Effects of Some Weather Factors and *Fusicladium effusum* Conidium Dispersal on Pecan Scab Occurrence

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ABSTRACT

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Dispersal of *Fusicladium effusum* conidia was diurnal with peak numbers trapped at 1200 hours. Few conidia were dispersed at night when pecan leaves either were wet, the relative humidity (RH) was 100%, or there was no wind. Highest daily numbers of conidia were recorded during the last week of May and first 2 wk of June. Numbers of airborne conidia were correlated positively with wind velocity, temperature, and rain, and negatively with RH during each or several of the months of May, June, and part of July in 1974, 1975, and 1980. Highly significant correlations were found between numbers of airborne conidia trapped 8 days after the date lesions were counted during 1974 and 1975. Characteristics and/or factors associated with the scab epidemic of 1975 were scab lesion counts at the fourth week of April were nearly equivalent to those made during the fourth week of May in nonepidemic years, number of airborne *F. effusum* conidia trapped were 63% higher than in a nonepidemic year, rainfall occurred weekly during May and June. The development of scab lesions 7–9 days following a 12-hr leaf wetness-infection period caused by rain revealed the inadequacy of a scab forecasting theory based upon 100 hr of leaf wetness before fungicide application.

Additional key words: epidemiology, disease forecasting.

Pecan scab, caused by the fungus *Fusicladium effusum* Wint., is the major limiting factor in the production of most pecan (*Carya illinoensis* (Wang.) K. Koch) cultivars in the humid areas of the southeastern United States. Because of the importance of this disease, most pecan disease control recommendations focus on scab (13). Control of pecan scab in Alabama has been achieved with seven fungicide applications starting in April with the first spray applied before pollination, the second 14 days later, and successive applications made at 21-day intervals (14).

Recently, a disease forecasting hypothesis for the control of pecan scab was proposed by Hunter et al (9). Their hypothesis was based on the accumulation of 100 hr of leaf wetness before commencing the application of fungicides. Other investigators have modified this hypothesis by increasing the number of hours of

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leaf wetness (17) or by scheduling fungicide applications after a prescribed number of hours at 90% and higher relative humidity (RH) before applying fungicides (4,19).

Improved timing of fungicide applications depends upon an understanding of the effect of weather factors on the production and dispersal of *F. effusum* conidia and the subsequent infection and disease development. Several investigators have correlated increases in scab severity with the incidence of rain (3,20,22). Converse (1) found that germination of *F. effusum* conidia in distilled water at 24 C was 34 and 77% after 4 and 6 hr, respectively. In an atmosphere of 100% RH, germination was 69% after 24 hr at 24 C. Valli (21) reported that infection of wet pecan leaves occurred in as little as 6 hr, but the minimum number of hours required for infection was not reported. Disease symptoms and sporulation developed within 7–10 days after inoculation (21). McNeill (16) successfully inoculated leaves of pecan trees incubated for 48 hr at 21 C and 100% RH, but obtained no infection under the same moisture conditions at 27 C. Dissemination of *F. effusum* conidia occurred when RH dropped below 100% (12).

This work was conducted to relate some meteorological factors to numbers of airborne *F. effusum* conidia and to the subsequent development of pecan scab.

MATERIALS AND METHODS

Airborne conidia of *F. effusum* 4.5–10 μm wide and 10–28 μm long were trapped from 3 April to 14 July 1974 and from 1 April to 14 July 1975 at the Bedingfield pecan orchard located 10 km west of Auburn, AL. Mature unsprayed trees of cultivars Elliot, Schley, and Stuart and seedling pecan trees made up the orchard of approximately 550 trees that were 16.8 to 18.3 m high and spaced 18.3 × 18.3 m. A Kramer-Collins 24-hr spore sampler (G. R. Manufacturing Co., Manhattan, KS 66502) housed in a standard instrument shelter was placed inside the drip line of a Schley pecan tree on the southeast side of the orchard. The orifice of the sampler was mounted 21 cm above the roof of the shelter (ie, 2.24 m above ground level) and directly beneath leaves infected by *F. effusum*; the orifice was protected from rain with a shield. The trap was adjusted to sample 22.5 L of air per minute to obtain 100% efficiency at wind velocities of approximately 3.22 km/hr (2 mph) (11) and to operate 4.5 min of every 15 min (ie, 0.41 m^3 of air sampled per hour). A second Kramer-Collins spore sampler, installed and adjusted as the first, was located 300 m to the west in a standard instrument shelter in the center of the orchard.

