Spread of Corn Anthracnose from Surface Residues in Continuous Corn and Corn-Soybean Rotation Plots

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ABSTRACT

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The development of anthracnose leaf blight was monitored at 14-day intervals to determine disease spread from corn residues on the soil surface in plots maintained under continuous corn or a corn-soybean rotation during 1984 and 1986. The number of infected leaves per plant was negatively correlated ($P < 0.01$) with distance from the residue area in both plots from 28 to 70 days after planting. No net increase in the number of infected leaves per plant was detected after this period (70–112 days). Among-group regression analysis indicated a significant difference ($P < 0.01$) between within-row and across-row spread of leaf blight in the corn-soybean rotation and the continuous-corn plots. The difference in slopes of the regression lines indicated that leaf blight spread more rapidly within rows than across rows. The percentage of plants with anthracnose stalk rot at the end of the season was negatively correlated ($P < 0.01$) with distance from the residue area in both plots in 1984, but only the corn-soybean rotation plot in 1986. Stalk rot incidence was higher in the continuous-corn plots than in the corn-soybean rotation plots, and incidence was higher at greater distances from the residue area. Results indicate that surface corn residues are an important source of inoculum for anthracnose and the rate of disease spread may depend on the orientation of corn rows in relation to the inoculum source and cropping history of the field.

Additional keywords: Colletotrichum graminicola, Zea mays.

Anthracnose is a prevalent disease of corn (*Zea mays* L.) in many areas of the United States (4,6,8,14,17). The pathogen, *Colletotrichum graminicola* (Ces.) Wils, causes characteristic lesions on leaves during the growing season (4,6,17) and shiny-black lesions on stalk surfaces of senescing plants (4,17). Yield losses have been attributed to both the leaf blight and stalk rot phases of the disease (1,4,7,17).

C. graminicola survives the winter in corn residues on the soil surface (8,9,12). Conidia developing on the surface of residues are spread to plants by splashing water (4,5). Warm, humid weather with many cloudy days favors anthracnose leaf blight (3,4,6,17), and low light intensity enhances lesion development (3).

It is generally assumed that conidia produced on residues left on the soil surface constitute the primary inoculum for the leaf blight phase (5,10,12), and sporulation in mature leaf lesions serves as a source of secondary inoculum. The source of inoculum, the infective unit, and mechanisms for infection are not known for the stalk rot phase (17).

Because *C. graminicola* overwinters in corn residues on the soil surface, clean plowing to bury residues and crop rotation are recommended for control (4,8–10,12,14,17). Under conventional tillage, a 1-yr rotation following clean plowing will eliminate the fungus from residues (8,9,12). However, under no-tillage, a 2-yr rotation away from corn may be necessary to eliminate the fungus from surface residues in northern regions (9). In continuous corn, clean plowing may reduce inoculum levels and the incidence of early season disease development, but it has not resulted in complete control of leaf blight or late-season stalk rot (10,17).

The overall objective of this investigation was to determine the relative importance of crop residue on the soil surface as a potential source of inoculum for anthracnose and to determine if there was a relationship between early-season leaf blight and late-season stalk rot. Further objectives were to describe the spread of anthracnose within plots from a central source of inoculum and compare disease spread in plots under a corn-soybean rotation and under a continuous-corn cropping system.

MATERIALS AND METHODS

Inoculum. Inoculum consisted of intact stalks of corn hybrid, Pioneer 3780, collected after harvest. Corn stalks selected had >25% of the rind surface covered with black-streak symptoms of anthracnose. Stalks were stripped of leaves, tied in loose bundles, and stored over winter in an unheated building before their use in the spring.

Field plots. Two field plots were established at South Charleston, OH, on Crosby silt loam in 1984 and at Wooster, OH, on Ravenna silt loam in 1986. In each year of the study, one plot had been maintained in a corn-soybean rotation for at least 4 yr, and the other in continuous corn for at least 3 yr before the initiation of the experiment. In the corn-soybean rotation plots, soybean was planted the year preceding the experiment. Both plots, in both years, were mold board plowed to a depth of 25 cm in the spring and fertilized by broadcasting 135 kg/ha of phosphorus, 135 kg/ha of potassium, and 280 kg/ha of nitrogen. Weeds were controlled by preplant incorporation of 2.2 kg/ha of metholachlor plus 3.4 kg/ha of cyanazine. Precipitation data for successive 14-day periods after planting (Table 1) were obtained from the Ohio Autoweather Network Station located 500 m from the plots at South Charleston in 1984 and 300 m from the plots at Wooster in 1986.

