Aerobiology of Two Peanut Leafspot Fungi

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ABSTRACT

Air was sampled continuously for fungal spores with a Hirst spore trap 0.5 m above a peanut (*Arachis hypogaea*) field during the growing seasons of 1969, 1970, and 1971. Low concentrations (spores per m^3 of air per 24-hr period) of *Cercospora arachidicola* conidia and *Leptosphaerulina crassiasca* ascospores were present until mid-July during all 3 years. On days without rain, peak catches of *L. crassiasca* ascospores occurred within 1 to 4 hr after sunrise, when air temperature was rising and foliage was drying, while the number of *C. arachidicola* conidia increased rapidly after the termination of leaf wetness, with daily peak catches ranging from 1100 to 1500 hr. On days with rain, concentrations of *C. arachidicola* conidia and *L. crassiasca* ascospores increased rapidly with the onset of rainfall. The peak concentration of *C. arachidicola* conidia (> 300 per m^3 of air) occurred from 3 to 4 September 1970, and the peak concentration of *L. crassiasca* ascospores (> 1,300 per m^3 of air) occurred from 23 to 24 August 1970. Very few (< 1%) phragmosporous ascospores were trapped during the study. Evidence for vertical dissemination of *C. arachidicola* conidia to heights of 2.7 m (9 ft) was obtained by exposing healthy test plants in the field for brief periods of time. The number of *C. arachidicola* lesions on test plants decreased as exposure height increased.

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Additional key words: epidemiology, groundnut, spore dispersal.

The aerobiology of several *Cercospora* spp. (1, 2, 7, 8, 10, 12, 14, 15) and at least one species of *Leptosphaerulina* (4, 11, 16) has been investigated. However, there is a paucity of information on the aerobiology of *Cercospora arachidicola* (Hori), the causal agent of early leafspot on peanuts or groundnuts (*Arachis hypogaea* L.). In addition, we are unaware of any published information on the aerobiology of *Leptosphaerulina crassiasca* (Sechet) Jackson & Bell, the causal agent of pepper spot and leaf scorch on *A. hypogaea*.

Sreeramulu (15) studied the aerobiology of *C. arachidicola* and *Cercosporidium personatum* from 15 February until 4 May 1959. He indicated that the weather was clear on all days during the trapping period, but no meteorological data were presented. Sreeramulu found that *C. arachidicola* and *C. personatum* conidia were airborne and that daily peak catches occurred at 1000 hours. Conidia of *C. arachidicola* were first trapped a month after emergence of peanut plants, and conidia of *C. personatum* were detected a week later. Peak catches of *C. arachidicola* and *C. personatum* occurred on 25 April.

Lyle (10) trapped *C. arachidicola* and *C. personatum* conidia on vaseline-coated microscope slides mounted on weather vanes and on container-grown peanut plants exposed in a peanut field for half-week periods. The largest numbers of conidia were detected during the period from 15 to 31 July, when minimum (22.2 C) and maximum (34.4 C) temperatures were highest, and the moisture supply (frequent rain and long periods of high relative humidity) was abundant. Neither Lyle (10) nor Sreeramulu (15) indicated that *L. crassiasca* ascospores were trapped, but Luttrell & Boyle (9) reported the occurrence of *L. crassiasca* on peanuts in Georgia in 1960.

TABLE 1. Average concentration of *Cercospora arachidicola* conidia and *Leptosphaerulina crassiasca* ascospores

Dates[a]	*C. arachidicola* conidia (no./m^3/day)	*L. crassiasca* ascospores (no./m^3/day)
1 June – 15 July 1969	0.6	1.7
16 July – 31 August 1969	18.6	45.1
1 June – 15 July 1970	0.9	2.6
16 July – 31 August 1970	55.9	147.4
1 June – 15 July 1971	0.4	2.2
16 July – 31 August 1971	52.3	229.0

[a] Argentine peanuts planted 24 April, 11 May, and 4 May of 1969, 1970, and 1971, respectively. Peanuts harvested 2 September, 10 September, and 27 August of 1969, 1970, and 1971, respectively.