Temperature and RH were measured with hygrothermographs (Bendix Corp., Baltimore, MD 21204) located in the instrument shelters and 1.2 m above ground level. Wind velocity was monitored with a cup anemometer (Belfort Instrument Co., Baltimore, MD 21224) attached to an operation recorder (Esterline Angus, Indianapolis, IN 46224) located in the first instrument shelter and mounted 2.5 m above ground level. Precipitation was measured with a 7-day recording rain gauge (Belfort Instrument Co., Baltimore, MD 21224) located 15 m from the spore trap and 0.3 m above ground level.

During 1980, research was continued at the Turnipseed-Ikenberry Place, Auburn University Experiment Station System, Union Springs. The orchard contained mature trees of cultivars Schley and Stuart and seedling pecan trees of the same size and spacing as in Auburn. Dispersal of airborne conidia was monitored from 29 April to 14 July with a Burkard 7-day recording volumetric spore trap (Burkard Manufacturing Co. Ltd., Rickmansworth, Hertfordshire, England) placed halfway from the tree trunk to the drip line of a Schley pecan tree, and mounted 1.6 m above ground level and directly beneath leaves infected by *F. effusum*. The trap was adjusted to operate at 0.6 m^3 of air sampled per hour. Leaf wetness was determined with a de Wit 7-day, recording, leaf-wetness meter (M. de Wit, Hengelo, The Netherlands) placed 1.5 m above ground between two pecan trees and 5.8 m from the spore trap.

Temperature and RH levels were measured with a hygrothermograph located in an instrument shelter 15.5 m from the spore trap. The wind recorder was housed in the same shelter with the cup anemometer mounted 2.5 m above ground level. The rain gauge was located 35.4 m from the spore trap in a clearing in the pecan orchard.

Conidia trapped in each hourly band by the Kramer-Collins samplers were counted, and the daily average number of conidia trapped was calculated. The Melinex tape used in the Burkard spore trap was cut into 48-mm-long strips and mounted on glass slides in sterile 50% glycerol-glass distilled water, and conidia at 1-mm intervals along the tape were counted.

Scab development was followed weekly during 1974 and 1975

TABLE 1. Seven-day cumulative numbers of *Fusicladium effusum* conidia trapped, scab lesions developed, and rain in an unsprayed pecan orchard

		1974				1975				1980			
Month	Week	Date[a]	Conidia per 68.9 m^3 of air	Lesions[b] (no.)	Rain (cm)	Date[a]	Conidia per 68.9 m^3 of air	Lesions[b] (no.)	Rain (cm)	Date[a]	Conidia per 68.9 m^3 of air	Lesions[c] (no.)	Rain (cm)
April	1	5	6	0	4.8	4	0	...	11.8	7	...	...	1.0
	2	12	15	0	3.6	11	5	...	2.2	14	...	...	9.7
	3	19	57	0.5	0.4	18	13	...	6.9	21	...	...	0.6
	4	26	35	2.8	3.1	25	30	36.2	0	28	...	5.5	3.5
May	1	3	111	4.5	0.5	2	2,429	69.3	3.6	5	43.7	7.3	1.5
	2	10	400	7.6	4.1	9	3,452	40.2	1.7	12	270.0	8.7	3.3
	3	17	3,570	10.9	1.8	16	7,563	286.0	3.2	19	848.2	17.8	4.8
	4	24	1,490	38.0	3.8	23	8.996	238.0	2.3	26	2,375.2	39.4	8.6
	5	31	868	80.2	1.3	30	16,530	300.0	1.6				
June	1	7	3,424	0.1	4.4	6	9,626	2.6	2.0	2	2,281.5	82.0	0
	2	14	5,410	0.7	2.0	13	6,115	7.9	4.4	9	5,369.6	0	0
	3	21	1,632	0.9	0	20	2,661	18.3	1.4	16	2,401.1	0	0
	4	28	1,140	2.4	0	27	1,537	56.3	4.4	23	3,783.2	0	5.8
	5									30	4,708.6	1.9	2.5
July	1	5	741	9.7	1.6	4	2,794	59.6	6.4	7	993.8	6.2	0.5
	2	12	4,260	24.3	0.9	11	1,646	...[d]	13.3	14	371.1	17.3	0
Totals			23,406		20.4		63,349		44.3		23,446.0		27.0

[a] Data accumulation date.
[b] Average number per compound leaf from 240 leaves per week, 4 April–30 May; average on 60 nuts per week, 31 May–14 July. Leaf surface area ranged from 0.6 × 10^2cm^2, 19 April to 3.0 × 10^2cm^2, 31 May 1974; and nutlets ranged from 0.6 × 1.2 cm, 31 May to 1.3 × 2.5 cm, 11–12 July 1974, 1975.
[c] Average number per compound leaf from 240 leaves per week, 28 April–2 June; average on 60 nuts per week, 3 June–14 July.
[d] Lesion coalescence precluded accurate counts.