Seed of Pioneer 3780 were planted on 18 May 1984 and 1 May 1986 with a conventional corn planter set to drop 70,000 seed/ha. Each plot consisted of 80 rows, 60 m long, planted in a north to south direction, with 75 cm between rows. After planting, corn-residue inoculum was placed on the soil surface in the center four rows of each plot (Fig. 1). Residues were positioned on both sides of each row in a band 5–20 cm wide for a length of 6 m. This central four-row area, hereafter referred to as the corn residue area (CRA), was the only area that received residue inoculum. Markers were placed every 0.75 m within and across rows to a distance of 7.5 and

6 m, respectively, from the edge of the CRA. The number of leaves on each plant between the markers with at least two distinct lesions at each distance from the CRA was recorded every 14 days from planting (day 0) to day 112. The percentage of plants with black-streak symptoms on the stalk surface plus internal discoloration of the pith at each distance from the CRA was determined 154 days after planting.

Statistical analyses. Individual plant data between each 0.75-m distance were averaged into means representing plants within rows (north-south direction) and across rows (east-west direction). Data from plants within the CRA were used in the analysis and represented plants at zero distance. When disease intensity data, as measured by mean number of leaves per plant with at least two lesions and mean percentage of plants with stalk rot, dropped to a series of zeroes beyond some distance, these data were not included in the analyses (2,11). The relationship between disease intensity and distance from the corn-residue inoculum was determined by linear regression analysis.

Regressions were performed after taking the logarithm (base 10) of the disease variable (+ 1). The independent variable, distance, was either transformed with logarithms or untransformed for the regressions (11). The latter case generally resulted in best fit of regression lines and is presented here.

Comparison of regression lines was conducted using among-group regression analysis (16). Comparisons were made of regression lines describing spread of anthracnose leaf blight over time (28, 42, 56, and 70 days after planting), in space (across row and within row), and between rotations (corn-soybean vs. continuous corn). *F*-tests ($P < 0.05$) were performed to determine whether regression lines were different (both slopes and intercepts different), parallel (slopes equal and intercepts different), or described a single line (slopes and intercepts equal).

RESULTS

Precipitation during the 1984 growing season was relatively low (38.4 cm) as compared with the same period for the previous 3 yr (mean 50.2 cm), but precipitation during the 1986 season (45.9 cm) was near normal (mean 46.7 cm) (Table 1). No evidence of anthracnose was detected 14 days after planting, but anthracnose lesions were detected on leaves of plants in both plots, both years, by 28 days (9- to 10-leaf stage) after planting (Figs. 2A and E, 3A and E). In the corn-soybean rotation plots, plants within 1.5 and 2.5 m of the CRA in 1984 and 1986, respectively, had leaf lesions on the lowest leaf, but in the continuous-corn plot, lesions occurred on plants up to 6 m from the CRA by 28 days, in both years. Leaf lesions developed on progressively higher leaves up to 70 days after planting (1 wk after pollen shed) (Figs. 2D and H, 3D and H). By this time, lesions developed on six to seven and seven to eight leaves per plant (out of a total of 20 leaves per plant) in 1984 and 1986, respectively, in the CRA of both the corn-soybean rotation and the continuous-corn plot. By 70 days after planting in the corn-soybean rotation plot, lesions developed on the lower leaves of plants both across and within rows up to 3 and 6 m from the CRA (Fig. 2D) in 1984, respectively, and lower leaves of plants both within and across rows up to 6 m from the CRA (Fig. 3D) in 1986. However, in the continuous corn plot, leaf lesions developed on the lower two to three leaves in 1984 and five to seven leaves in 1986 of plants within rows up to 7.5 m and across rows up to 6 m from the CRA (Figs. 2H and 3H). No new lesions were detected on previously unaffected leaves by 84 days (blister stage), 98 days (beginning dent), or 112 days (full dent) after planting. Eight to 10 of the lower leaves on plants with advanced lesion development died by 112 days after planting in both plots, both years. Lesion development rarely exceeded 20% of the leaf area affected on infected leaves.

All regression equations calculated for each date within and across rows were significant ($P < 0.05$) in both the corn-soybean rotation and continuous corn plots (Table 2). Coefficients of determination (r^2) were generally above 0.6 and were higher at days 56 and 70 than at days 28 and 42 in 1984 but not in 1986 (Table 2). Comparisons of regression equations between successive 14-day intervals indicated that significant ($P < 0.05$) changes in disease gradients occurred from 28 to 56 days after planting in both the

TABLE 1. Precipitation for successive 14-day periods from planting (day 0) to assessment of stalk rot incidence (day 154) at South Charleston (1984) and Wooster (1986)[a], Ohio

Days after planting	Precipitation per 14-day period (cm)		No. days of precipitation in each 14-day period	
	1984	1986	1984	1986
14	7.9	0.8	8	3
28	0.1	3.4	2	9
42	5.3	7.5	6	8
56	5.0	5.6	6	7
70	1.1	10.0	5	8
84	5.4	4.4	6	3
98	4.3	0.3	4	4
112	1.7	1.4	5	5
126	3.0	1.7	6	4
140	3.0	3.0	5	6
154	1.6	7.8	7	8
Total	38.4[b]	45.9[b]	60	65

[a] Data obtained from the Ohio Autoweather Network, the Ohio Agricultural Research and Development Center, Wooster, OH.

