Early Leafspot of Peanuts: Effect of Conservational Tillage Practices on Disease Development[1]

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ABSTRACT

The effects of tillage systems on the incidence and severity of early leafspot of peanut (*Arachis hypogaea* L.) caused by *Cercospora arachidicola* were determined in three peanut cultivars during a four-year field study. Conventional and conservational tillage systems were utilized. In the conventional system, the land was tilled with a moldboard plow to a depth of approximately 25 cm, disked, and peanut seed were planted in soil with minimum plant residue. In the conservational system the existing winter cover crop, wheat (*Triticum aestivum* L.), was killed with a herbicide. Two methods of seedbed preparation were used (in-row tillage and band-tillage) in the conservational tillage systems. A 25-cm wide band was tilled with a modified rotary tiller in the band-tilled plots. In the in-row tilled plots, seed were planted directly into the killed winter wheat residue with minimal soil preparation. At the end of the growing season, leafspot incidence and severity were significantly less in 1984 and 1986 than in 1985 and 1987. Leaflet infection, precentage defoliation, and lesions per leaflet were significantly greater in conventional tilled plots than in band-tilled or in-row tilled plots. Disease incidence and severity were similar in band-tilled and in-row tilled plots. Pod yields were greater in conventional tilled plots than in band-tilled or in-row tilled plots.

Key Words: *Arachis hypogaea*, early leafspot, *Cercospora arachidicola*, tillage, disease development.

Conservational farming systems, sometimes referred to as reduced tillage or minimum tillage, have been introduced in many areas of the United States (6) to reduce production costs, conserve soil moisture, and reduce soil erosion. Conservational tillage systems for peanut (*Arachis hypogaea* L.) differ greatly from procedures utilized in conventional tillage systems where existing crop residue is buried by deep plowing. With conventional tillage systems, seed are planted in a seedbed residue free. Such a system allows good soil-seed contact. Production with conventional tillage systems is more costly and erosion of soil by water and wind is greater than with conservational tillage systems. However, conventional tillage does aid in weed control. Conservational tillage systems are characterized by the presence of residue maintained on the soil surface after planting (1). Increased weed problems are usually associated with such tillage procedures. In some conservational tillage systems, seed are planted directly into a killed crop of small grain or in residue from a previous crop without any attempt to develop a clean, debris-free seedbed. In other systems, seed are planted into a seedbed prepared in a narrow band of soil that had been tilled either in the killed cover crop or in residue from existing crops.

Interest in the use of conservational tillage in peanut production has developed during the past decade; but the use of such a production system in peanut is usually associated with several unfavorable factors. These include a suspected increase in disease development related to residue buildup, poor plant stands due to poor seedbed preparation, reduced plant growth due to compacted soil, lack of satisfactory weed control, and reduced pod and seed quality (3, 5, 16, 17, 18). Diseases caused by both soilborne and foliar pathogens decrease in a number of crops grown using conservational tillage systems that do not eliminate residue from the soil surface (2, 10, 14, 15). Bowman *et al.* (2) observed a significant reduction in the recovery rate of *Alternaria* spp. from soybean seed grown under minimum tillage systems. Diseases of wheat decreased under some minimum tillage systems but increased in others (8, 10). Incidence of purple stain seed decay, caused by *Bacillus subtilis*, in soybeans was less under minimum tillage systems (14). Root rots caused by several soilborne fungi, including *Fusarium* spp., *Phytophthora* spp., and *Rhizoctonia* spp., were generally lower under conservational tillage systems (15). Although Garren (4) demonstrated that plant residue increased the incidence of stem rot caused by *Sclerotium rolfsii* Sacc., recent studies have shown that the presence of residue associated with minimum tillage had little to no effect on the incidence of stem rot (3, 5, 7). In a five-year study (7) in Alabama, stem rot severity in peanut did not increase under reduced tillage systems even though plant residues remained on top of the soil,. Also, visual differences in late leafspot, caused by *Cercosporidium personatum* (Berk. and Curt.) Deighton, were not noted between tillage treatments. No previous study has examined in detail the effects of conservational tillage on early leafspot in peanut. The objective of this study was to determine the late season incidence and severity of early leafspot, caused by *Cercopora arachidicola* Hori, on three peanut cultivars grown under conventional tillage and two conservational tillage systems. This study was a part of a larger study to determine the pod yield and market quality of peanut production for conventional and conservational tillage systems.

