Source and Dispersal of Conidia of *Drechslera poae* in Kentucky Bluegrass Turf

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ABSTRACT

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Populations of conidia of *Drechslera poae* in Kentucky bluegrass turf and the atmosphere were monitored in 1979 and 1980. Leaf litter clippings, not thatch, were found to be the primary source of conidia. Conidia were first detected in leaf litter in late March. Populations of conidia in leaf litter were highest in May and June and fell to near zero by July. Airborne conidia were most numerous in mid-May through June, whereas few conidia were detected in early April to mid-May. Very few conidia were collected from early July through the remainder of the season. Diurnal conidial release was highest at 1200–1600 hours and correlated negatively with decreases in relative humidity.

Melting-out caused by *Drechslera poae* (Baudys) Shoem. (=*Helminthosporium poae* Baudys, *H. vagans* Drechs., and *D. vagans* (Drechs.) Shoem.) is recognized as an important disease throughout the range of Kentucky bluegrass (2,3,5,6,8,9,17). Two distinct phases of melting-out generally develop during the growing season. The leaf spot phase is most visible during the spring and fall, whereas the crown rot phase is most prominent during the summer (2,5,6).

It has been speculated that Kentucky bluegrass thatch (5), leaf litter (2–5), or lesions on diseased living plants (8) may serve as the principal source of conidia of *D. poae*. Large populations of conidia of *Bipolaris sorokiniana* (=*H. sorokinianum*) and *Helminthosporium* spp. have been found on Kentucky bluegrass and bermudagrass leaf litter, respectively (3,4). Halisky and Funk (8) noted that sporulation of *D. poae* on naturally infected leaves of Kentucky bluegrass was heaviest from October to April and lowest from May through September. Hagan (7) observed that sporulation of *D. poae* was fourfold to 10-fold greater on detached Kentucky bluegrass leaves than on intact leaves.

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Limited information concerning the seasonal and diurnal dispersal of conidia of *Drechslera* spp. on turfgrasses is available. Meredith (14) noted that airborne conidia of *D. gigantea* (=*H. gigantea*) over bermudagrass turf displayed diurnal periodicity with maximum conidial concentrations occurring at 1000 hours. It was also observed that few conidia of *D. gigantea* were collected during hot weather, whereas highest concentrations of airborne conidia were trapped on days following periods of rain or heavy dew (14). Seasonal periodicity of airborne conidia of *D. poae* has been found to coincide with the development of leaf spot symptoms on Kentucky bluegrass in the spring (18). Nutter et al (18) have also shown that maintenance practices such as mowing contribute to the dispersal of conidia of *D. poae*.

The objective of this study was to determine the site of conidium production as well as the seasonal and diurnal occurrence of airborne conidia of *D. poae* within a field of Kentucky bluegrass throughout the growing season.

MATERIALS AND METHODS

Inoculum source. Samples of thatch, the layer of living and dead stems and roots between the foliage and soil, were collected weekly from 26 March to 21 November 1979 and from 17 March to 10 July 1980 with a 2.5-cm-diameter soil probe from a 95-m^2 plot divided into 64 subplots. Leaf litter, composed of partially decomposed leaf clippings, was collected weekly from four subplots from 16 August to 21 November 1979 and from 15 March to 10 July 1980. Before processing, each sample was air-dried at room temperature to prevent further conidium production.

Conidia of *D. poae* were separated from thatch and leaf litter using the mineral oil flotation technique (13) as modified by Colbaugh and Endo (4). Ten grams (dry weight) of thatch or 5 g (dry weight) of leaf litter was placed in a flask