[b] Means for the same period during 1981, 1982, 1983, at South Charleston was 50.2 cm and during 1983, 1984, and 1985 at Wooster was 46.7 cm.

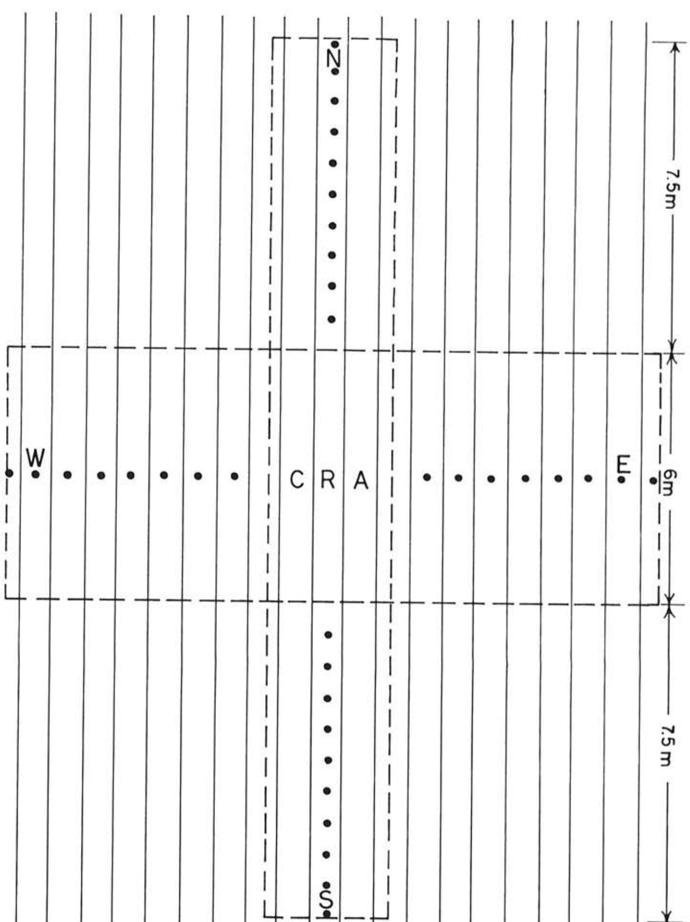

Fig. 1. Field plot design used to evaluate spread of anthracnose from surface corn residues. Infected corn stalks were placed on the soil surface around the central four rows to a length of 6 m (corn residue area: CRA). Spread was monitored within rows (N-S direction) and across rows (E-W direction) from CRA. Individual plant ratings within each 0.75-m interval were averaged for analysis.

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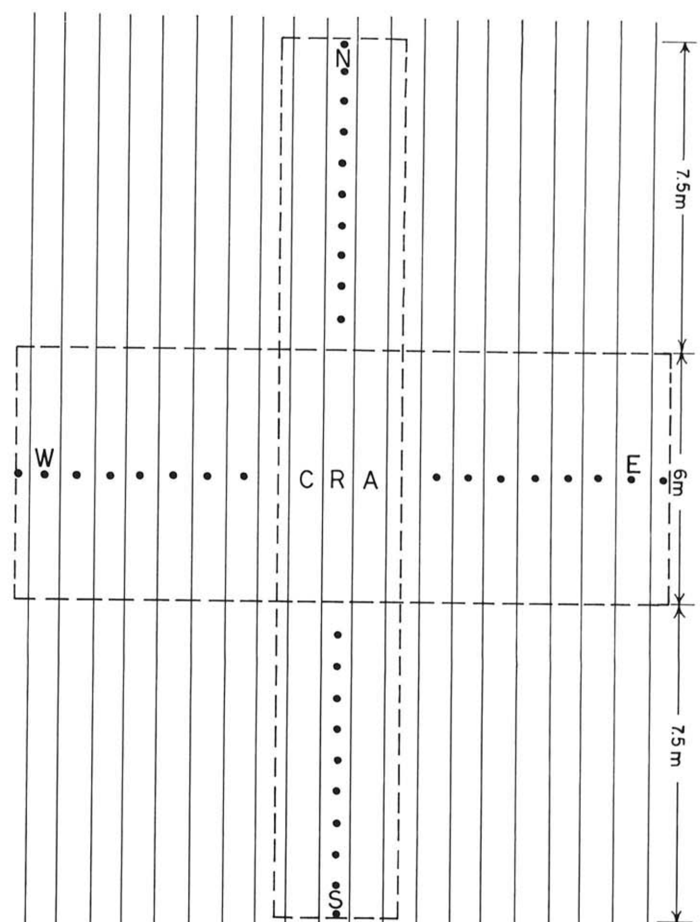