The purpose of this paper is to report the results of aerobiological studies of *C. arachidicola* and *L. crassiasca* during the growing seasons of 1969, 1970, and 1971. A preliminary report has been published (14).

MATERIALS AND METHODS.–Air was continuously sampled with a Hirst spore trap (6) in a field of *A. hypogaea* 'Argentine' at Experiment, Georgia during 1969, 1970, and 1971. The trap was located in the middle of the field, with 30.5 m (100 ft) rows evenly spaced at 96.5 cm (38 inches). The 2- × 14-mm trap orifice was ca. 0.5 m above the soil surface, and the air flow rate was adjusted to 10 liters/min. Unstained vaseline-coated microscope slides were examined at a magnification of ×400.

At the experimental site temperature and relative humidity were recorded at ground level with a hygrothermograph, and rainfall data were obtained with a weighing rain gauge. Duration of leaf wetness was recorded continuously with a leaf wetness sensor (3) exposed horizontally at a height of 35.6 cm (14 inches) above the soil surface. Wind speed and direction were monitored with a recording system. Only the 1970 leaf wetness and rainfall data will be presented in this paper.

Potted Argentine peanut plants (21 days old) were used as spore traps at times during the study. Plants, grown in the greenhouse for a minimum of 21 days, were exposed in a peanut field for at least 4 days. After field exposure, plants were enclosed in plastic bags for 48 hr under the greenhouse bench, unbagged, and returned to the greenhouse bench. The number of lesions per plant was determined 21 to 28 days later. During 1971 this technique was used to study the vertical dispersal of *C. arachidicola* conidia at the soil surface, 0.9, 1.8, and 2.7 m (0, 3, 6, and 9 ft). At least two plants were exposed at each height in 13 separate field exposure periods ranging from 4 to 8 days during the period from 14 July to 12 September 1971.

To determine the seasonal progress of the peanut leafspot epidemic, quantitative estimates of disease (defoliation percentage) were obtained periodically during the growing seasons of 1969, 1970, and 1971. The defoliation percentage was based on a random sample of five central stems from each replicate, and it was computed by dividing the total number of defoliated leaflets by the total number of leaflets produced. This provided an estimate of plant growth as well as epidemic progress.

RESULTS.–Airborne *C. arachidicola* conidia and *L. crassiasca* ascospores were trapped in a peanut field during the growing seasons of 1969, 1970, and 1971. Both spore types were distinguishable on unstained spore trap slides. Although *L. crassiasca* produces both muriform and phragmosporous ascospores, very few (<1%) phragmosporous ascospores were trapped.

Cercospora arachidicola conidia and *L. crassiasca* ascospores were trapped on ca. one-half or more of the days during each of three growing seasons. *Cercospora arachidicola* conidia were trapped on 60 to 76 days per season, and *L. crassiasca* ascospores were trapped on 71 to 89 days per season.

TABLE 2. Average daily duration of leaf wetness in a field of *Arachis hypogaea* 'Argentine' peanuts at Experiment, Georgia during 1969, 1970, and 1971

Year	1 June–15 July (hr)	16 July–31 August (hr)
1969	8.3	14.2
1970	10.4	13.9
1971	10.3	15.0

The concentration of both spore types was low during the first half of the growing season (Table 1). The average concentration of *C. arachidicola* conidia for 3 years was 0.6 per m^3 of air/day from 1 June to 15 July and 42.3 per m^3 of air/day from 16 July to 31 August. The concentration of *L. crassiasca* ascospores averaged 2.1 per m^3 of air/day from 1 June to 15 July and 140.5 per m^3 of air/day from 16 July to 31 August.

It is quite probable that the increased concentration of *C. arachidicola* conidia and *L. crassiasca* ascospores during the period from 16 July to 31 August 1970 was associated with an increase in the average daily duration of leaf wetness during that period. The average duration of leaf wetness for 3 years was 9.7 hr from 1 June to 15 July and 14.3 hr from 16 July to 31 August (Table 2). Presumably, the increased duration of leaf wetness favored the production and liberation of *C. arachidicola* conidia and *L. crassiasca* ascospores.