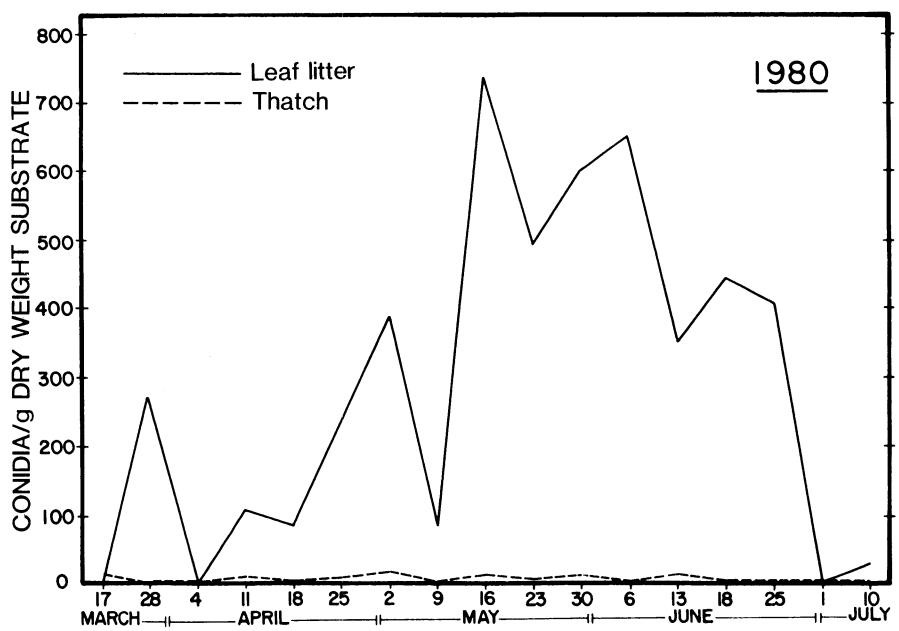

Fig. 1. Populations of conidia of *Drechslera* recovered from leaf litter and thatch samples collected from Kentucky bluegrass turf in 1980.

containing 100 ml of distilled water. The flask was shaken vigorously for 3 min and the suspension filtered through a 200-mesh screen to remove debris. The filtrate was poured into a graduated cylinder, brought to a volume of 100 ml, distributed into 25-ml aliquots, and centrifuged. The supernatant was discarded and the pellet mixed with 5 ml of light mineral oil. About 20 ml of double-distilled water was added to the mineral oil-soil suspension and mixed in a Vortex mixer to form an emulsion that was poured into a glass petri dish and allowed to settle. Four plates were prepared from each 10-g thatch or 5-g leaf litter sample. Six fields were examined at ×60 of each plate with a dissecting microscope and the number of conidia was recorded. The area of the microscope field and petri plate was calculated and the number of conidia in the four plates totaled. The number of conidia per gram (dry weight) of sample was calculated and recorded.

Conidium trapping. Airborne conidia of *D. poae* were collected with a Kramer-Collins intermittent band spore sampler (G-R Electric Manufacturing Co., Manhattan, KS) or a Burkard 7-day continuous spore sampler (Burkard Scientific Ltd., Rickmansworth, Hertfordshire, England).

The Kramer-Collins spore trap was adjusted to operate for about 23 min/hr during a 24-hr period at a flow rate of 35 L/hr through an orifice 15 cm above the turf. Particulate matter was deposited on a glass slide coated with WD-40. Samples were collected with the Kramer-Collins trap from 10 April to 10 July 1979. Slides were changed daily, stained with 0.5% cotton blue in lactophenol, and examined for conidia of *D. poae*.

The Burkard spore trap operated at a flow rate of 11 L/min through an orifice 30 cm above the turf from 27 July to 2 November 1979 and from 4 April to 11 August 1980. Tapes collected weekly from the trap were cut in 48-mm strips, mounted on glass slides, stained with 0.5% cotton blue in lactophenol, and examined at ×100 and 430 with a compound light microscope. The number of conidia of *D. poae* collected during each 2-hr period was recorded.

Both spore traps were placed in an 11-acre common Kentucky bluegrass (*Poa pratensis L.*) field naturally infested with *D. poae* at the ChemLawn Research Facility in Milford Center, OH. The spore traps were situated to take advantage of the prevailing west-south winds. Turf was maintained at a height of 3.8–5.1 cm, irrigated when necessary, and treated in early spring with herbicides to control broadleaf weeds. Irrigation was recorded as rainfall.