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corn-rotation and continuous corn plots (Table 3). Slopes became less negative over time as spread continued in the plots. Likewise, intercepts increased over time up to 56 days. Disease spread did not continue in all plots after 56 days after planting. Among-groups regression analysis indicated that regression equations for across-row spread in 1984 and within-row spread in 1986 in the corn-soybean rotation plot, and both across-row and within-row spread in the 1986 continuous-corn plots were not different between 56 and 70 days (*F*-test for the two regression equations describing a single line was significant [$P < 0.01$]).

During the time plants were rated for disease development, it became apparent that plants within rows had a greater number of

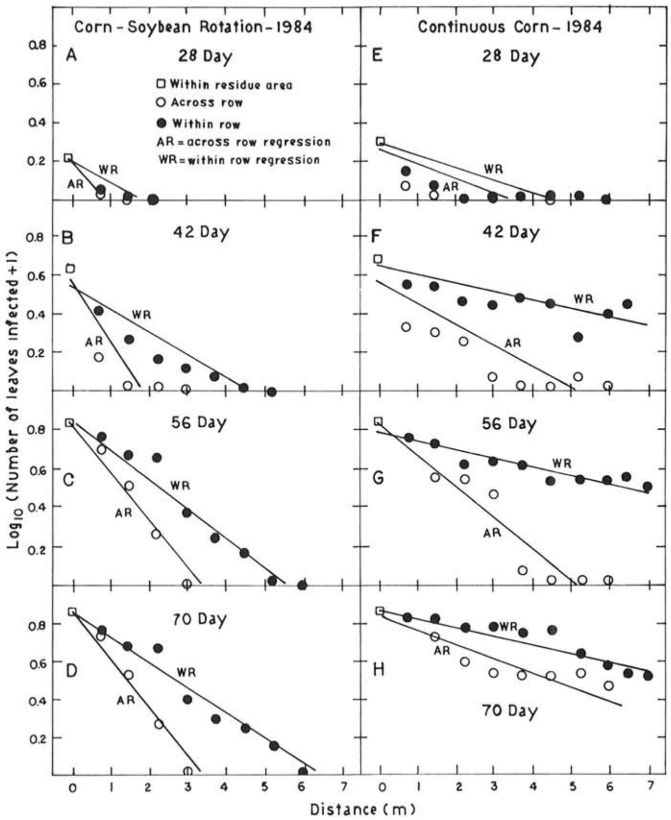

Fig. 2. Relationship between $\log_{10}$ (number of leaves with anthracnose lesions per plant + 1) and distance from surface corn residues within and across rows 28, 42, 56, and 70 days after planting in plots maintained under a corn-soybean rotation (A, B, C, and D) and continuous corn (E, F, G, and H) at South Charleston, OH, in 1984. Distance 0 represents the central corn-residue area.