The distribution pattern of *C. arachidicola* conidia and *L. crassiasca* ascospores for the 1970 growing season is presented in Fig. 1A and 1D, while rainfall and leaf wetness data for 1970 are presented in Fig. 1B and 1C. The daily peak concentration (> 300 per m^3 of air) of *C. arachidicola* conidia in the entire study occurred in the 24-hr period from 3 to 4 September 1970. The maximum concentration (> 1,300 per m^3 of air) of *L. crassiasca* ascospores occurred during the 24-hr period from 23 to 24 August 1970. Each year the concentration of *L. crassiasca* ascospores was low until the defoliation percentage reached ca. 37%.

During the latter part of the growing season *C. arachidicola* conidia and *L. crassiasca* ascospores were present continuously in the air because they were trapped in every hour of the day at some time during the study. On days without rain the highest concentrations of *L. crassiasca* ascospores occurred within 1 to 4 hr after sunrise, during the period of rising air temperature and drying foliage (Fig. 2A).

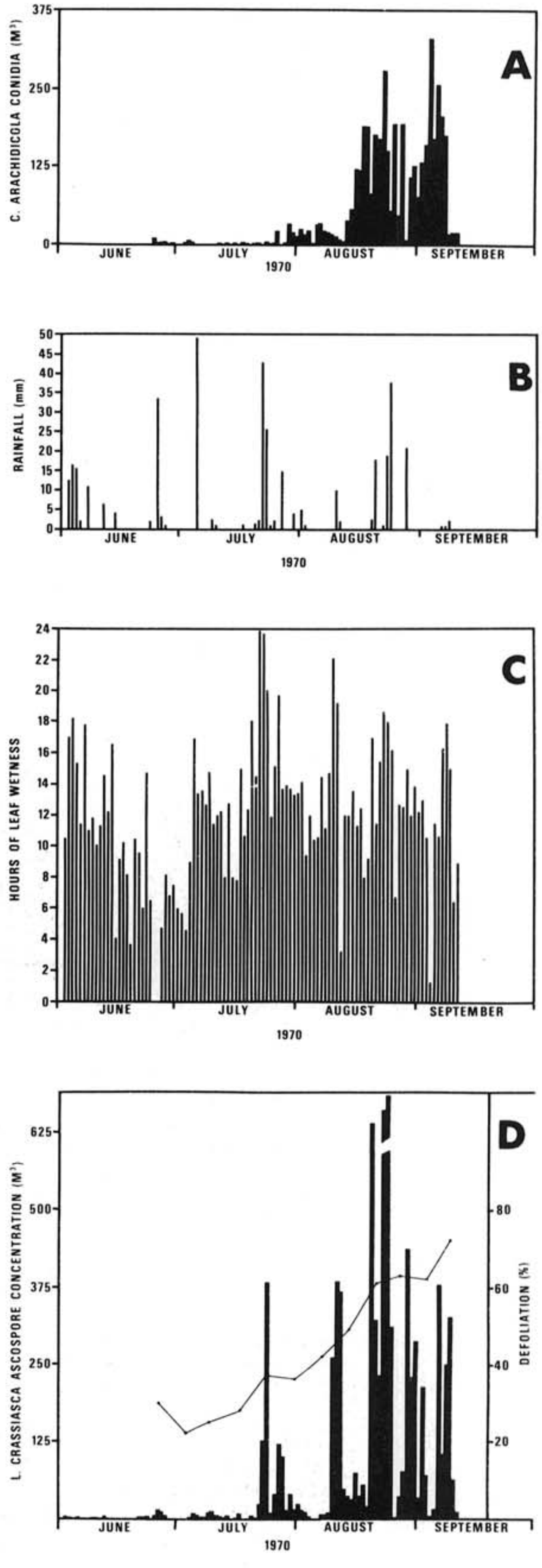

Fig. 1. **A)** Daily concentration (spores/m³ of air) of *Cercospora arachidicola* conidia during 1970. **B)** Daily rainfall (mm) during 1970. **C)** Daily hr of leaf wetness during 1970. **D)** Daily concentration (spores/m³ of air) of *Leptosphaerulina crassiasca* ascospores and percentage defoliation of Argentine peanuts during 1970. Concentration for 23 and 24 August 1970 (broken bars) was 756 and 1,327 spores m³ of air, respectively.