and twice a week in 1980 by collecting 20 compound leaves per tree, five from each of four different branches at equally spaced locations around the canopy of each of 12 Schley pecan trees. The first leaf on the shoot was collected. As younger leaves developed, the second, third, fourth, fifth, and sixth compound leaves were collected until the end of May or first week of June, when the leaves were completely developed. Lesions on each leaflet were counted, and the average number of lesions per leaf was calculated for the week. Average numbers of lesions per nuts per week were determined from five nuts on marked branches starting the first week of June and continuing until 14 July.

Scab-free Schley pecan trees were used as "trap crop" or test trees during 1980. One-year-old Schley trees (45–61 cm shoot) were grown in plastic bags (10.2 × 76.2 cm) in a pine bark-soil potting mix (7:1, v/v). A suspension of *F. effusum* conidia was prepared from diseased Schley leaves collected in the orchard by brushing the lesions under water. The concentration was adjusted to 5×10^4 conidia per milliliter with a Howard mold counting chamber (Hausser Scientific, Bluebell, PA 19422), and the suspension was sprayed to runoff on six trees in the immature, scab-susceptible, yellow-green leaf stage; six trees were not sprayed. The test trees were suspended in the orchard at heights ranging from 1.8 to 5.5 m from limbs of trees under which the Burkard spore trap was located and also from limbs of two adjacent Schley trees. After exposure for 1 wk, the test trees were returned to the laboratory where the foliage and shoots were dipped in a suspension of azinphosmethyl (1.14 g in 3.789 L of water) to control insects and mites. The test trees were placed in a greenhouse and observed for 30 days for disease development; during this period, no water was allowed to contact the foliage. The test was repeated over a period of six consecutive weeks from 29 May to 14 July. The occurrence of scab was rated on a 0 to 3 scale, in which 0 = no lesions, 1 = 2–5 lesions, 2 = 6–20, and 3 = > 21 lesions per leaf.

Pearson correlation coefficients were calculated on an hourly and daily mean basis to relate numbers of trapped conidia to wind velocity (km/hr), temperature (C), relative humidity (%), and rainfall (cm).

RESULTS

Airborne conidia. The numbers of conidia trapped during April 1974 and 1975 were low, but showed a gradual increase with time (Table 1). After an eightfold increase in the total number of conidia trapped per week was reached 17 May, the conidial count fluctuated. Leaves of pecan trees had emerged by the end of May providing abundant, susceptible leaf tissue for lesion development and the consequent increase to the peak of 5,410 conidia per 68.9 m^3 of air for the week ending 14 June (Table 1). After this date, when the majority of pecan leaves had matured and become resistant to infection, the number of conidia trapped showed a trend to lower counts through the first week of July (Fig. 1A). A resurgence in the number of conidia trapped during the second week of July was associated with increased numbers of lesions on nuts (Table 1). During 1974, the number of conidia trapped per cubic meter of air exceeded 100 only six times (Fig. 1A).

During 1975, a rapid increase in the dispersion of conidia occurred after the fourth week of April with a total of 2,429 conidia per 68.9 m^3 of air trapped for the week ending 2 May (Table 1). After this time, very high numbers of conidia were trapped throughout the experimental period (Fig. 1B). The number of conidia peaked at 16,530 per 68.9 m^3 of air for the last week of May; this total was three times greater than for the peak number of conidia trapped during 1974 and occurred 3 wk earlier than in 1974. Total numbers of conidia declined each week during June (Table 1), then showed an abrupt increase on 4 July as scab lesions