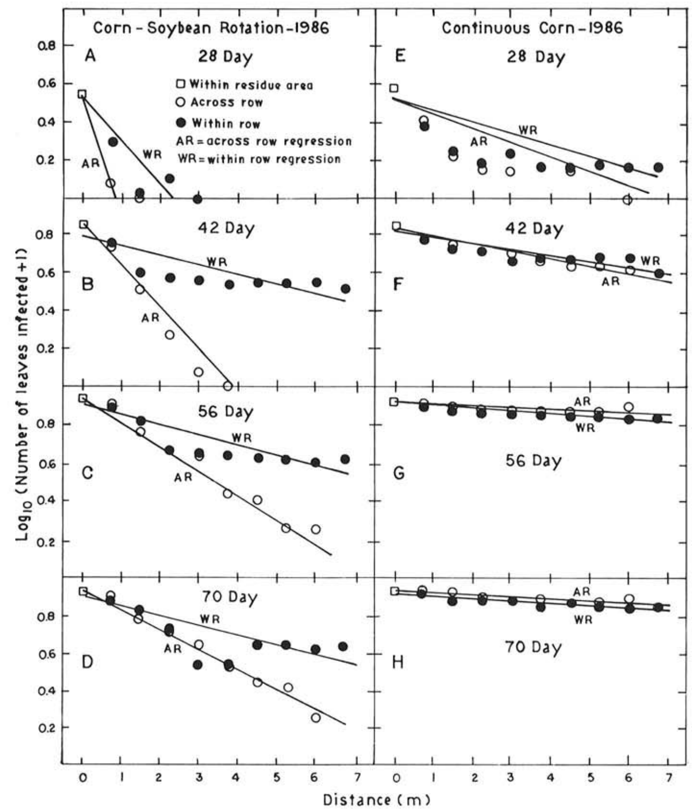

Fig. 3. Relationship between the $\log_{10}$ (number of leaves with anthracnose lesions per plant + 1) and distance from surface corn residues within and across rows 28, 42, 56, and 70 days after planting in plots maintained under a corn-soybean rotation (A, B, C, and D) and continuous corn (E, F, G, and H) at Wooster, OH, in 1986. Distance 0 represents the central corn-residue area.

TABLE 2. Coefficients of determination, levels of significance, and regression equations for the relationship between the $\log_{10}$ (number of leaves with anthracnose lesions per plant + 1) (y) and distance (x) across and within rows from a surface corn-residue area in corn-soybean rotation and continuous corn plots at successive 14-day intervals from planting

		Corn-soybean rotation			Continuous corn		
Year and days after planting	Direction from residue area	Coefficient of determination (r^2)	Significance level (P)	Regression equation	Coefficient of determination (r^2)	Significance level (P)	Regression equation
1984							
28	Across row	0.81	0.04	$y = 0.22 - 0.233x$	0.69	0.01	$y = 0.27 - 0.078x$
	Within row	0.82	0.01	$y = 0.21 - 0.119x$	0.77	0.02	$y = 0.27 - 0.054x$
42	Across row	0.87	<0.01	$y = 0.58 - 0.297x$	0.58	<0.01	$y = 0.58 - 0.115x$
	Within row	0.89	<0.01	$y = 0.56 - 0.121x$	0.79	<0.01	$y = 0.63 - 0.043x$
56	Across row	0.98	<0.01	$y = 0.83 - 0.239x$	0.94	<0.01	$y = 0.83 - 0.152x$
	Within row	0.96	<0.01	$y = 0.85 - 0.151x$	0.90	<0.01	$y = 0.80 - 0.045x$
	Across row	0.99	<0.01	$y = 0.87 - 0.251x$	0.90	<0.01	$y = 0.84 - 0.072x$
70	Within row	0.97	<0.01	$y = 0.87 - 0.137x$	0.92	<0.01	$y = 0.88 - 0.044x$
1986							
28	Across row	0.97	<0.01	$y = 0.54 - 0.626x$	0.60	<0.01	$y = 0.50 - 0.065x$
	Within row	0.87	<0.01	$y = 0.52 - 0.233x$	0.73	<0.01	$y = 0.51 - 0.064x$
42	Across row	0.99	<0.01	$y = 0.86 - 0.254x$	0.95	<0.01	$y = 0.84 - 0.040x$
	Within row	0.76	<0.01	$y = 0.79 - 0.049x$	0.79	<0.01	$y = 0.82 - 0.031x$
56	Across row	0.98	<0.01	$y = 0.95 - 0.121x$	0.67	<0.01	$y = 0.93 - 0.007x$
	Within row	0.85	<0.01	$y = 0.91 - 0.053x$	0.95	<0.01	$y = 0.92 - 0.014x$
70	Across row	0.99	<0.01	$y = 0.96 - 0.108x$	0.69	<0.01	$y = 0.94 - 0.009x$
	Within row	0.87	<0.01	$y = 0.92 - 0.054x$	0.88	<0.01	$y = 0.93 - 0.014x$

leaves with lesions at greater distances from the CRA than did plants across rows. Comparison of regression equations using among-group regression analysis confirmed that regression lines describing within-row and across-row gradients had significantly different intercepts and slopes ($P < 0.01$) or different intercepts only ($P < 0.01$) for 42, 56, and 70 days after planting in both rotation plots in 1984, and for 28–70 days after planting in the corn-soybean rotation and 56 and 70 days after planting in the continuous corn plot in 1986 (Table 4). In general, there were steeper slopes across rows than within rows (Table 2). Differences in spread of anthracnose between plants grown in the corn-soybean rotation plots and the continuous corn plots were evident both years. Among-group regression analysis for comparison of anthracnose spread in the corn-soybean rotation vs. the continuous corn plot at each date indicated that regression lines had different intercepts and slopes ($P < 0.02$) or different intercepts only ($P < 0.02$) except for the 28-day across-row regression equations in 1984, which were not different (Table 5). The continuous corn plots had slopes less negative than the corn-soybean rotation plots.

