Effects of Sprinkler Irrigation on Peanut Diseases in Virginia

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ABSTRACT

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A 4-yr field study was conducted to determine the effects of sprinkler irrigation on the incidence and severity of foliar and soilborne peanut diseases in southeastern Virginia. The plant canopy was denser and soil moisture content was higher with irrigated production regimes. Incidence and severity of Sclerotinia blight (*Sclerotinia minor*), pod rot (*S. minor* and *Pythium myriotylum*), and early leaf spot (*Cercospora arachidicola*) increased with sprinkler irrigation.

Virginia-type peanut (*Arachis hypogaea* L.) generally has a dense foliar canopy in contrast to valencia types and some spanish types. Although aerial flowers are produced within the canopy, pods containing peanut seed are produced in the soil, where there is high microbial activity. Peanut growth habit, presence of pathogens, and environmental interactions directly affect, both quantitatively and qualitatively, disease incidence and severity. Diseases such as Sclerotinia blight (11) caused by *Sclerotinia minor* Jagger (9), leaf spots caused by *Cercospora arachidicola* Hori and *Cercosporidium personatum* (Burk & Curt.) Deighton, and pod rot (pod breakdown) caused by *Pythium myriotylum* Drechs. are common in the Virginia-North Carolina peanut production area (12). These diseases result in annual crop losses of millions of dollars.

Environmental extremes, either natural or induced by crop management practices, often increase the incidence and severity of peanut diseases (4,5,7,18,20,21). Extremes in growth habit, including increased canopy density, leaf wetness, high soil moisture, high relative humidity, cool temperatures, etc., are directly correlated with disease development in many crops (15). After sprinkler irrigation, the plant microenvironment can be conducive to the development of both foliar and soilborne plant pathogens. The incidence of peanut pod rot caused by *P. myriotylum* (5) and white mold of dry beans (2,10) increased with irrigated conditions. Sprinkler irrigation, which has increased rapidly since 1980 in the Virginia-North Carolina peanut production area to ensure seasonal yield potentials, may provide environmental conditions conducive to the rapid development of peanut diseases. The purpose of this investigation was to determine the influence of sprinkler irrigation on the severity of Sclerotinia blight, leaf spot, and pod rot.

MATERIALS AND METHODS

Peanut seed (cultivar Florigiant) was planted in a field near Carrsville, VA, in 1980, 1981, 1982, and 1983. Production practices recommended by the Virginia Extension Service were used throughout the growing season. The soil type was Typic Paleudult, pH 5.8–6.2. A peanut-corn rotation was used within the same field. Each year, the test site was moldboard-plowed in late March, then disked twice. The tillage treatments of the 4-yr study were arranged in a split-plot experimental design within a nonirrigated and an irrigated block because of the type of equipment used to apply water. Plots were 15.2 m (50 ft) long by four rows wide (row width 0.9 m). The center two rows of each plot were used for pod yield data. The outside rows were used for disease ratings. Treatments were replicated four times within irrigated and nonirrigated plots. Disease data were subjected to an analysis of variance and Duncan's multiple range test.

Plots were irrigated with a Hobbs Reel Rain hose tow-traveling gun. The procedures used for irrigation were described by Wright et al (23). A water balance model described by Ritchie (14) was used to schedule irrigation. Plants were irrigated during daylight. Rainfall and irrigation data are presented in Table 1. The amount of water per application ranged from 33 to 41 mm, and the number of irrigations per season varied between three and eight. Rainfall for 1981 and 1982 was near normal. Irrigations were scheduled to supply the daily plant water requirements even though total rainfall for the growing season appeared to be sufficient for peanut production.

Measurements of disease severity and incidence were made from mid-growing season until harvest. Plants, chosen at random from throughout each plot, were

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Table 1. Normal rainfall (R) and amount of supplemental water applied by sprinkler irrigation (SI) for 4 yr during the peanut-growing season in Virginia

Month	Normal rainfall[a] (mm)	1980 R (mm)	1980 SI[b] (mm)	1981 R (mm)	1981 SI (mm)	1982 R (mm)	1982 SI (mm)	1983 R (mm)	1983 SI (mm)
July	152	64	152	97	81	173	33	76	76
August	152	46	109	216	41	112	33	66	114
September	107	0	0	84	41	84	33	99	0
Subtotal	411	110	261	397	163	369	99	241	190
Total	411	371		560		468		431	
Total irrigations per year		8		4		3		5	
Average amount applied		36		41		33		38	
Total amount applied		292		163		99		190	

[a] Normal rainfall based on 50-yr average.