Meteorological equipment. A hygrothermograph (Weather Measure Corp., Sacramento, CA), an anemometer (Weather Measure Corp.), a leaf wetness meter (14), a pyranograph (Weather Measure Corp.), and a recording rain gauge (Meteorology Research Inc., Altadena, CA) were installed in a 1.5-m enclosure near the spore traps. Ambient air and turf microclimate temperatures were monitored with T-type thermocouples placed in Kentucky bluegrass turf 50 m from the enclosure. Thatch temperature means were reported as the daily average of the hourly readings.

Disease incidence. Incidence of the crown rot and leaf spot phase of melting-out was monitored weekly from March through November 1979 and from March through July 1980. Disease incidence was expressed as the percentage of plants with lesions on the crowns or leaves in a 25-plant sample.

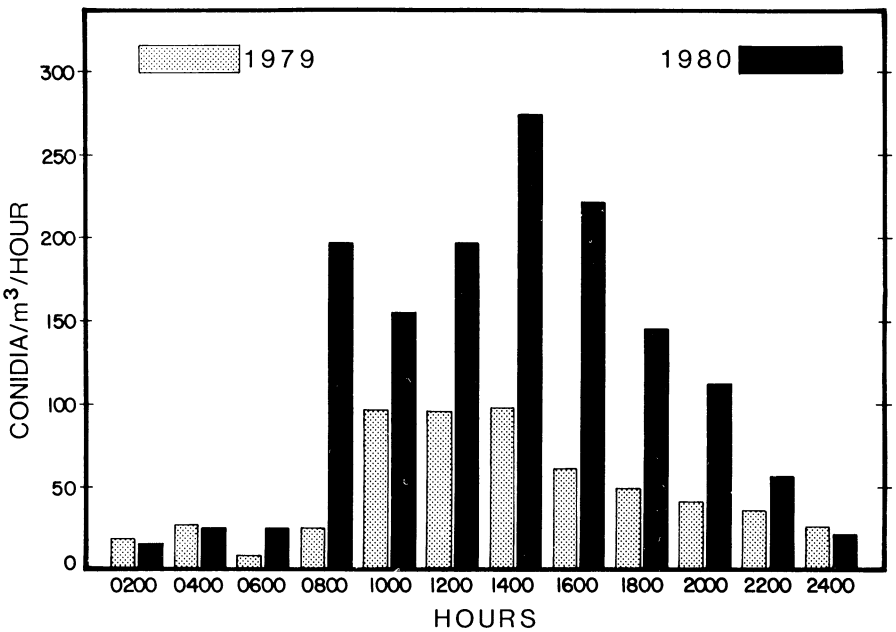

Fig. 2. Diurnal periodicity of airborne conidia of *Drechslera poae* within a field of Kentucky bluegrass in 1979 and 1980.