The percentage of plants with stalk rot by day 154 decreased significantly ($P < 0.01$) with distance from the CRA in the corn-soybean rotation plots both years, and in the continuous corn plot only in 1984 (Table 6). Coefficients of determination (r^2) were high both years for the regression equations in the corn-soybean rotation plots (0.83–0.84) but were low for the continuous corn plots (0.15–0.51). This probably was due to the high variability of plants with stalk rot at the various distances from the CRA in the continuous corn plots (Fig. 4B and D). The percentage of plants with stalk rot in the CRA in the corn-soybean rotation and the continuous-corn plots were about the same, 85 and 83%, respectively, in 1984, and 58 and 64%, respectively, in 1986. However, a higher incidence of stalk rot occurred in the continuous-corn plot than in the corn-soybean rotation plot at greater distances from the CRA (i.e., mean 53 and 24%, respectively, in 1984, and 50 and 12%, respectively, in 1986, at 6 m) (Fig. 4A–D). Among-group regression analysis confirmed this difference between corn-soybean rotation and the continuous corn plots since regression equations had statistically ($P < 0.01$) different intercepts and slopes (Table 7).

Regression equations calculated for the incidence of stalk rot across rows over distance from the CRA had different slopes and intercepts ($P < 0.01$) from the within-row regression equations for the corn-soybean rotation, but equations for continuous corn plots described single lines ($P < 0.01$) for both years (Table 7).

DISCUSSION

The corn hybrid chosen for this study (Pioneer Brand 3780) had a high incidence of anthracnose stalk rot, indicating its susceptibility to this phase of the disease. Leaf lesions had bright yellow-orange discoloration surrounding a central necrotic area. Nicholson and Warren (15) described this lesion type as resistant. In preliminary inoculation experiments, 82 of 95 commercial hybrids, representing 35 seed companies, developed this yellow-orange lesions type, and sporulating acervali developed within these lesions when placed under moist conditions (Lipps, *unpublished*). This leaf-lesion type, common to most commercial

TABLE 3. Comparison of regression lines between successive 14-day intervals from planting for across-row and within-row spread of anthracnose leaf blight in corn-soybean rotation and continuous-corn plots by using among-group regression analysis where regression equations describe the relationship between the $\log_{10}$ (number of leaves with lesions per plant + 1) and distance from a surface corn-residue inoculum source

			Among-group regression[a]			
			Corn-soybean rotation		Continuous corn	
Year	Direction from residue area	Regression comparison days after planting	Probability (P)	Regression lines	Probability (P)	Regression lines
1984	Across row	Day 28 vs. day 42	<0.01	Parallel	<0.01	Parallel
		Day 42 vs. day 56	<0.01	Parallel	<0.01	Parallel
		Day 56 vs. day 70	<0.01	Single	<0.01	Different
	Within row	Day 28 vs. day 42	<0.01	Parallel	<0.01	Parallel
		Day 42 vs. day 56	<0.01	Parallel	<0.01	Parallel
		Day 56 vs. day 70	0.04	Parallel	<0.01	Parallel
1986	Across row	Day 28 vs. day 42	<0.01	Different	<0.01	Parallel
		Day 42 vs. day 56	<0.01	Different	<0.01	Different
		Day 56 vs. day 70	0.04	Different	<0.01	Single
	Within row	Day 28 vs. day 42	<0.01	Different	0.01	Different
		Day 42 vs. day 56	<0.01	Parallel	<0.01	Different
		Day 56 vs. day 70	<0.01	Single	<0.01	Single

[a] Among-group regression analysis (16) indicated regression lines with significant ($P \leq 0.05$) probabilities were different (different slopes and intercepts), parallel (equal slopes and different intercepts), or single (equal slopes and intercepts).

TABLE 4. Comparison of regression lines between across-row and within-row spread of anthracnose leaf blight for successive 14-day intervals from planting in corn-soybean rotation and continuous corn plots using among-group regression analysis where regression equations describe the relationship between the $\log_{10}$ (number of leaves with lesions per plant + 1) and distance from a surface corn-residue inoculum source

		Across-row vs. within-row among-group regression[a]			
		Corn-soybean rotation		Continuous corn	
Year	Days after planting	Probability (P)	Regression lines	Probability (P)	Regression lines
1984	28	<0.01	Single	<0.01	Single
	42	<0.01	Different	<0.01	Different
	56	<0.01	Different	<0.01	Different
	70	<0.01	Different	<0.01	Different
1986	28	<0.01	Different	<0.01	Single
	42	<0.01	Different	<0.01	Single
	56	<0.01	Different	<0.01	Different
	70	<0.01	Different	<0.01	Parallel

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hybrids, in combination with the susceptibility to stalk rot exhibited by this hybrid, made it particularly useful in this study to evaluate the potential spread of anthracnose under a commercial setting.