[b] Supplemental water applied with traveling gun type irrigator calibrated to deliver specific amounts of water. Peanuts were irrigated (31 mm) once in June 1980.

assayed for Sclerotinia blight, pod rot, and leaf spot incidence and severity.

Sclerotinia blight evaluation. Infection of lateral branches of the peanut plant was determined at specific days after planting (DAP) during each growing season. Plants (eight per plot) randomly selected from the outside rows of each plot were hand-dug, and the infected lateral branches of each plant were counted. A branch was considered infected if one or more lesions typical of *S. minor* was observed. Pods, handpicked from each plant, were washed and observed for evidence of rot. Rotted pods with *S. minor* sclerotia were classified as being colonized by this fungus. The percentage of rotted pods with sclerotia either on or in the pod was determined. Additionally, a disease severity index for Sclerotinia blight was established for each plot. Forty plants selected at random from each plot were scored on a scale of 1–5 based on degree of severity (1 = no disease present and 5 = dead plant). The average of the scores was recorded as the disease index.

Leaf spot evaluation. Disease measurements were made before harvest on the uppermost 32 leaflets of the main branch of 16 plants selected at random from each plot. The number of leaflets infected and the total number of lesions per main branch of the 16 main branches selected were determined. Also, percentage defoliation was determined by dividing the leaflets remaining on the top eight petioles of the main branch by 32 (the number representing no defoliation).

Pod rot evaluation. Pod rot caused by *S. minor* was characterized by the presence of sclerotia on or inside the pod. Pod rot caused by *P. myriotylum* was determined as follows: Pieces of shell (about 5 mm square) containing some rotted tissues were cut from partially rotted pods and surface-disinfected for 3 min in 0.5% NaOCl. Shell pieces were plated, five pieces per plate, on selective media (6) and incubated for 4 days at 30 C. Morphological characteristics of the hyphae and reproductive structures were used to identify *P. myriotylum*.

Plants were dug and pods were harvested and dried according to standard procedures. Pod yields were based on the dried weight (10% moisture content) of the peanut.

Soil cores (10 per plot taken at random to a depth of 12.7 cm) were taken weekly with a core sampler with a diameter of 2.54 cm. Soil cores were thoroughly mixed and samples were drawn for soil moisture determinations. Soil moisture was determined by oven-drying (105 C for 24 hr) soil and calculating weight loss percentages.

RESULTS

Average rainfall during the growing season of 1980 was the lowest recorded in 50 yr (Table 1). Rainfall during 1981 and 1982 approached normal but was below normal in 1983. With the exception of the data for 120 DAP in 1983, soil moisture in irrigated plots was more than twice that in the nonirrigated plots (Table 2).

Table 2. Effects of no irrigation (NI) and sprinkler irrigation (SI) on soil moisture and incidence of Sclerotinia blight in peanuts

		Soil moisture (%) (12.7-cm depth)		Branches infected (no.)[x]		Pod rot (%)[y]	
Year	DAP[w]	NI	SI	NI	SI	NI	SI
1980	81	4.6	10.0	0.1 b[z]	1.1 a	0.0 a	1.2 a
	115	1.8	10.2	0.0 b	5.0 a	0.3 b	2.4 a
	144	1.8	4.1	0.0 b	7.8 b	0.7 b	5.4 a
1981	78	4.7	15.8	0.5 b	2.8 a	1.9 a	1.5 a
	113	8.2	10.7	3.5 b	11.5 a	4.5 a	7.9 a
	142	6.8	9.8	2.7 b	8.7 a	5.6 b	13.1 a
1982	88	4.2	8.7	0.4 a	1.6 a	0.1 a	0.2 a
	116	3.3	8.5	0.8 b	3.3 a	3.7 a	6.4 a
	142	6.3	12.1	2.1 b	6.9 a	6.9 b	11.5 a
1983	91	4.2	11.2	0.3 a	1.2 a	3.9 b	11.8 a
	120	11.6	10.7	0.2 b	2.5 a	7.5 b	19.5 a
	147	···	···	0.3 b	3.0 a	6.9 b	17.8 a

