Dispersal of Airborne Spores of Boll-Rotting Fungi and the Incidence of Cotton Boll Rot

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ABSTRACT

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A Kramer-Collins Spore Sampler was operated in cotton fields at several locations in Louisiana during 1974 and 1975 to monitor the spore dispersal of boll-rotting fungi. Conidia of *Alternaria gossypina*, *Curvularia* spp., *Diplodia gossypina*, *Fusarium* spp., and *Helminthosporium gossypii* were counted in hourly samples taken over 24-hr periods at intervals throughout the season. Spore counts increased soon after the onset of flowering, with peak spore catches approximately 50 days later. Spore numbers decreased rapidly after the peak periods of spore dispersal. The first rotted bolls were observed soon after the time of peak spore catches. With the exception of *Alternaria*, most spores were detected at night.

Additional key words: *Gossypium hirsutum*.

Boll rots have been associated with reduced yields of cotton (*Gossypium hirsutum* L.) (3). In Louisiana, losses have averaged approximately 11% during the past 25 yr (3). Although many boll-rotting organisms have been identified in Louisiana, only a few fungi are responsible for the majority of the losses due to boll rot (4, 7).

At present, there are no successful control measures for cotton boll rot. To develop an effective control program for the organisms involved in the boll rot complex, information relating to inoculum production and dissemination is needed. The purposes of this research were to study levels of airborne spores of boll rot fungi in the field and to determine if the spore levels are related to the incidence and severity of boll rot.

MATERIALS AND METHODS

Airborne conidia were collected with a Kramer-Collins Intermittent Band Deposit Spore Sampler (G-R Electric Manufacturing Company, Manhattan, KS 66502). The particulate matter from 170 liters of air was deposited in 3 min in a 1-mm × 16-mm band on a glass microscope slide coated with WD-40 (WD-40 Company, San Diego, CA 92110). Samples were taken once each hour for 24 hr.

The sampler was placed at the same location between rows near the center of the field on each sampling date. The intake orifice was located 30 cm above the soil surface.

Microscope slides with deposited bands were returned to the laboratory and examined at ×430 with a compound light microscope. Spores of *Alternaria gossypina* (Thuem.) Hopkins, *Curvularia* spp., *Diplodia gossypina* Cke., *Fusarium* spp., and *Helminthosporium gossypii* Tucker were counted.

In 1974, spore samples were taken at four locations at 2-wk intervals beginning 1 wk after flowers first appeared and ending before harvest. Location I (Rosa) was planted with cultivar Deltapine 16 on 21 April. Location II (Natchitoches) was planted with Stoneville 213 on 25 April. Location III (St. Joseph) was planted with Deltapine 16 on 1 May. Location IV (Baton Rouge) was planted with Deltapine 16 on 1 May. Fields in which samples were taken ranged from 0.4 ha in size at Location IV to 200 ha at Location II. Initially, all the samples taken during a 24-hr period were examined; later, however, only samples taken at 0600, 1200, 1800, and 2400 hr were examined. Additional samples were taken periodically throughout the season 10 to 100 m away from cotton fields to determine a background level of spore numbers.

Cotton plants in an area approximately 0.2 ha in size around the spore trap sites were examined for rotted bolls on each sampling date. All rotted bolls in a 9.3 m^2 area around the spore traps were collected after the final sampling period at each location. Insect-damaged bolls were discarded. The rotted bolls were returned to the laboratory and stored at 7 to 10 C until they could be examined. A 1-cm^2 section of carpel wall of each boll was surface sterilized in 0.5% sodium hypochlorite for 3 min, drained, and placed on acidified nutrient potato dextrose agar (NPDA-Difco Laboratories, Detroit, MI 48201) at room temperature. After 5 days, the plates were observed for fungal growth, and a 3 mm disk from each morphologically different colony was transferred to fresh NPDA plates. The plates were incubated at room temperature until identification of the fungal organisms could be made.

In 1975, spore traps were operated weekly at two locations. Location III (St. Joseph) was planted on 20 May with Coker 310. Location V (Alexandria) was planted on 24 May with Stoneville 213. Both plots were approximately 0.8 ha in size. Only the samples taken at 0600 hr and 2400 hr were examined.

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TABLE 1. Relative abundance of conidia of boll-rotting fungi identified on spore trap slides exposed in cotton fields in Louisiana during 1974 and 1975

Location	Proportion of total spores identified				
	Alternaria gossypina (%)	*Curvularia* spp. (%)	*Diplodia gossypina* (%)	*Fusarium* spp. (%)	*Helminthosporium gossypii* (%)
1974:					
I (Rosa)	2	0	36	62	0
II (Natchitoches)	9	3	60	24	4
III (St. Joseph)	10	1	80	8	1
IV (Baton Rouge)	5	0	65	23	7
1975:					
III (St. Joseph)	6	13	60	20	1
V (Alexandria)	5	12	33	48	2

In 1974 and 1975, cultures of the five genera of fungi from rotted bolls were tested weekly for their ability to induce boll rot (9). Disks of agar bearing the test organisms were placed on surface-sterilized, greenhouse-grown bolls. The bolls were placed in an incubator at 32 C and observed for 2 wk.