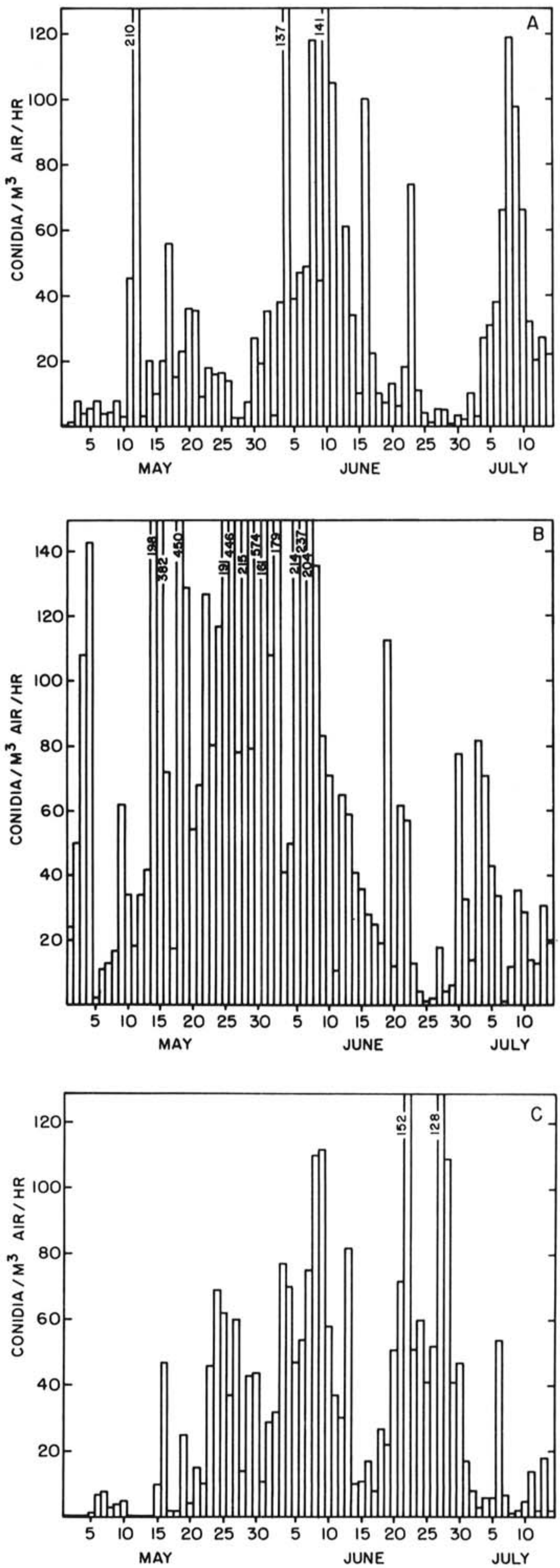

Fig. 1. Mean hourly counts of *Fusicladium effusum* conidia trapped by using **A** and **B**, Kramer-Collins spore traps adjusted for 0.41 m^3 of air sampled per hour during 1974 and 1975, and **C**, a Burkard spore trap adjusted for 0.6 m^3 of air sampled per hour during 1980.

matured on the nuts. During 1975, the number of conidia trapped per cubic meter of air per hour exceeded 100 twenty times (Fig. 1B).

Numbers of conidia trapped with the Burkard spore trap during 1980 sampling 0.6 m^3/hr or 100.8 m^3 of air for a 7-day period were converted to 68.9 m^3 of air sampled as in 1974 and 1975 (Table 1). During May 1980, the total number of conidia trapped per week increased sixfold from the first to the second week, then tripled each week for the rest of the month. As in 1974, the highest weekly totals of trapped conidia occurred during the second week of June (5,369.6 conidia per 68.9 m^3 of air), when leaf development was complete. The terminal three to five leaflets on compound leaves had developed severe scab symptoms and provided the lesions for the high production of inoculum. A second, but lower, peak number of conidia occurred during the fifth week of June, but this could not be associated with lesions on nuts owing to the low lesion count. Numbers of conidia decreased markedly from the 30 June total during each successive week of July (Table 1). During 1980, the number of conidia trapped per cubic meter of air per hour exceeded 100 only five times (Fig. 1C).

Periodicity in numbers of airborne conidia of *F. effusum* and correlations with weather factors. Trends in numbers of airborne *F. effusum* conidia trapped and weather factors were determined for the 75-day period 1 May through 14 July 1980. For each day, hourly numbers of conidia were normalized as a percentage of the maximum trapped during any hour of the day. Hourly values for RH, temperature, and wind velocities also were recorded. For each hour of the day, the normalized number of conidia and the weather data were averaged over the 75-day period and represented by circadian periodicity (Fig. 2).

Concentrations of airborne conidia showed a marked diurnal periodicity. The major peak for trapped conidia occurred at 1200 hours in association with decreasing humidities; a minor peak developed at 1900 hours with increasing humidities. Numbers of conidia were low from about 2200 to 0600 hours, then increased to maximum concentrations between 1100 and 1300 hours in association with increasing wind velocities. As wind diminished, a corresponding reduction occurred in the number of trapped conidia (Fig. 2).

Highly significant ($P = 0.01$) positive correlations of numbers of conidia trapped each hour and wind velocities were found for each month of each year except July 1975 (Table 2). Significant daily correlations of trapped conidia and wind velocities were found on 77, 57, and 64% of the days in 1974, 1975, and 1980, respectively.