[w] Days after planting.
[x] Average number of branches from 32 plants (eight per plot × four replicates) showing some evidence of disease.
[y] Average number of pods from 32 plants (eight per plot × four replicates) showing some evidence of pod rot. Rot was caused by both *Sclerotinia minor* and *Pythium myriotylum*.
[z] Values for treatment within a year and DAP followed by different letters are significantly different at $P = 0.05$ according to Duncan's multiple range test.

Sclerotinia blight. Disease severity in all plots was greatest in years with high rainfall (Tables 1 and 2). The average numbers of branches of 32 plants infected at the end of the growing season in 1980, 1981, 1982, and 1983 were 0.0, 2.7, 2.1 and 0.3, respectively. Rainfall during July, August, and September of these years was 110, 397, 369, and 241 mm, respectively. The number of lateral branches with characteristic symptoms of *S. minor* at the end of the growing season (DAP > 140) was always greater ($P = 0.05$) in irrigated peanut plants than in nonirrigated plants (Table 2). Five times as many infected branches were observed in irrigated plots as in nonirrigated plots.

The disease index ratings were usually two to three times greater in irrigated plots than in nonirrigated plots (Table 3). Disease severity increased with time during the growing season each year. The 4-yr disease index averages in the nonirrigated and the irrigated plots were 1.5 and 2.8, respectively. During years of normal rainfall (1981 and 1982), Sclerotinia blight was moderately severe, but in years of low rainfall (1980 and 1983), the disease was almost nonexistent.

Table 3. Effects of no irrigation (NI) and sprinkler irrigation (SI) on severity of Sclerotinia blight in peanuts

		Disease index[y]	
Year	DAP[x]	NI	SI
1980	120	1.0 b[z]	2.4 a
	138	1.0 b	2.9 a
1981	125	1.6 b	3.1 a
	140	2.4 b	3.7 a
1982	116	1.4 b	3.1 a
	143	2.2 b	3.8 a
1983	122	1.0 a	1.5 a
	156	1.2 b	2.2 a

[x] Days after planting.
[y] Disease index of 40 plants selected at random from each plot based on a scale 1–5 (1 = no disease present and 5 = death of plant).
[z] Values for treatment within a year and DAP followed by different letters are significantly different at $P = 0.05$ according to Duncan's multiple range test.

Pod rot. The incidence of pod rot, caused by a combination of *S. minor*, *P. myriotylum*, and other fungi, increased with irrigation (Table 2). The average pod rot during the 4-yr study was 8.2% in irrigated plots and 3.5% in nonirrigated plots. In 1980 and 1982, pod rot was caused primarily by *S. minor*. In 1983, *P. myriotylum* caused about 40% of the rot and *S. minor* was observed on about 20% of the rotted pods. Other fungi including *Rhizoctonia* spp., *Fusarium* spp., and *Pythium* spp. were also isolated from rotted pods. In all years except 1983, the severity of pod rot increased as the growing season progressed.

Leaf spot. Leaf spot severity was usually two to three times greater with irrigation in the 3 yr when disease incidence was determined (Table 4). Although *C. arachidicola* was the predominant leaf spot pathogen, a few lesions caused by *C. personatum* were found late in the growing season. The percentage of leaflets infected, the number of lesions per plant, and the percentage of defoliation were 28, 46, and 57% higher in irrigated plots than in nonirrigated plots.