Unlike *L. crassiasca*, the concentration of *C. arachidicola* conidia increased rapidly after the termination of leaf wetness, with daily peaks ranging from 1100 hours to 1500 hours (Fig. 2B).

On rainy days, concentrations of *C. arachidicola* conidia increased rapidly shortly after the onset of rainfall (Fig. 2C, 2D). After the onset of rainfall, *C. arachidicola* conidia usually appeared on the Hirst spore trap slides shortly before *L. crassiasca* ascospores.

Evidence for vertical dissemination of *C. arachidicola* conidia was obtained by observing lesions which developed on *A. hypogaea* Argentine plants exposed in the field at different heights above the ground. During 13 exposure periods ranging from 4 to 8 days from 14 July to 12 September 1971 the average number of lesions that developed on plants at 0, 0.9, 1.8, and 2.7 m was 140.5, 88.6, 77.7, and 51.7, respectively. These data show that *C. arachidicola* conidia were present in the air above a peanut field and that the number of conidia decreased as exposure height increased.

DISCUSSION.–Several workers (4, 11, 16) have demonstrated that *L. briosiana* ascospores were aerially disseminated. Our studies on the diurnal and seasonal periodicity of *L. crassiasca* ascospore dissemination represent the first report on the aerobiology of *L. crassiasca*. It appears that muriform ascospores are much more effectively disseminated than phragmosporous ascospores, since very few phragmosporous ascospores were observed on Hirst trap slides. Graham & Luttrell (5) found that up to 34% of ascospores in crushed mounts were phragmosporous, while few or no phragmosporous ascospores were ejected from ascocarps onto agar plates.