The circadian periodicity in numbers of airborne conidia showed other correlations with circadian trends in weather variables (Fig. 2). Significant positive correlations of numbers of conidia trapped hourly and temperatures occurred for each month of the 1974 and 1975 test periods, but not for July 1980 (Table 2). Significant daily correlations of trapped conidia and temperature were found on 43, 46, and 61% of the 1974, 1975, and 1980 days, respectively.

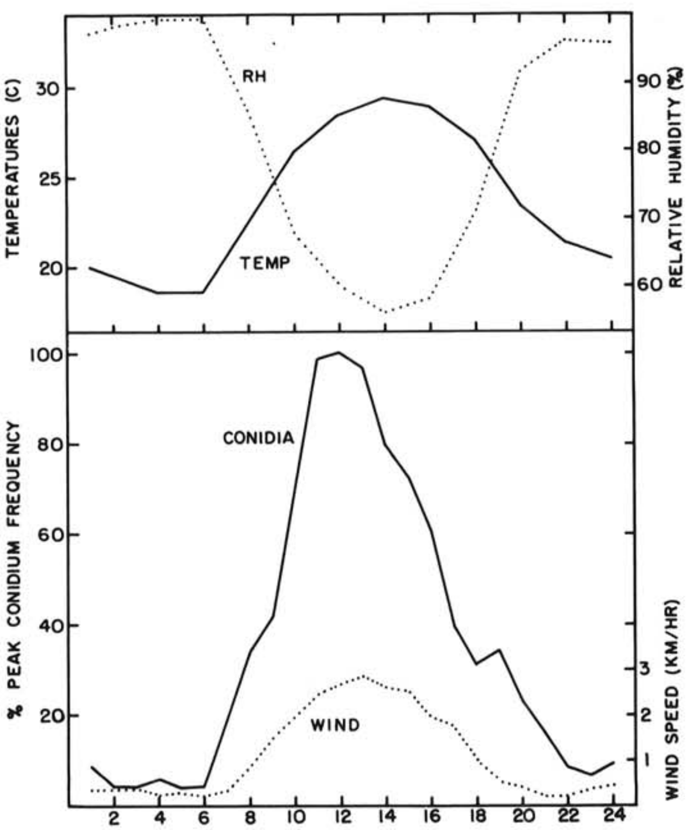

Fig. 2. Circadian periodicities for relative humidity (RH), temperature, wind speed, and airborne conidia of *Fusicladium effusum*. Conidium frequency is expressed as a percentage of the peak arithmetic mean for the period 1 May to 14 July 1980.

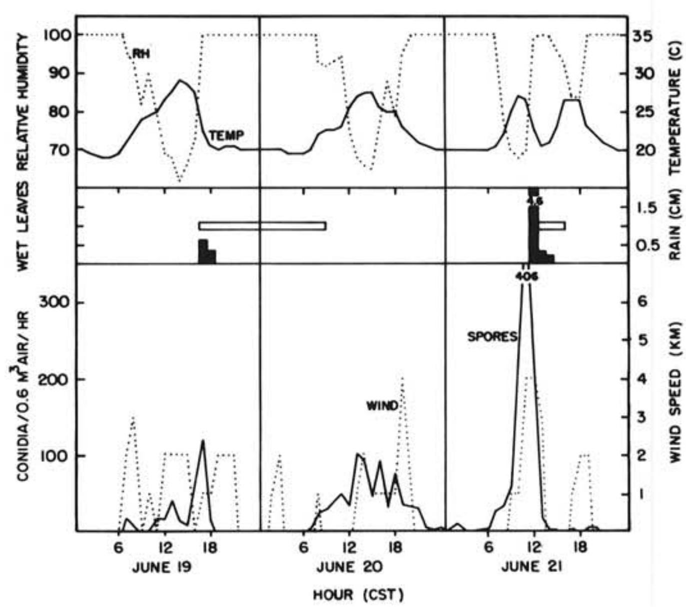

Fig. 3. Circadian periodicities in numbers of airborne conidia of *Fusicladium effusum* in relation to wind speed, leaf wetness, rain, temperature, and relative humidity during 19–21 June 1980.