Materials and Methods

Field test sites (1984-1987) were located on a Kenansville loamy sand (loamy, siliceous, thermic Arenic Hapludults). Field plots were 15 m long by four rows (3.7 m) wide with four replications. Treatments were arranged in a split plot randomized complete block design. Tillage treatments were the main plots; cultivar treatments were the subplots. Cultivars, Florigiant and VA 81B, both susceptible to early leafspot, and NC 6, resistant to early leafspot, were planted following corn in a two-year rotation (corn, peanuts, corn, peanuts, etc.) on 14 May 1984, 15 May 1985, 16 May 1986, and 12 May 1987. Peanut production practices recommended by the Virginia Cooperative Extension Service were followed each year except for the tillage systems. Since the primary objective of the larger study was to determine the effects of tillage systems on pod yield and market quality, steps were taken to provide control of early leafspot (4 to 5 applications of benomyl 50WP at 0.19 kg/ha plus mancozeb 80WP at 0.76 kg/ha per application per growing season). Fungicides were applied on a preventative

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schedule with the first application applied during the first week of July. Although these fungicides provided some control of leafspot, sufficient disease was present at the end of the growing season to measure disease incidence and severity.

Tillage treatments included both conventional and conservational tillage systems. In the conventional system, the soil was tilled with a moldboard plow about 25 cm deep in late March or early April. In such systems, debris is buried at the botton of the plowed zone (20-25 cm). Soil was then disked twice prior to planting. Peanut seed were then planted in a flat seedbed. In these two tillage systems, immature winter wheat cover crop (ca 40 cm tall) was killed using glyphosate at 2.34 L/ha about two weeks prior to planting. A conservational tillage implement (Kelly Manufacturing Company, Tifton, Georgia 31794) with planters attached was used to prepare the soil and plant the in-row tilled plots. The implement was set up with the fluted, press-type coulter mounted behind a clay-type, ripper shank which had been shortened by 15 cm to minimize soil disturbance. A 51-cm ripple coulter was mounted in front of the shortened ripper shank which ripped the soil to a depth of 10-12 cm. The implement was designed to provide some in-row tillage (ca 10 cm wide) without under-row ripping. Peanut seed were planted in one pass through the wheat residue. A Ferguson power-driven rotary tiller (Ferguson Manufacturing Company, Suffolk, Virginia 23434) with planters attached was used to prepare the band-tilled plots. Rotors were removed from the tiller except the two that were centered on the plant row. The tiller was operated at a depth of 6 to 8 cm to prepare a 25-cm wide band of cultivated soil for the seedbed. Peanut seed were planted in one pass through the wheat residue. Immediately following planting, the herbicide (Dual) metolachlor was applied to all treatments at the rate of 1.7 L/ha shortly after planting. A second herbicide application of metolachlor plus dinoseb was applied at 1.7L and 14.0 L/ha, respectively, at emergence.

The incidence and severity of early leafspot, caused by natural sources of inoculum of *C. arachidicola*, were determined near the end of the growing season (30 September 1984, 29 September 1985, 27 September 1986, and 17 October 1987). Percentage leaflet infection, defoliation, and the number of lesions per leaflet were determined using one randomly selected lateral branch from 10 plants from each plot. Infection levels on the upper eight fully expanded leaves of each branch (a total of 320 leaflets) were determined from each plot. Plant defoliation was determined by dividing the number of leaflets shed from each branch by the total number of potential leaflets per branch (4 leaflets/leaf x 8 leaves =32). Percentage leaflet infection was determined by dividing the number of leaflets with leafspot lesions by the number of leaflets remaining on the branch. The number of lesions per leaflet was determined by counting the number of lesions on the leaflets remaining on the branch and dividing by the number of leaflets remaining on the branch.