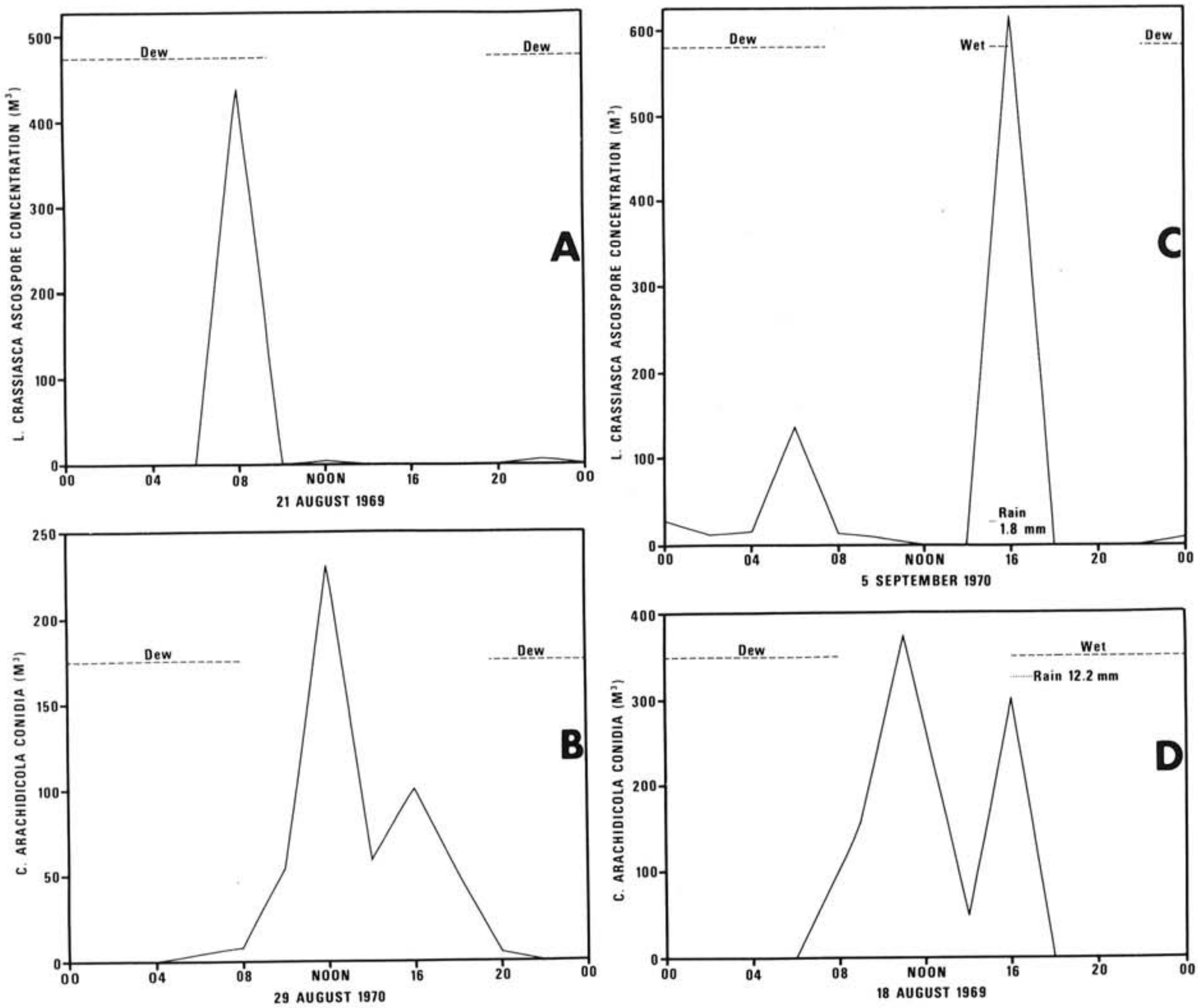

Fig. 2. A) Concentration (spores/m³ of air) of *Leptosphaerulina crassiasca* ascospores in absence of rain on 21 August 1969). **B)** Concentration (spores/m³ of air) of *Cercospora arachidicola* conidia in absence of rain on 29 August 1970. **C)** Concentration (spores/m³ of air) of *L. crassiasca* ascospores typical of a rainy day (5 September 1970). **D)** Concentration (spores/m³ of air) of *C. arachidicola* typical of a rainy day (18 August 1969).

The direct relationship between the seasonal progress of defoliation and increasing concentration of *L. crassiasca* ascospores probably exists because *L. crassiasca* ascocarps are produced only in necrotic leaf tissue. Thus, as fallen leaflets accumulate on the soil and become necrotic, the rate of ascocarp development increases. This, in turn, is reflected by the increased concentration of trapped ascospores during the growing season.

Our results on the dirunal periodicity of *L. crassiasca* ascospore dispersal are in general agreement with those of Sundheim (16), who found that *L. briosiana* ascospores were most abundant in the air during daylight hours, with highest concentrations between 1600 hours and 2000 hours. However, in the absence of rain we trapped the highest concentrations of *L. crassiasca* ascospores within 1 to 4 hr (0630 hours to 0930 hours) after sunrise. Sundheim detected increased numbers of ascospores in the air after the onset of rainfall, and we have observed this with *L. crassiasca* on numerous occasions.

Diurnal periodicity of *Cercospora* conidia has been reported for several species, with peak catches during the daytime. However, there is at least one report (13) where *Cercospora* conidia were present in the air during the day and night, with no definite peaks. Therefore, it is difficult to generalize about the diurnal periodicity of conidial dispersal in the genus *Cercospora*. Our data are in agreement with the preponderance of published information; i.e., peak catches during the daytime.

Sreeramulu (15) reported that *C. arachidicola* had a typical forenoon pattern of diurnal periodicity, with daily peak catches of conidia at 1000 hours and relatively high concentrations from 0800 hours to 1400 hours. In our study daily peak catches ranged from 1100 hours to 1500 hours. During our investigation soil moisture was supplied only by rainfall. In Sreeramulu's study soil moisture was apparently supplied only by irrigation. Perhaps this factor is at least partially involved in the difference between our results and those of Sreeramulu.