The onset of boll rot in the field was determined each year by inspecting the experimental sites at weekly intervals. The boll rot incidence for each sample area was determined (6) before harvest.

Daily temperature and rainfall data for Location III and Location V were obtained from the Northeast Louisiana Experiment Station, St. Joseph, and National Weather Service, Esler Field, Alexandria.

TABLE 2. Relative abundance of airborne conidia of boll-rotting fungi identified on spore trap slides exposed in Louisiana cotton fields at four sample periods (combined for entire 1974 season)

Location	Proportion of total spores identified			
	0600 hr (%)	1200 hr (%)	1800 hr (%)	2400 hr (%)
I (Rosa)	37	19	4	40
II (Natchitoches)	37	10	9	44
III (St. Joseph)	35	15	7	43
IV (Baton Rouge)	43	7	8	42

RESULTS

In 1974, *Diplodia* spores (Table 1) ranged from 36% of the total spores identified in samples from Location I to 80% of the total spores at Location III. *Fusarium* spore populations ranged from 8% of the total spores trapped at Location III to 62% of the total spores at Location I. *Alternaria*, *Curvularia*, and *Helminthosporium* spores each represented 10% or less of the spores at each location.

Examination of the bands on several slides in 1974 indicated little hourly variation in numbers of spores; however, more spores were deposited at night than during the day. For this reason, only spores deposited at 0600, 1200, 1800, and 2400 hr were examined in subsequent samples. Total spores in bands taken at 0600 and 2400 hr represented 77 to 85% of the total spore deposit during all four sample periods (Table 2).

Again in 1975, more *Diplodia* and *Fusarium* spores were collected than other genera (Table 1). *Diplodia* spores represented 33% of the total identified spores from Location V and 60% of the total identified from Location III. Spores of *Alternaria, Curvularia,* and *Helminthosporium* each represented 13% or less of the total.

Most spores were trapped approximately 50 days after the onset of flowering (Fig. 1, 2, 3). This was especially evident with *Diplodia* and *Fusarium* spores. However, spores of the other three fungi usually were detected only during late August and early September. The first rotted

TABLE 3. Boll-rotting fungi isolated from diseased bolls from four Louisiana cotton fields in 1974

Organism isolated	Frequency of isolation			
	Rosa (no.)	Natchitoches (no.)	St. Joseph (no.)	Baton Rouge (no.)
Alternaria gossypina	0	0	0	0
Aspergillus spp.	7	0	0	0
Curvularia spp.	0	0	0	0
Diplodia gossypina	50	21	22	15
Fusarium spp.	2	1	1	1
Helminthospirum gossypii	0	0	0	0
Pestalotia spp.	2	0	1	2
Phytophthora spp.	4	1	1	0
Rhizoctonia spp.	1	0	0	0
Unknown	7	6	5	5

bolls at all locations in 1974 and 1975 were observed approximately 60 days after initiation of flowering; ie, 10 days after the peak spore catches.

In 1974, at all locations, *Diplodia* rotted from 65 to 73% of the bolls collected in the area surrounding the spore traps (Table 3). Each of the other boll-rotting organisms rotted from 0 to 10% of the remaining rotted bolls.

All of the fungi which were isolated from bolls were capable of rotting 40-day-old Deltapine 16 bolls within 2 wk at 32 C. The most rapid development (1 wk) of boll rot symptoms occurred when bolls were inoculated with *Diplodia*.

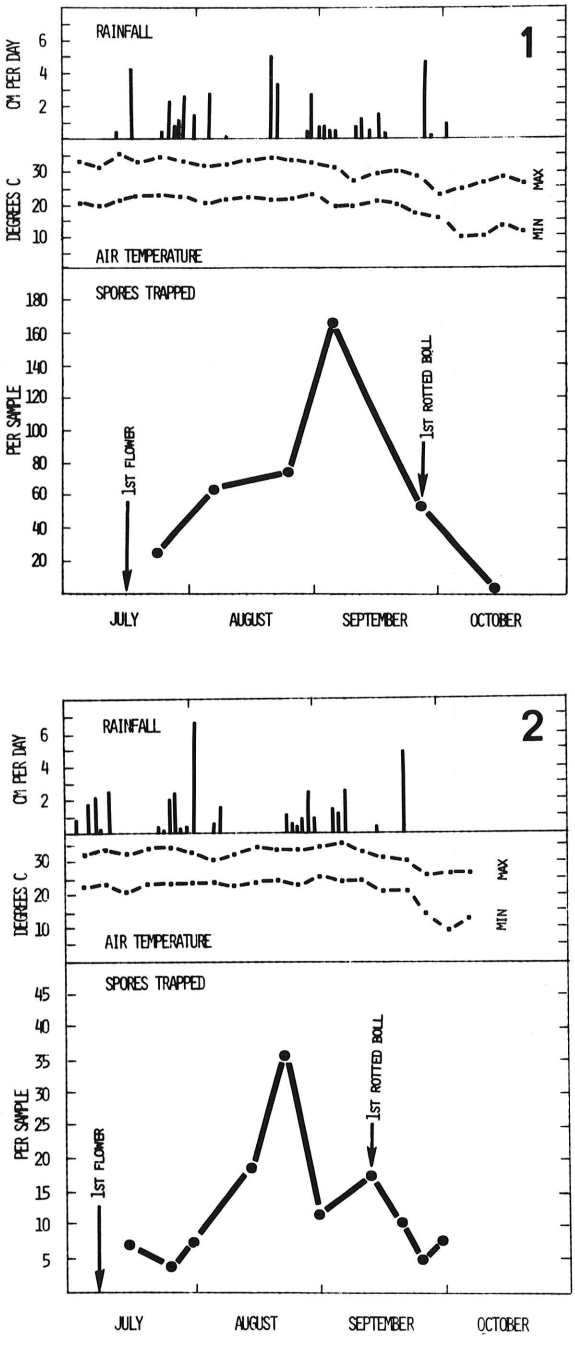
The concentration of *Alternaria*, *Curvularia*, *Diplodia*, *Fusarium*, and *Helminthosporium* conidia was considerably less in areas 10-100 m away from the cotton fields than in the fields. During the periods of peak dispersal within cotton fields, a maximum of two spores per band of each genus was observed in samples taken outside the fields. Therefore, the background level spore concentration was considered negligible.