Peanut plants were dug with a digger-shaker-inverter and harvested with a commercial combine. The weight and moisture content of peanut pods were determined for each plot. Yield was computed based on 8% pod moisture content.

Data were analyzed using the general linear models procedure developed by Statistical Analysis Systems, Cary, North Carolina, (11) and significant differences between means were determined using Duncan's multiple range test.

Results

Analysis of variance for leafspot data from the four-year field study indicate differences between the main effects of tillage and cultivars were significant in most years (Table 1). Significant interaction between tillage and cultivar occurred more frequently for percentage infection and lesion number than for defoliation data.

In general, the incidence (percentage leaflet infection) and severity (percentage defoliation and number of lesions per leaflet) of early leaspot were significantly greater in conventional tilled peanuts than in peanuts planted under conservational tillage systems (Table 2). Although disease incidence and severity levels varied from year to year, percentage defoliation was significantly greater on plants in conventional tilled plots than on those in conservational tilled plots. Incidence and severity of infection were similar for plants in both conservational tillage systems. In three of the four years, percentage leaflet infection was significantly greater when using conventional tilled plots than when conservational tilled plots were used. Leaflet infection was greater with conventional tilled plots than with in-row tilled plots in 1984, 1985, and 1987. Lesions per leaflet were significantly less with both conservational tilled systems than with conventional tilled plots except in 1986. Lesions per leaflet were similar in the band-tilled and in-row tilled plots except in 1985. In all years, pod yields were greater when conventional tilled plots were used. Except for 1986, yields were greater in band-tilled plots than in the in-row tilled plots.

The incidence of early leafspot was usually less in the

Table 1. Analysis of variance for effects of tillage and peanut cultivar on incidence (percentage leaflet infection) and severity (defoliation percentage and number of lesions per leaflet) of early leafspot in 1984-1987.[Y]

		F Values			
Source	df	1984	1985	1986	1987
		Leaflet infection (%)			
Total	35				
Rep	3	1.74 ns	1.28 ns	1.59 ns	0.92 ns
Tillage (T)	2	87.32 **	88.77 **	81.99 **	25.12 **
Error (a)	6	72.50 [Z]	0.27	0.89	1.08
Cultivar (C)	2	33.38 **	3.63 *	11.57 **	100.89 **
T X C	4	9.53 **	0.79 ns	1.71 ns	18.94 **
Error (b)	18	16.50 [Z]	84.70	83.80	24.98
		Defoliation (%)			
Total	35				
Rep	3	3.35 ns	0.98	2.21 ns	6.86*
Tillage (T)	2	56.88 **	8.60 *	14.07 **	308.61 **
Error (a)	6	3.31 [Z]	1.28	0.28	0.32
Cultivar (C)	2	18.41 **	0.02 ns	18.65 **	35.20 **
T X C	4	5.00 ns	3.50 *	1.83 ns	0.74 ns
Error (b)	18	6.54 [Z]	19.00	39.55	64.64
		Lesions per leaflet (#)			
Total	35				
Rep	3	0.41 ns	0.70 ns	0.66 ns	0.83 ns
Tillage (T)	2	130.15 **	119.60 **	2.30 ns	165.22 **
Error (a)	6	1.00 [Z]	0.48	2.41	0.35
Cultivar (C)	2	17.95 **	4.32 *	3.43 ns	46.13 **
T X C	4	12.80 **	0.57 ns	1.29 ns	7.15 **
Error (b)	18	0.07 [Z]	0.34	0.32	16.08

[Y] = Significant levels are indicated by single * for $P \leq 0.05$ and a double ** for $P \leq 0.01$.