On days without rain peak catches of *L. crassiasca* ascospores preceded peak catches of *C. arachidicola* conidia, but after the onset of rain the reverse was true. The most plausible explanation for this is that the release mechanism for *C. arachidicola* conidia involved a hygroscopic process as described for *C. beticola* (12). On rainy days conidia were probably mechanically released as a result of rain droplets impacting directly on sporulating lesions.

Berger & Hanson (2) trapped *C. zebrina* conidia on vaseline coated microscope slides at a height of 2.7 m above the ground. We are not aware of any other attempts to study vertical dissemination of *Cercospora* conidia. Our results with exposure of potted plants at different heights indicated that vertical dissemination of *C. arachidicola* conidia occurred and that a gradient existed. Since the number of lesions on exposed plants decreased as exposure height increased, it is presumed that the principal source of conidia was within the immediate peanut field.

LITERATURE CITED

1. BERGER, R. D. 1971. Numbers of trapped Cercospora apii spores determined by length of temperature, favorable moisture periods, and disease incidence. Phytopathology 61:885 (Abstr.).
2. BERGER, R. D., & E. W. HANSON. 1963. Pathogenicity, host-parasite relationships and morphology of some forage legume Cercosporae, and factors related to disease development. Phytopathology 53:500-508.
3. DAVIS, D. R., & J. E. HUGHES. 1970. A new approach to recording the wetting parameter by the use of electrical resistance sensors. Plant Dis. Reptr. 54:474-479.
4. ELLIOT, A. M., & R. D. WILCOXSON. 1964. Effect of temperature and moisture on formation and ejection of ascospores and on survival of Leptosphaerulina briosiana. Phytopathology 54:1443-1447.
5. GRAHAM, J. H., & E. S. LUTTRELL. 1961. Species of Leptosphaerulina on forage plants. Phytopathology 51:680-693.
6. HIRST, J. M. 1952. An automatic volumetric spore trap. Ann. Appl. Biol. 39:257-265.
7. KAISER, W. J., & F. L. LUKEZIC. 1965. Brown spot disease of banana fruit caused by Cercospora hayi. Phytopathology 55:977-980.
8. KAISER, W. J., & F. L. LUKEZIC. 1966. Influence of certain environmental conditions on spore dispersal and survival of Cercospora hayi from banana. Phytopathology 56:1290-1293.
9. LUTTRELL, E. S., & L. W. BOYLE. 1960. Leaf spot of peanut in Georgia caused by Leptosphaerulina arachidicola. Plant Dis. Reptr. 44:609-611.
10. LYLE, J. A. 1964. Development of Cercospora leafspot of peanut. J. Ala. Acad. Sci. 35:9.
11. MARTINEZ, E. S., & E. W. HANSON. 1963. Factors affecting growth, sporulation, pathogenicity, and dissemination of Leptosphaerulina briosiana. Phytopathology 53:938-945.
12. MEREDITH, D. S. 1967. Conidium release and dispersal in Cercospora beticola. Phytopathology 57:889-893.
13. PADY, S. M., C. L. KRAMER, & B. J. WILEY. 1962. Kansas aeromycology. XII. Materials, methods, and general results of diurnal studies. Mycologia 54:168-180.
14. SMITH, D. H., & F. L. CROSBY. 1971. Aerobiology of peanut leafspot fungi. Phytopathology 61:912 (Abstr.).
15. SREERAMULU, T. 1970. Conidial dispersal in two species of Cercospora causing Tikka leaf-spots on groundnut (Arachis hypogaea L.). Indian J. Agr. Sci. 40:173-178.
16. SUNDHEIM, L., & R. D. WILCOXSON. 1965. Leptosphaerulina briosiana on alfalfa: infection and disease development, host-parasite relationships, ascospore germination and dissemination. Phytopathology 55:546-553.