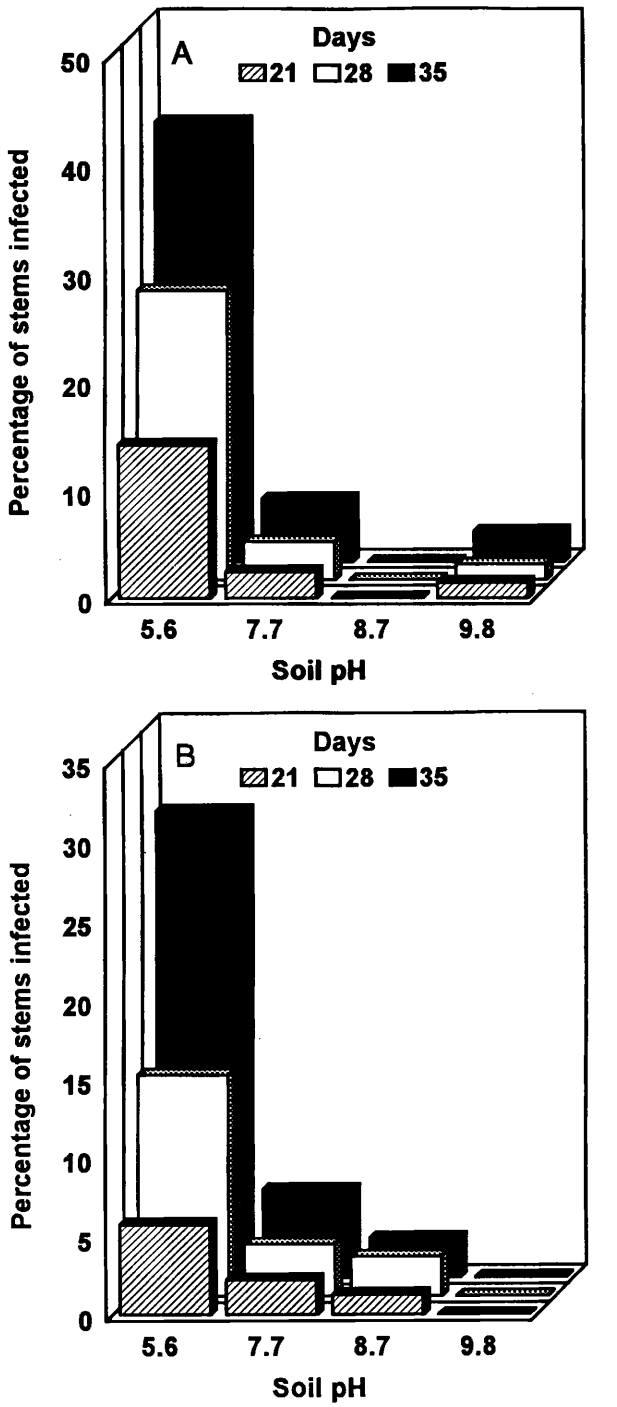

Fig 2. Effect of soil pH on incidence of stem rot of peanut incited by *Sclerotium rolfsii* in greenhouse tests. A. Isolate Sr1/1 from peanut, $LSD_{0.05}$ values for 21, 28, and 35 d after inoculation were 10.2, 12.1, and 15.9, respectively. B. Isolate Sr1/9 from tomato, $LSD_{0.05}$ values for 21, 28, and 35 d after inoculation were 5.8, 9.0, and 12.5 respectively. Data are combined means from two experiments.

infected by Sr1/9 at soil pH 7.7, 8.7, and 9.8 were only 38, 23.6, and 19%, respectively of those at soil pH 5.6. The percentages of stems infected by Sr1/1 or Sr1/9 at alkaline soil pHs were not different ($P \leq 0.05$).

Previous studies of the effects of pH on *S. rolfsii* reported that optimal mycelial growth and sclerotial germination occurred at low pH (3.0-5.5) and that no growth occurred above pH 8.0 (Aycock, 1966; Punja, 1985). Punja (1982) reported that sclerotia of *S. rolfsii* did not germinate above pH 7.0 on agar media, but we found germination of sclerotia in field soil occurred at pH as high as 8.7. In Texas peanut fields, stem rot does occur at soil pH > 7.0 (R. Lemon, pers. commun., 1995). In this study, disease was observed at soil pH values above 8, but disease incidences were significantly lower than at acidic soil pH. This study documents that sclerotia of *S. rolfsii* can germinate and incite disease at pH values well above the maximum value of pH 7.0 reported from agar medium studies (Punga and Grogan, 1982).

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