[Z] = Mean square value for error term.

Table 2. Incidence (percentage infection) and severity (percentage defoliation and lesions per leaflet) of early leafspot and pod yield in relation to tillage systems, 1984-1987.[Z]

Year	Tillage	Leaflet infection (%)	Defoliation (%)	Lesions per leaflet (#)	Pod yield (kg/ha)
1984	Conventional	58.5 a	8.7 a	3.3 a	3506 a
	Band-till	32.3 b	2.1 b	1.9 b	3105 ab
	In-row till	25.6 c	1.7 b	1.7 b	2740 b
1985	Conventional	76.8 a	50.5 a	4.6 a	3953 a
	Band-till	59.9 b	42.1 b	2.7 b	3245 b
	In-row till	51.0 c	46.1 b	2.2 c	3206 b
1986	Conventional	33.6 b	25.1 a	2.6 a	4608 a
	Band-till	12.3 c	20.4 b	2.2 a	3903 a
	In-row till	41.1 a	18.0 b	2.9 a	4208 a
1987	Conventional	98.9 a	85.3 a	23.8 a	4426 a
	Band-till	85.2 b	42.3 c	7.7 b	3827 b
	In-row till	86.6 b	49.9 b	9.4 b	3647 b

[Z] Treatment means (four replications and three cultivars) within a year followed by a common letter are not significantly different at the $P \leq 0.05$ level as determined by Duncan's multiple range test.

Table 3. Incidence and severity of early leafspot and pod yield of peanut planted in conventional and conservational tillage tests, 1984-1987.[z]

Year	Cultivar	Leaflet infection (%)	Defoliation (%)	Lesions per leaflet (#)	Pod yield (kg/ha)
1984	Florigiant	42.9 a	7.8 a	2.5 a	3113 a
	NC 6	31.0 b	2.2 b	2.0 b	3178 a
	VA 81B	42.6 a	2.5 b	2.6 a	3060 a
1985	Florigiant	66.1 a	46.2 a	3.6 a	3853 a
	NC 6	56.8 b	46.5 a	2.9 b	3383 b
	VA 81B	64.9 a	46.1 a	3.0 b	3170 c
1986	Florigiant	39.1 a	29.8 a	2.9 a	4193 ab
	NC 6	26.3 b	19.2 b	2.4 b	4426 a
	VA 81B	21.8 b	14.4 b	2.4 b	4101 b
1987	Florigiant	97.4 a	70.9 a	14.8 b	3879 a
	NC 6	73.5 b	44.0 c	5.2 c	4154 a
	VA 81B	99.7 a	62.5 b	20.8 a	3867 a

[z] Treatment means (four replications and three tillage systems) within a year followed by a common letter are not significantly different at the $P \leq 0.05$ level as determined by Duncan's multiple range test.

peanut cultivar, NC 6, than in Florigiant and VA 81B (Table 3). Defoliation was significantly greater in Florigiant than in the other cultivars except in 1985. Leaflet infection percentages were significantly less in NC 6 than in Florigiant and VA 81B except in 1986. In three years of the study, disease incidence was similar in Florigiant and VA 81B. NC 6 generally had fewer lesions per leaflet than the other two cultivars. Lesion numbers per leaflet were low during 1984, 1985, and 1986. In 1987, lesions per leaflet in plots of Florigiant and VA 81B were five to seven times greater than during 1984, 1985, and 1986. Although large significant differences were not observed in pod yields, there was a trend for yields of NC 6 and Florigiant to exceed those of VA 81B.

An analysis of combined tillage and cultivar disease data over years demonstrated a year effect in the level of disease incidence and severity (Table 4). The average level of defoliation was least severe in 1984 (4.2%) and 1986 (21.2%) than in 1985 (46.2%) and 1987 (59.2%). The average level of leaflet infection was greater in 1985 and 1987 than in 1984 and 1986. The average level of lesions per leaflet was 2.3 in 1984, 3.2 in 1985, 2.6 in 1986, and 13.6 in 1987. Significant pod yield differences were noted between all four years but differences were not correlated to disease development.