TABLE 2. Correlation of numbers of *Fusicladium effusum* conidia per cubic meter of air per hour with meterologic factors for 3 mo during 1974, 1975, and 1980

Meterologic factor	Simple correlation coefficients								
	1974			1975			1980		
	May	June	July	May	June	July	May	June	July
Wind velocity (km/hr)	0.47**[a]	0.33**	0.16**	0.35**	0.42**	0.06	0.32**	0.47**	0.21**
Temperature (C)	0.23**	0.14**	0.25**	0.16**	0.20**	0.19*	0.45**	0.38**	0.12
Relative humidity (%)	−0.20**	−0.05	−0.14	−0.12**	−0.20**	−0.05	−0.31**	−0.34**	−0.17*
Rainfall amount (cm)	0.02	0.16**	0.48**	0.03	0.02	0.11*	−0.04	0.11**	0.38**

[a]Single asterisks (*) indicate significant correlation coefficients, $P = 0.05$; double asterisks (**) indicate significant correlation coefficients, $P = 0.01$.

Relative humidity was usually at or near 100% at night in the pecan orchard, especially when leaf development was complete (Figs. 2 and 3); under such conditions, only small numbers of *F. effusum* conidia were trapped. Conidia were not trapped when RH was 100% from 1700 hours on 19 June to 0630 hours on 20 June. Although it was windy between 0130 and 0330 hours, leaves were wet and dispersal of conidia did not occur (Fig. 3). Although leaves were wet from 0630 until 0830 hours, some conidia were trapped. The source of these conidia might have been lesions in the tops of trees where sunlight could effect more rapid drying and dispersal of conidia than at the level of the leaf wetness meter. The leaf wetness meter did not show drying conditions at the Turnipseed-Ikenberry orchard until 0800–0900 hours following rains that occurred the previous late afternoon, evening, or night, unless wind developed during the intervals. Significant negative correlations of hourly numbers of conidia with RH occurred for May 1974, May and June 1975, and May, June, and July 1980 (Table 2). The negative correlations indicated that numbers of conidia trapped declined as RH increased, whereas they increased with temperature (Fig. 2). Significant daily correlations of conidia trapped and RH were found on 41, 43, and 61% of the days in 1974, 1975, and 1980, respectively.

During the rains of 19 and 21 June 1980, a precipitous drop in numbers of conidia trapped was recorded (Fig. 3). On 21 June, 406 conidia were trapped from 1100 to 1200 hours as rain moved into the orchard; subsequently, the number of conidia trapped were 219, 20, 3, and 0 for the periods 1200–1300, 1300–1400, 1400–1500, and 1500–1600 hours, respectively. A total of 4.6 cm of rain fell from 1130–1430 hours (Fig. 3). Similar reductions in numbers of conidia trapped occurred on other days when rain fell. On 19 and 21 June, the numbers of trapped conidia peaked during the day in association with the weather front or rain squall (Fig. 3). On 22 June, 152 conidia per cubic meter of air per hour were trapped (Fig. 1C), which was the highest daily total for the year. Significant positive correlations of numbers of conidia per hour and rain were found for June and July 1974, July 1975, and June and July 1980. The daily correlations of conidia and rain for 1974, 1975, and 1980 were significant 11, 11, and 3% of the days, respectively.

Development of scab on pecan test trees. Disease-free trees exposed in the orchard on 29 May, 9 June, and 7 July failed to develop any symptoms of leaf scab (Table 3). During these time periods, daily *F. effusum* inoculum averaged 53.7 conidia per cubic meter of air per hour from 29 May–8 June, 48.6 conidia per cubic meter of air per hour from 9–15 June, and 6.2 conidia per cubic meter of air per hour from 7–13 July (Fig. 1C), but no rain fell on the orchard from 24 May through 18 June or 7–14 July. The average daily RH above 90% amounted to 10.9 hr, with a total of 283 hr from 24 May to 18 June.

All inoculated test trees exposed on 16, 23, and 30 June developed leaf scab except one unthrifty plant (Table 3). Scab lesions developed within 7–9 days of the occurrence of rain. Uninoculated trees in the 16, 23, and 30 June exposure periods also developed scab lesions 7–9 days after a rain. Rain fell in the orchard on 6 July, which was the seventh day of the exposure period; only a few lesions were found on the trees 12 days later. The duration of leaf wetness that accompanied the rains of 19 and 23 June and 6 July were 16 hr, 12 hr 45 min, and 12 hr, respectively.

Relation of number of trapped conidia to lesions and rain. During 1974, the numbers of scab lesions gradually increased from 19 April through the third week of May (Table 1). Subsequently, the number of lesions tripled between the third and fourth week of May then doubled during the fourth and fifth week of May. The coefficient of correlation between lesion numbers occurring 8 days prior to numbers of trapped conidia was 0.84 ($P = 0.001$). Rain fell each week until the third week of June. Low numbers of lesions on nuts were associated with the lack of rains at the time. Numbers of nut lesions increased rapidly after 1.6 cm of rainfall during the first week of July 1974 (Table 1).