The number of infected leaves per plant was chosen as the variable to assess disease spread because attempts to determine total percentage leaf area affected was hampered by early and rapid death of the lower leaves. Other workers (1,7) encountered similar difficulties in assessing anthracnose leaf blight severity on certain genotypes in the field. Rapid death of lower leaves plus an increase in the number of leaves per plant during early growth stages made it difficult to adequately assess the leaf area affected over time. The total number of infected leaves per plant was readily determined by marking leaves with lesions at each observation date and recording the number of additional leaves with lesions on the following date. This method provided data that adequately followed the spread of disease upward on plants and to adjacent plants.

This work confirms previous investigations that surface residues of the previous corn crop constitute the major source of inoculum for anthracnose leaf blight (6,8–10,12). Leaf lesions were first detected on plants within and adjacent to the CRA, indicating that inoculum originated from these surface residues. However, in the

TABLE 5. Comparison of regression lines between corn-soybean rotation and continuous corn plots for across-row and within-row spread of anthracnose leaf blight at 14-day intervals from planting by using among-group regression analysis where regression equations describe the relationship between $\log_{10}$ (number of leaves with lesions per plant + 1) and distance from a surface corn residue inoculum source

Year	Direction from residue area	Days after planting	Corn-soybean rotation vs. continuous corn among-group regression[a] Probability (P)	Regression lines
1984	Across row	28	<0.01	Single
		42	<0.01	Different
		56	0.02	Different
		70	<0.01	Different
	Within row	28	0.02	Parallel
		42	<0.01	Different
		56	<0.01	Different
		70	<0.01	Different
1986	Across row	28	<0.01	Different
		42	<0.01	Different
		56	<0.01	Different
		70	<0.01	Different
	Within row	28	<0.01	Different
		42	<0.01	Parallel
		56	<0.01	Different
		70	<0.01	Different

[a] Among-group regression analysis (16) indicated regression lines with significant ($P \leq 0.05$) probabilities were different (different slopes and intercepts), parallel (equal slopes and different intercepts), or single (equal slopes and intercepts).

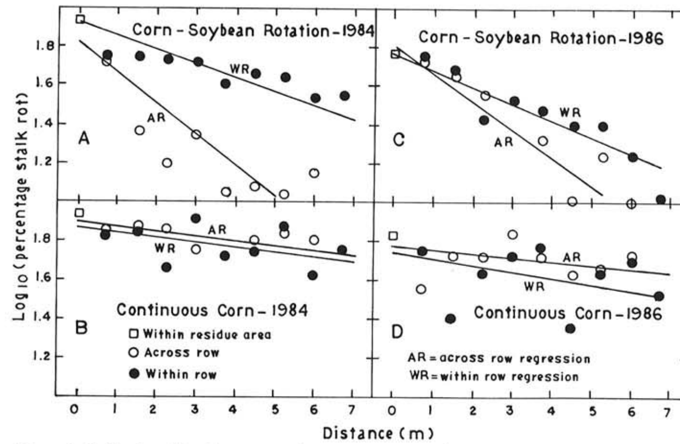

Fig. 4. Relationship between the percentage of plants with anthracnose stalk rot and distance from surface-corn residues within and across rows 154 days after planting in plots maintained under a corn-soybean rotation (A and C) and continuous corn (B and D) at South Charleston, OH, in 1984 and Wooster, OH, in 1986, respectively. Distance 0 represents the central corn-residue area.

TABLE 6. Coefficients of determination, levels of significance, and regression equations for relationship between $\log_{10}$ (percentage of plants with anthracnose stalk rot) (y) and distance (x) across and within rows from a surface corn-residue area in corn-soybean rotation and continuous corn plots

		Corn-soybean rotation			Continuous corn		
Year	Direction from residue area	Coefficient of determination (r^2)	Significance level (P)	Regression equation	Coefficient of determination (r^2)	Significance level (P)	Regression equation
1984	Across row	0.83	<0.01	$y = 1.38 - 0.158x$	0.51	<0.01	$y = 1.90 - 0.024x$
	Within row	0.83	<0.01	$y = 1.91 - 0.071x$	0.44	<0.01	$y = 1.88 - 0.025x$
1986	Across row	0.85	<0.01	$y = 1.82 - 0.147x$	0.15	0.21	$y = 1.77 - 0.015x$
	Within row	0.89	<0.01	$y = 1.78 - 0.091x$	0.26	0.07	$y = 1.75 - 0.033x$