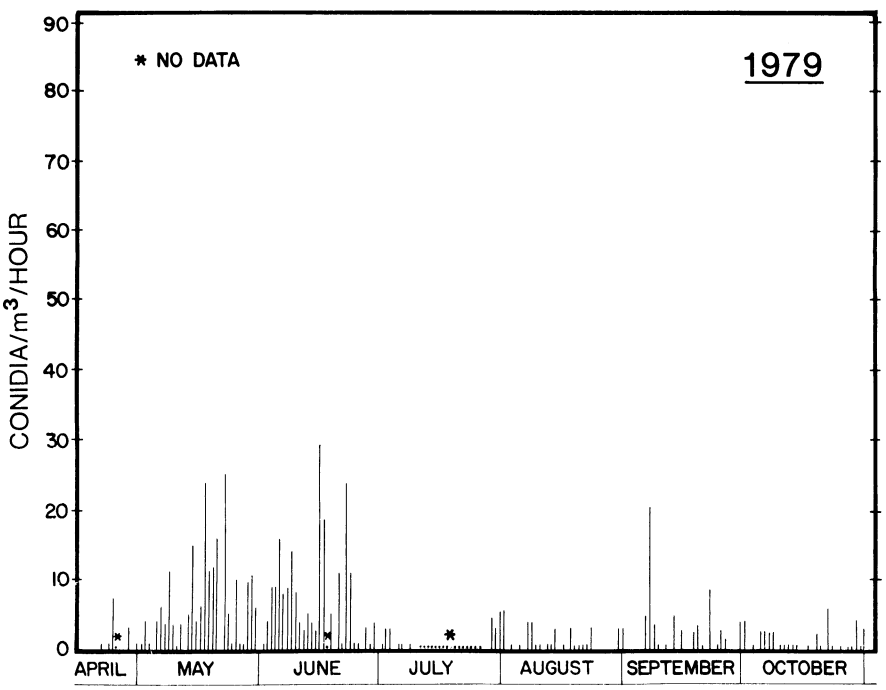

Fig. 3. Daily counts of airborne conidia of *Drechslera poae* collected in 1979 with a Kramer-Collins (10 April–10 July) and Burkard spore sampler (27 July–1 November).

RESULTS

Inoculum source. Leaf litter consisting of partially decomposed Kentucky bluegrass leaf fragments was the primary source of conidia of *D. poae*, whereas thatch was a minor source of inoculum (Fig. 1). Relatively few conidia were collected from leaf litter samples from

August to November 1979. In 1980, conidia were first detected in leaf litter in late March and conidial populations gradually increased through May (Fig 1). Highest populations of conidia were noted on leaf litter collected from mid-May through late June. A sharp decrease in conidium populations was observed in early July.

Populations of conidia of *D. poae* in the thatch of Kentucky bluegrass turf did not approach those in the leaf litter. No more than 35 conidia per gram (dry weight) of thatch were detected in any sample collected in 1979. In 1980, populations did not exceed 20 conidia per gram (dry weight) of thatch anytime during the spring (Fig 1).

Influence of thatch temperature on conidial concentrations in leaf litter. At mean daily thatch temperatures of 12–18 C, populations of 400–700 conidia per gram (dry weight) were recorded on Kentucky bluegrass leaf litter. Below 12 C, fewer than 400 conidia per gram (dry weight) were noted on leaf litter. Conidium production almost completely stopped in July when temperatures exceeded a mean of 20 C.

Diurnal periodicity of conidial dispersal. The incidence of airborne conidia of *D. poae* followed a diurnal pattern in 1979 and 1980 (Fig 2). Substantial increases in the number of conidia trapped between 0800 and 1000 hours was negatively correlated with decreases in relative humidity ($r = -0.531$). There was no correlation between conidial dispersal and rainfall, leaf wetness, wind speed, and temperature. The occurrence of airborne conidia was highest between 1200 to 1600 hours both years.

Seasonal periodicity of airborne conidia. Similar patterns of the periodicity of airborne conidia of *D. poae* were observed in 1979 and 1980 (Figs. 3 and 4). In both years, airborne conidia were first detected sometime in early to mid-April. Few airborne conidia were collected through early May. Airborne conidia were most numerous from mid-May until the end of June. Daily totals during this period varied from as few as one to 229 conidia per cubic meter. Sharp decreases in the number of airborne conidia trapped were observed between late June 1979 and early July 1980. Collection of low numbers of airborne conidia continued as long as the spore traps remained operational in 1979 and 1980. Slight differences in the seasonal periodicity of airborne conidia of *D. poae* between 1979 and 1980 probably reflected differences in weather variables and disease development during those 2 yr.