The number of lesions (36.2) recorded for the fourth week of April 1975 was of similar magnitude to that found in 1974 and 1980 during the fourth week of May. Subsequent to these unusually high numbers of lesions for April, the numbers of conidia increased 80-fold during the first week of May and continued to increase rapidly to a peak of 16,530/68.9 m^3 air in the fifth week of May, after which they slowly declined. The correlation coefficients for the relation of number of lesions and numbers of conidia trapped 8 and 10 days later were 0.83 ($P = 0.002$) and 0.69 ($P = 0.019$), respectively, during 1975. The peak number of conidia was associated with an average of 300 lesions per compound leaf, which was a conservative count of the lesions on leaves that were almost completely covered with diseased tissue. Disease incidence became so high that defoliation of trees was observed from 15 July through August. Pecan orchards developed a springlike appearance in September from tree refoliation. Rain fell each week except the fourth week of April, and the number of nut lesions more than doubled each week during June; coalescence of lesions during the second week of July made accurate counts difficult. Nuts shriveled, dried, and fell from the trees until only seven of the 60 nuts monitored for disease development were found on the trees on 25 July.

A gradual increase in number of lesions occurred in 1980 similar to the season of 1974 (Table 1). From the second through fourth week of May 1980, the number of scab lesions increased more than twofold each week. The coefficient of correlation of the relation between number of lesions and numbers of conidia trapped was 0.91 ($P = 0.001$) during May. The absence of rain during the first 3 wk of June was associated with the absence of lesions on nuts until after rains occurred during the fourth week of June. Collecting leaves for lesion counts became impractical after the first week of June when leaf development was complete; only a minor amount of leaf growth continued from the indeterminate primary shoot of the branch. The numbers of conidia remained high and increased to a second peak during the last week of June 1980, after the development of lesions on the terminal leaflets.

DISCUSSION

Rains in early April washed primary inoculum from the overwintering *F. effusum* stroma onto developing pecan leaves (3,9). As the leaf tissue and number of scab lesions increased, the number of conidia increased proportionately. By the end of April, a sufficient number of lesions had developed to provide a broad base for inoculum production. Subsequently, rains led to very rapid increases in numbers of lesions during May and part of June, and numbers of conidia increased.

As has been reported for other dry-spored Fungi Imperfecti (6,10), a diurnal periodicity in concentration of airborne *F. effusum* conidia was discovered. Conidium dispersal increased at 0600 hours to a peak at 1200 hours as the RH declined and the temperature increased. This dispersal prior to wind acceleration at 0700 hours indicated that *F. effusum* responded to weather factors in the same manner that Leach (15) found for *Drechslera maydis* and *D. turcica* using controlled environmental conditions in the laboratory. He found that the number of conidia released was

TABLE 3. Occurrence of scab lesions on cultivar Schley pecan test trees suspended in an orchard of scabby pecan trees

Exposure period	Disease intensity on test trees[a]		Occurrence date	
	Inoculated[b]	Uninoculated[c]	Rain	Lesions
29 May–9 June	......	0,0,0,0,0,0	...	...
		0,0,0,0,0,0	...	...
9 June–16 June	......	0,0,0,0,0,0	...	...
		0,0,0,0,0,0	...	...
16 June–23 June	3,3,3,3,3,3	3,2,2,2,1,1	19 June	28 June
23 June–30 June	3,3,3,3,3,3	3,3,1,1,1,1	23 June	30 June
30 June–7 July	2,1,1,1,1,1	2,1,1,1,1,0	6 July	13 July[d]
7 July–14 July	0,0,0,0,0,0	0,0,0,0,0,0	...	...

[a]0 = no lesions, 1 = 2–5 lesions per leaf, 2 = 6–20 lesions per leaf, 3 = >21 lesions per leaf.

[b]Test trees inoculated with 5×10^4 conidia per milliliter.

[c]Natural infection from airborne *F. effusum* in the pecan orchard.

[d]Three test trees with lesions 13 July; others were observed 18 July.

higher when changes in RH occurred at fairly low levels and was less near saturation. A minor peak occurred when humidities increased; such increases corresponded with conditions during late afternoon and evening in the pecan orchard.

Several investigators have shown that wind promoted dispersal of conidia (5,6). Maximum wind speed occurred 1 hr after numbers of airborne conidia peaked and 1 hr before RH reached the lowest point and temperature the highest point. During the hour prior to 1200 hours, other mechanisms (10) of spore release associated with the drying of conidiophores and violent discharge of spores proposed by Meredith (18) may have been operative.