DISCUSSION

Conidia of the genera *Alternaria*, *Curvularia*, *Diplodia*, *Fusarium*, and *Helminthosporium* were chosen for microscopic identification because of the role of these fungi in boll rot and because their individual morphology allowed rapid visual identification.

Although no association was noted between temperature or rainfall and the abundance of total spores, most of the spores were deposited at 0600 and 2400 hr when the relative humidity under the canopy was nearly 100% (1). Only *Alternaria* was deposited in greater numbers at the two daytime sample periods (1200 and 1800 hr). However, the number of *Alternaria* spores was small compared to the number of spores from several other genera.

There is a possible relationship between airborne spore concentrations of specific fungi and the incidence of boll rots caused by those fungi. More boll rot was produced by fungi whose airborne spores were in greatest abundance in field air. In 1974, the concentration of *Diplodia* conidia



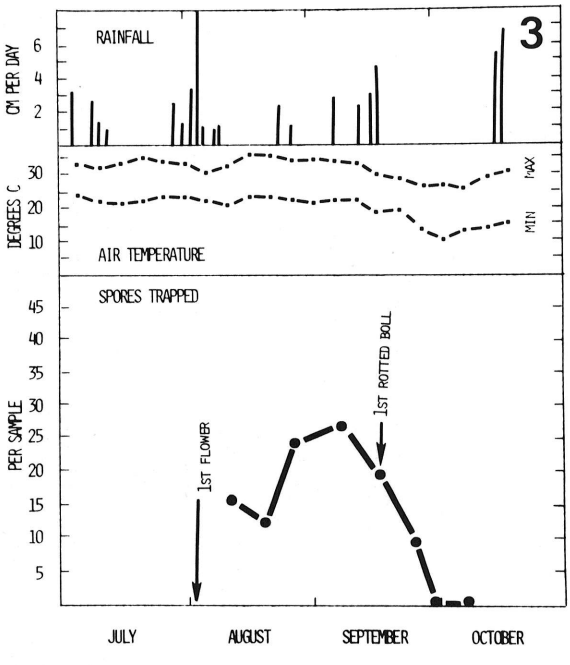


Fig. 1-3. Total numbers of conidia of *Alternaria gossypina*, *Curvularia* spp., *Diplodia gossypina*, *Fusarium* spp., and *Helminthosporium gossypii* identified on spore trap slides exposed in Louisiana cotton fields. Air temperature is given as a 5-day average of maximum and minimum temperatures. Locations: **1)** St. Joseph, 1974; **2)** St. Joseph, 1975; and **3)** Alexandria, 1975.

was higher than that of all other genera at Locations II, III, and IV, and second to *Fusarium* at Location I. *Diplodia* also was the predominant fungus in rotted bolls at all locations in 1974. In 1975, *Diplodia* was the predominant spore in field air at Location III and was second to *Fusarium* at Location V.

The spores probably did not originate on rotted bolls because the first rotted bolls appeared after the peak spore catch at each location in both years. However, it is probable that the spores were part of an initial mass of inoculum which was produced on naturally-shed flowers, bolls, squares, and leaves deposited on the soil surface after the onset of flowering (8). The debris apparently acted as a medium for the growth and sporulation of many fungi including those capable of causing boll rot.

The levels of airborne spores of boll-rotting fungi detected through the season approximate curves of the normal shedding of flowers, bolls, and squares from cotton plants (2, 5). Shedding of these structures usually began at flower initiation, increased to a peak approximately 30 days later and decreased rapidly thereafter.

Attempts to control cotton boll rot with protective fungicides applied to the plants have been unsuccessful (1). Using the incidence of airborne spores of boll-rotting fungi as a guide for timing applications, it may be possible to reduce inoculum production by applying fungicides to plant debris on the ground. This approach should limit the number of spores available to initiate boll rot.

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