Disease incidence. A close relationship between leaf spot and crown rot incidence and seasonal periodicity of conidia of *D. poae* was noted in 1980 (Fig. 5). From late March to early May, detection of conidia on leaf litter preceded disease development by about 2 wk. Increases in disease incidence followed the detection of sizable populations of conidia of *D. poae* on leaf litter in mid-May. Leaf spot and crown rot incidence remained high throughout May and June, when conidia on leaf litter were most numerous. Turf began to recover in July after conidial production on the leaf litter declined.

The relationship between disease incidence and number of airborne conidia was not as clear in 1979 as in 1980 (Fig. 6). Substantial increases in both phases of melting-out occurred before the spore trap was operational. Significant numbers of airborne conidia were not trapped until disease development was well advanced in May. Incidence of leaf spot and crown rot remained high through May and June, when airborne conidia were most numerous. As in 1980, a decline in disease incidence began several weeks after collection of airborne conidia decreased in late June. Incidence of both phases of melting-out continued to decline throughout the summer and fall of 1979. This occurrence may have been a result of the very low populations of airborne conidia available to serve as inoculum during this period.

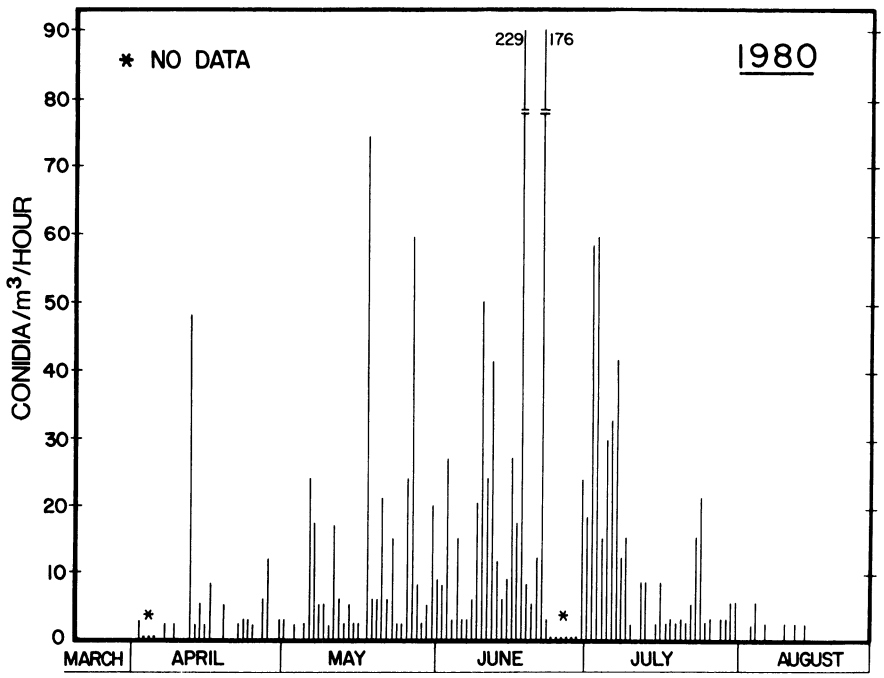

Fig. 4. Daily counts of airborne conidia of *Drechslera poae* collected in 1980 with a Burkard spore sampler (4 April–11 August).