High numbers of *F. effusum* conidia were trapped in association with violent leaf and branch movements caused by air turbulence during some rainstorms. Such shock effects seem to be in accord with the research of Leach (15), who demonstrated massive discharge of *D. maydis* and *D. turcica* conidia from sporulating leaf lesions by heavy vibration. Additionally, Hirst (6) reported that massive concentrations of conidia of *Cladosporium, Alternaria*, and other fungal genera were trapped during a thunderstorm when rain started to fall; subsequently, concentrations of conidia decreased rapidly during the rain. Similar results were found for *F. effusum* conidia in pecan orchards. Hirst also investigated the initial effects of rain on the liberation of spores through puff or splash dispersal (8) and suggested that conidia are removed from air through the scrubbing effects of rain (7). Davies (2) found that spores were captured and carried by rain according to the wettability of the spore surface. Splash dispersal and washing were probable means by which *F. effusum* conidia were dispersed from lesions located at higher levels in diseased pecan trees to the healthy test trees suspended from lower limbs.

The occurrence of peak numbers of conidia (5,369.6 per 68.9 m^3 of air) during the second week of June 1980, and again (4,708.6 per 68.9 m^3 of air) 3 wk later is an enigma. Possibly, conidial production during the third week of June was inhibited by drought. This would seem to be true since the majority of leaves had matured and become resistant to *F. effusum* during the first 2 wk of June. Pecan trees in full foliage could not produce sufficient, new susceptible leaves, nor would there be sufficient incubation time after the rains of 19 and 21 June for new lesions to produce conidia to account for the year's peak conidial discharge recorded 22 June. Rather, it would seem that *F. effusum* stroma had been quiescent several days or until plant water supplies could permit generation of numerous conidia. A similar situation may have occurred during the third and fourth week of June and first week of July 1974 when a drastic drop in numbers of conidia was associated with an absence of rain during June. After the rainy period of the first week of July, numbers of conidia for the second week were only 1,150 lower than the total for the second week of June.

Suspending healthy pecan test trees among the foliage of scabby pecan trees showed that susceptible leaves were infected during a wetness period of 12 hr. This corresponded with Valli's (21) report that infection occurred on wet leaves, but he claimed that 6 hr were required for infection. The amount of rain did not appear critical for infection and lesion development, since as little as 0.08 cm provided sufficient moisture for infection. Test trees did not become infected during an extended rainless period when RH of 100% occurred for only 1–11 hr per day.

The high levels of *F. effusum* inoculum that occurred from the middle of May through June emphasize the need for effective application of fungicides during this period and particular attention to related weather factors to attain economical control of scab with maximum effectiveness through timing. Data in this report do not support current forecasting theories for pecan scab control that suggest 100 to 120 cumulative hours of leaf wetness prior to fungicide applications (9,17). Scab developed on test trees 7–9 days after a rainy day when the leaf wetness periods ranged only 12–16 hr. Also, modifications of the leaf wetness theory using 90% and higher RH for scheduling fungicide applications are tenuous (4,19). The failure of *F. effusum* to infect test trees during the drought might be attributed to the average moisture period of 10.9 hr of RH above 90% being inadequate since infection had been demonstrated at 100% RH when accompanied by 48 hr of incubation (16). Depending upon which forecasting theory was followed, one or two fungicide applications could have been made during the drought since 283 hr of RH above 90% occurred; however, during this same period of time, test trees exposed in the orchard to very high levels of inoculum remained uninfected until rain fell. Therefore, until the minimum time required for infection by *F. effusum* to occur at 90 to 100% RH has been determined, fungicide applications should be based on the occurrence of rain and the residual activity of the recommended fungicide.

A comparison of conidium and rainfall totals for 1974 and 1975 showed that there was 63.6% more conidia and 54% more rain during 1975, the scab epidemic year. A similar comparison of conidium and rainfall totals for 1975 and converted 1980 numbers showed there were 63% more conidia and 39.1% more rain during 1975. Thus, the most obvious factors related to the scab epidemic of 1975 would appear to be high numbers of *F. effusum* conidia and an abundance of rain. These data support the observations of other investigators who reported severe pecan scab during a rainy growing season (3,22). However, an analysis of lesion numbers for the fourth week of April showed that numbers for the epidemic year 1975 were 12.9 times greater than 1974 and 6.6 times greater than 1980. Thus, with the strong inoculum-producing base and weekly rains thereafter, the number of lesions caused by *F. effusum* increased and coalesced to such an extent that they precluded accurate counts on 12 July. Subsequently, within the next 2 wk most of the nuts fell from the trees.

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