Toxicity of Crop Residue to Peanut Seed and Sclerotium rolfsii

H. W. Boyd and D. V. Phillips

Department of Plant Pathology, University of Georgia, College of Agriculture Experiment Stations, Georgia Station, Experiment 30212. Present address of senior author: Department of Biology, Brevard College, Brevard, North Carolina 28712.

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ABSTRACT

Water extracts of soil containing various crop residues inhibited radicle growth of germinating peanut seeds. Some extracts also inhibited mycelial growth from sclerotia of *Sclerotium rolfsii*. Extracts from soil at high or low soil moisture levels were more toxic than those from soil at an intermediate level after 3 weeks' incubation. Extracts remained inhibitory to germinating seed after freezing, sterilization by filtration, or heating to 100 C.

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A scheme of culture developed by Boyle (1) has resulted in improved control of southern blight of peanut (*Arachis hypogaea* L.) caused by *Sclerotium rolfsii* Sacc. A basic part of this culture scheme involves burial of plant residue to remove sources of food from the pathogen near the soil surface. Boyle (2) speculated that under certain conditions, decomposition of the buried organic materials may result in substances toxic to peanuts. Some decomposition products of crop residues have been identified (5). In addition to the effects on higher plants, organic amendments (4) and decomposition products (3) have been shown to influence the growth of *S. rolfsii*. Thus, under certain conditions, disease development might be influenced by toxins acting on the host and/or the pathogen.

The objective of this study was to determine whether crop residues decomposing under controlled conditions produce substances toxic to peanut plants and *S. rolfsii*. The procedures were designed to simulate conditions which might occur in the field.

MATERIALS AND METHODS.–Both immature (3-week-old) and mature (gathered in October from fields after harvest) peanut, soybean, corn, sorghum, and cotton plants were used as organic materials. All were oven-dried, ground in a Wiley Mill (1.6 mm mesh), and stored in sealed jars. Mature peanut plant material was used unless otherwise indicated.

Ten g of plant material were layered 2.5 cm below the surface in 920 g of soil (Davidson loam ca. 3% moisture) in clay pots. Distilled water (19.5 ml) was added to bring the moisture level to 5% by weight, except where different moisture levels were tested. Each pot was sealed in a polyethylene bag to prevent moisture loss, and incubated at 24 ± 2 C for 3 weeks. No crop residue was added to the soil in pots used as controls.

After 3 weeks, the top 2.5 cm of soil plus the organic matter layer was removed from 10 pots, mixed thoroughly with 1 liter of distilled water, and left overnight at room temperature. The liquid was decanted and centrifuged at 10,000 rpm for 10 min, filtered, concentrated by lyophilization to 0.5 original volume, filter-sterilized, and stored at 5 C until assayed.

For assay, 20 ml extract were added to a petri plate containing four peanut seeds (cultivar Argentine). The plates were replicated 10 times, and the radicles measured after 72-hr incubation at 30 C.

Extracts were tested for toxicity to *Sclerotium rolfsii* sclerotia produced on sterilized oats. Petri plates were fitted with dark filter paper wetted with 5 ml distilled water and autoclaved. Nine sclerotia were placed symmetrically on the surface, and 3 ml of the extract added. Diameter of mycelial growth was measured after incubation for 48 hr at 30 C.

RESULTS.–It was necessary for us to standardize several factors before extracts were consistently toxic to peanut radicle growth. Temperature was not critical, but a 3-week period of decomposition was necessary and a minimum of 10 g organic material (ca. 1%, w/w) was required. A ×2 concentration

TABLE 1. Effect of water extracts from soil containing immature or mature peanut crop residue at three moisture levels on peanut radicle growth

Residue	Moisture level[a]	Mean radicle length[b]
Immature	High	9.4 a
	Medium	23.4 c
	Low	9.8 a
Mature	High	16.2 b
	Medium	47.5 f
	Low	32.3 d
None	High	40.7 e
	Medium	42.3 e
	Low	40.5 e

[a] Approximately 25% (saturated), 15%, and 5% by weight.

[b] Mean of 40 seeds. Figures with common letters not different at 5% level of significance.

TABLE 2. Effect of water extracts of soil containing various mature crop residues on peanut radicle growth

Crop residue	Mean radicle length[a] (mm)		
	Experiment 1	Experiment 2	Experiment 3
Soybean	18.0 a	2.8 a	4.1 a
Corn	32.3 b	4.0 a	9.9 b
Sorghum	33.5 b	5.5 a	
Peanut	34.1 b	14.3 b	5.4 ab
Cotton	43.1 c	5.9 a	7.7 ab
None	43.7 c	24.3 c	16.6 c

[a] Mean of 32 seeds. Figures with common letters not different at 5% level of significance, comparable within experiments only.

resulted in a more reliable assay than nonconcentrated (X) extracts. The soluble salt concentration, pH, and ammonia concentration did not differ significantly between the control extracts and the toxic residue-soil extracts. Thus, these factors are apparently not responsible for the toxicity of the residue-soil extracts. Extracts were toxic after sterilization by filtration, freezing, or heating to 100 C.

Toxicity was significantly greater with the highest and lowest moisture levels, and extracts from soil with mature as well as immature crop residues were toxic (Table 1). Toxicity to germinating peanuts resulted when various crop residues were added to soil (Table 2).

A preliminary test of toxicity to *S. rolfsii* sclerotia indicated that some extracts reduced the germination percentage. Toxicity was confirmed in another experiment using rate of mycelial growth as an index. Extracts from soil with soybean or peanut residue significantly reduced mycelial growth. Extracts from soil with sorghum, corn, or cotton reduced mycelial growth slightly, but not significantly (5% level).

DISCUSSION.—In contrast to results indicating that high moisture conditions are necessary for toxin production (5), the most toxic conditions in these studies resulted at both high and low moisture levels. One explanation for this might be that a partial breakdown of organic material is necessary for toxin production. Decomposition may be restricted by lack of oxygen at high moisture levels, and by lack of water at low moisture levels. At intermediate moisture levels, decomposition may be more complete.

In these experiments, the organic material was not mixed throughout the soil, but was layered to simulate pockets of concentrated material which could occur in the field. Toxicity of extracts to peanut seeds and *S. rolfsii* under these conditions supports the hypothesis that toxic compounds produced during the decomposition of crop residues can be important in peanut culture. Since both the host and the pathogen are influenced and the response may be dependent on toxin concentration (3), toxins from the incorporation of crop residue might promote or retard disease development under field conditions.

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