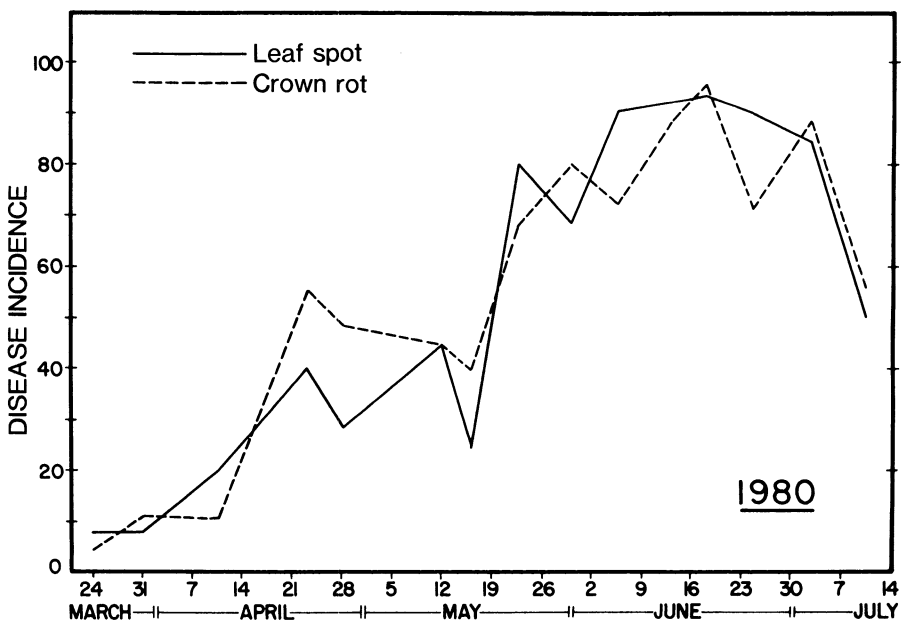

Fig. 5. Incidence of the leaf spot and crown rot phase of melting-out of Kentucky bluegrass in 1980. Data expressed as percentage of plants diseased in 25-plant sample.

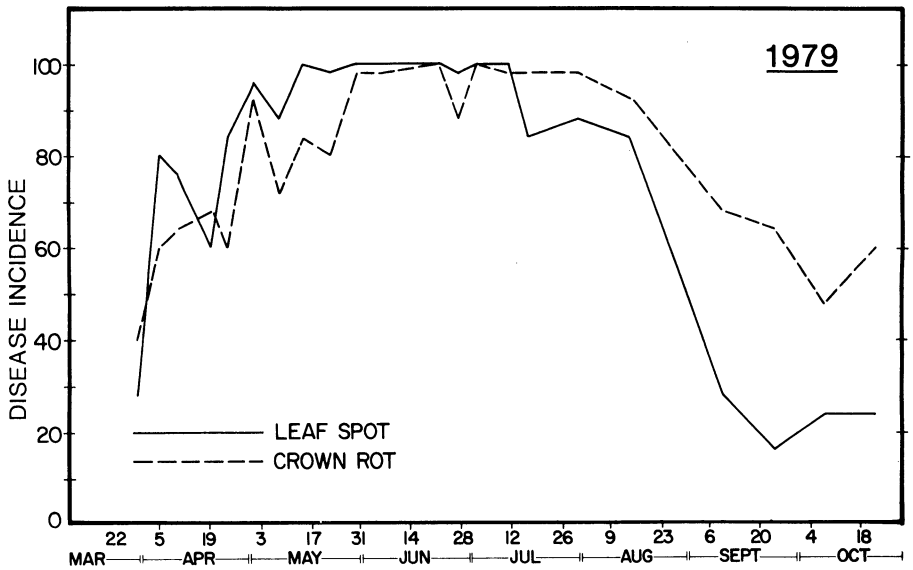

Fig. 6. Incidence of leaf spot and crown rot phase of melting-out of Kentucky bluegrass in 1979. Data expressed as percentage of plants diseased in 25-plant sample.

DISCUSSION

Kentucky bluegrass was identified as a primary source of conidia of *D. poae*. Leaf litter has been reported as a major source of conidia of *Helminthosporium* spp. and *B. sorokiniana* on bermudagrass (2) and Kentucky bluegrass (3). Thatch, which has also been considered a possible site of conidial production (5), was at best a minor source of conidia. Most conidia found on thatch probably were dislodged from leaf litter. Populations of conidia on leaf litter were far below those noted by Colbaugh and Beard (3) on bermudagrass.

Highest populations of conidia of *D. poae* were found on leaf litter at thatch temperatures with a daily mean of 12–18 C, which was within the optimum temperature range of sporulation (7,19). Outside this range, conidial populations on leaf litter were sparce.