Discussion

In our study, the incidence and severity of leafspot were significantly less in conservational tilled plots than in conventional tilled plots. Similar findings of decreased disease in conservational tilled plots have been noted in other crops (2, 10, 14, 15). The reason for this decrease in leafspot in peanut plants produced under conservational tillage systems have not been identified but could be related to management of plant debris or residue. The principal source of leafspot inoculum is thought to be soilborne originating from peanut crop debris (9). In the conventional tillage system, soil is plowed or turned with a moldboard plow. In two-year rotations, such as used in this study and currently practiced in Virginia, peanut debris containing over-wintering propagules of *C. arachidicola* may be returned to the soil surface and could account for disease development in conventional tilled plots. In conservational tillage systems, the soil is minimally disturbed and not turned. This reduces the possibility of returning infested peanut residues from the previous crop to the soil surface to initiate infection.

Table 4. Disease incidence and severity data combined over tillage and peanut cultivars for conventional and conservational tillage tests, 1984-1987.[z]

Year	Leaflet infection (%)	Defoliation (%)	Lesions per leaflet (#)	Pod yield (kg/ha)
1984	38.8 c	4.2 d	2.3 c	3118 d
1985	62.6 b	46.2 b	3.2 b	3468 c
1986	29.0 d	21.2 c	2.6 c	4240 a
1987	90.1 a	59.2 a	13.6 a	3966 b

[z] Treatment means within each column followed by a common letter are not significantly different ($P \leq 0.05$) according to Duncan's multiple range test.

The micro-environment associated with conservational tillage systems may also be less conducive to disease development than that of conventional tillage systems (13). Soil moisture is usually higher and temperatures are cooler in conservational tillage systems than in conventional tillage systems. These factors, especially cooler temperatures, could have influenced disease development especially since *C. arachidicola* favors warmer temperatures for optimum development (9).

Leafspot incidence and severity were greater in 1985 and 1987 than in 1984 and 1986. Differences in disease during these years may be related to rainfall. Rainfall was abundant during September of 1985 (25.2 cm) and 1987 (15.2 cm). Minimum rainfall occurred in 1984 (3.1 cm) and 1986 (1.3 cm). According to Smith and Crosby (12) conidia of *C. arachidicola* increase during periods of rainfall. Rainfall increases relative humidity which is a prerequisite for infection to occur (9). Splashing rainfall droplets also aid in movement of conidia from the soil surface to plant tissues (9). However, the presence of wheat debris in conservational tillage systems, such as described in this study, could minimize effects of splashing rain and thus reduce the potential inoculum. Even under normal conservational tillage conditions, the debris or residue on the soil surface could serve as a barrier and intercept soilborne inoculum.

We noted that pod yields were greater in conventional tilled plots even though leafspot was less in conservational tilled plots. Factors other than the presence of a foliar pathogen, such as *C. arachidicola*, must have influenced pod development and subsequent yield increases in conventional tilled plots. Perhaps crop residues present on the soil surface in conservational tilled plots affect continued peg (gynophore) development and result in embryo abortion, peg distortion, etc. Gaseous compounds given off during the decaying process of the wheat residue and chemical residue resulting from the application of glyphosate to kill the wheat cover crop may be potential reasons for the yield decreases noted in conservational tilled plots. The undisturbed soil surface of the sandy soil type in conservational tilled plots was not believed to adversely impact pod growth and development.

In this four-year field study, we found that the tillage system influenced the incidence and severity of early leafspot in peanuts (Table 2). Also, pod yields were negatively impacted by conservational tillage (Table 2). Additional research is needed to ascertain the reasons for decreased incidence of early leafspot in conservational tillage systems and increased pod yields in conventional tillage systems.

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