Yields. The effects of sprinkler

Table 4. Effects of no irrigation (NI) and sprinkler irrigation (SI) on incidence and severity of early leaf spot in peanuts

Year	Irrigation	Disease incidence and severity[y] Leaflet infection (%)	Lesions per plant (no.)	Defoliation (%)
1981	NI	6.7 b[z]	7.1 b	1.5 b
	SI	14.0 a	17.3 a	4.6 a
1982	NI	21.3 a	4.9 a	26.1 b
	SI	22.5 a	5.8 a	45.5 a
1983	NI	19.8 b	15.4 a	8.8 a
	SI	24.8 a	16.7 a	7.2 a

[y] Assessments for leaf spot severity were made on the top eight leaves from each of 16 main branches selected from irrigated and nonirrigated plots.

[z] Values for treatment within a year and with and without irrigation followed by different letters are significantly different at $P = 0.05$ according to Duncan's multiple range test.

Table 5. Effects of no irrigation (NI) and sprinkler irrigation (SI) on peanut pod yields

Year	Yield (kg/ha) NI	SI
1980	2,289 b[z]	4,483 a
1981	5,553 a	4,095 b
1982	5,447 a	3,885 b
1983	4,959 a	4,539 b

[z] Values for treatment within a year followed by different letters are significantly different at $P = 0.05$ according to Duncan's multiple range test.

irrigation on peanut yields varied significantly among years (Table 5). In 1980, increase in yield for irrigated plots compared with nonirrigated plots was 196%, or about twofold, whereas in 1981, 1982, and 1983, the yields in the irrigated plots compared with nonirrigated plots were 26, 29, and 8% lower. High pod losses observed in the field after combining, though not measured, were observed at digging time and primarily attributed to *S. minor*.

DISCUSSION

The dense canopy and environmental factors associated with irrigated crops have been related to the increase in the incidence and severity of several important pathogens (15,16). Production practices, including irrigation, that result in increased canopy density often result in increased disease. White mold of dry bean (4,10) and bean (17) increased as canopy density and irrigation increased. Canopy structure has been correlated with incidence of Sclerotinia blight (3) and southern stem rot of peanut (19). Sclerotinia blight of peanut increased as soil moisture increased (21).

Duration of leaf wetness is an important factor in the development of several diseases. Prolonged leaf wetness was associated with white mold in bean (1). Infection of wet bean leaves by *S. sclerotiorum* took 16 hr compared with 72 hr when leaf surfaces were exposed to drier ambient conditions. Leaf spot lesions on peanut develop within 12–14 days if prolonged periods of leaf wetness occur along with high humidity and temperatures in the range of 25–31 C (12). Conidial production is also influenced by leaf wetness (20). With irrigation, older peanut leaflets are particularly susceptible to *C. personatum* (15). New flushes of plant growth occurring at branch tips after irrigation are also prone to infection by the leaf spot fungi. The optimum temperature for infection by *S. minor* is 18 C (8). Severity of Sclerotinia blight of peanut is usually associated with prolonged cool night temperatures (4,22). Peanut canopy temperature as well as soil temperature are often reduced by sprinkler irrigation (16). Any of these factors alone or in combination might explain the increased incidence and severity of these diseases in peanut after sprinkler irrigation.

Although a nutritional source is a prerequisite for infection of plant tissue by *Sclerotinia* spp. (13), a variety of substrates can be used. Senescing peanut leaflets often shed within the dense canopy. Exudates from older peanut leaves can be enhanced by irrigation (15). The presence of these fallen leaflets on the soil surface underneath the dense plant canopy probably increases the severity of Sclerotinia blight. This is especially true when leaflets are kept moist for long periods. Studies by Hau et al (7) showed that volatile stimulants from remoistened peanut leaves stimulated mycelial germination of *S. minor*. This phenomenon may account for some of the increased activity in *S. minor* after irrigation of peanuts, because most infection sites occur at soil-plant contact points.

Results clearly demonstrate that sprinkler irrigation of peanuts as described in this study and under Virginia environmental conditions significantly increases the incidence and severity of several major peanut plant pathogens. It is probable, however, that these diseases may be minimized provided measures are taken to decrease periods of leaf wetness or to decrease periods of high soil moisture. Examples of production practices that might aid in reducing the incidence and severity of *S. minor* would include applying irrigation water at night, applying a maximum amount of water per irrigation to reduce the number of applications (15), applying water only when nighttime temperatures exceed 21 C, and reducing seeding rates to reduce canopy density (4).

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