TABLE 7. Comparison of regression lines between corn-soybean rotation and continuous corn plots using among-group regression analysis and across-row and within-row incidence of anthracnose stalk rot, where regression equations describe the relationship between $\log_{10}$ (percentage plants with stalk rot) and distance from a surface-corn-residue inoculum source

Regression equation comparisons	Year	Factor	Among-group regression Probability (P)	Regression lines[a]
Corn-soybean rotation vs. continuous corn	1984	Across row	<0.01	Different
		Within row	<0.01	Different
	1986	Across row	<0.01	Different
		Within row	<0.01	Different
Across-row vs. within-row	1984	Corn-soybean rotation	<0.01	Different
		Continuous corn	<0.01	Single
	1986	Corn-soybean rotation	<0.01	Different
		Continuous corn	<0.01	Single

[a] Among-group regression analysis (16) indicated regression lines with significant ($P \leq 0.05$) probabilities were different (different slopes and intercepts), parallel (equal slopes and different intercepts) or single (equal slopes and intercepts).

continuous corn plots, both years, leaf lesions appeared on plants up to 6–7.5 m distant from the residue area by 28 days after planting (Figs. 2E and 3E). Gregory (2) stated that background inoculum, i.e., inoculum originating from sources other than the source studied, would have the effect of flattening the primary gradient or slope of the regression lines. This was observed as less negative slope values of regression lines for the continuous corn plots compared with the corn-soybean rotation plots (Table 2). Apparently, conidia of *C. graminicola* were produced on residues not completely buried by plowing in the continuous-corn plots. This also indicates that small amounts of residue left on the soil surface after plowing may provided sufficient inoculum for initiating leaf infections. This amount of inoculum may be considerably less than that in no-tillage fields where all the residue is left on the soil surface. Although development of severe leaf blight is highly dependent on weather conditions (3,4,6,13,17), the greater amount of surface residues in no-tillage as compared with plowed continuous-corn fields indicates a greater probability for development of epidemics in reduced tillage fields due to higher inoculum levels.

Among-groups regression analysis indicated a significant difference between across-row and within-row regression lines for 42–70 days in 1984 and 56–70 days in 1986 in the continuous-corn plot. This difference in the development of leaf lesions at increased distances from the CRA indicates that the rate of spread of leaf blight was greater within rows than across rows. The greater spread of leaf blight within rows as compared to across rows could be explained by the mode of dispersal of inoculum. Dispersal of conidia within rows (down the row) would be facilitated by open spaces between rows permitting conidia in windblown water drops to be transported greater distances. Spread of conidia across rows would be restricted because rows of corn plants could act as physical barriers preventing rain splashed conidia from reaching distant plants. More research is needed to determine the importance of rain splash dispersal of conidia in the epidemiology of anthracnose.

A notable event in the development of anthracnose was the lack of disease spread after the plants tasseled (70–112 days after planting). Leonard and Thompson (6) reported similar observations from experiments designed to evaluate the influence of plant age on lesion development by *C. graminicola*. They reported that plants inoculated 2–9 days after pollen shed developed fewer and smaller lesions than those inoculated at an earlier or later date. They concluded that this difference was due to changes in host susceptibility at or near the pollen-shed growth stage. The lack of lesion development on the upper leaves of plants during both years of this study could have resulted from this change in susceptibility. However, a late-season increase in disease development was not observed in this study, even on the upper leaves of senescing plants that are more susceptible to infection (6,13). Perhaps sporulation from previously infected leaves was low at this time since most of these leaves (leaves 8–10) were dead and dried by 112 days after planting, restricting the amount of available inoculum.

The infection process leading to stalk rot development has not been determined, and the source of inoculum is unknown (4,10,17). However, in this study the relationship between the incidence of stalk rot and distance from the CRA was very similar to the relationship between leaf blight and distance from the CRA. First, like leaf blight, the incidence of stalk rot was negatively correlated with distance from the CRA in the corn-soybean rotation plots, both years (Table 6). Secondly, among-group regression analysis indicated a significant difference between within-row and across-row regression lines in the corn-soybean rotation, both years (Table 7). Thirdly, the more flattened regression lines in the continuous-corn plots compared with the corn-soybean rotation plots may have indicated background sources of inoculum (2), multiple infections per individual (2), and/or increased variability (low correlation coefficients) of the plants with stalk rot at greater distances from the CRA. The pattern of stalk-rotted plants in both rotation plots (Fig. 4A–D) could be explained based on dispersal of inoculum from residues and leaf lesions, similar to arguments presented above for leaf blight. These results and results of previous studies (10) suggest that conidia, not buried residues, are the infective propagules responsible for the stalk rot phase of anthracnose.

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