Dispersal of conidia of *D. poae* followed a diurnal pattern. Numbers of airborne conidia rose sharply at 0800 hours, peaked at 1200–1600 hours, then dropped rapidly at 2400 hours. A similar dispersal pattern has been reported for related fungi including *B. maydis* (1), *D. gigantea* (14), and *Exserohilum turcica* (12,16). A significant negative correlation was noted between the increased occurrence of airborne conidia of *D. poae* and a reduction in ambient relative humidity. Meredith (14–16) and Leach et al (10–12) have previously noted a similar relationship between relative humidity and the number of airborne conidia. A relationship between the numbers of airborne conidia and the other monitored environmental parameters was not observed in this study.

A close relationship was observed between the occurrence of conidia on Kentucky bluegrass leaf litter and the number of airborne conidia. When conidial populations on leaf litter were low in the fall of 1979 and early spring of 1980, few airborne conidia were trapped. The number of airborne conidia was considerably higher in May and June as populations on leaf litter increased, then fell sharply in early July after conidial production on leaf litter ceased. Nutter et al (18) observed a similar seasonal pattern of periodicity for airborne conidia.

Development of disease symptoms was preceded by an increase in conidial populations of *D. poae* on leaf litter in April and May 1980. Incidence of both the leaf spot and crown rot phases of melting-out fell in July shortly after conidial production stopped. Nutter et al (18) also noted that increased disease development coincided with peak populations of airborne conidia of *D. poae*.

Historically, melting-out on Kentucky bluegrass has been controlled using preventive fungicide sprays in the spring in combination with cultural control procedures. Mid-April to early May probably is the period of primary inoculum production and dispersal in Ohio and Pennsylvania (19) (Figs. 3 and 4). Initiation of fungicide spray programs during this period, rather than in June, should suppress inoculum production and result in improved disease control. Improved timing of fungicide applications should also lead to more efficient use of available fungicides. Furthermore, management procedures that reduce leaf litter should be closely evaluated as a technique to reduce inoculum.

LITERATURE CITED

1. Aylor, D. E., and Lukens, R. J. 1974. Liberation of *Helminthosporium maydis* spores by wind in the field. Phytopathology 64:1136-1138.
2. Beard, J. B. 1973. Turfgrass: Science and Culture. Prentice-Hall, Englewood Cliffs, NJ. 658 pp.
3. Colbaugh, P. F., and Beard, J. B. 1981. Influence of cultural practices on conidial production by *Helminthosporium* spp. on improved bermudagrass. Pages 97-99 in: Advances in Turfgrass Pathology. P. O. Larsen and B. G. Joyner, eds. Harcourt Brace Jovanovich, Duluth, MN. 197 pp.
4. Colbaugh. P. F., and Endo, R. M. 1974. Drought stress: An important factor stimulating the development of *Helminthosporium sativum* on Kentucky bluegrass. Pages 328-333 in: Proceedings of the Second International Turfgrass Research Conference. E. C. Roberts, ed. American Society of Agronomy.
5. Couch, H. B. 1973. Diseases of Turfgrasses. Krieger Publishing Co., Huntington, NY. 348 pp.
6. Drechsler, C. 1930. Leafspot and foot rot of Kentucky bluegrass caused by *Helminthosporium vagans*. J. Agric. Res. 40:447-456.
7. Hagan, A. K. 1980. Epidemiological studies of melting-out of Kentucky bluegrass and development of a fungicide bioassay. Ph.D. thesis. Ohio State University, Columbus. 149 pp.
8. Halisky, P. M., and Funk, C. R. 1966. Environmental factors affecting growth and sporulation of *Helminthosporium vagans* and its pathogenicity to *Poa pratensis*. Phytopathology 56:1294-1296.
9. Horsfall, J. G. 1930. A study of meadow-crop diseases in New York. Cornell Univ. Agric. Exp. Stn. Man. 130. 139 pp.
10. Leach, C. M. 1975. Influence uf relative humidity and red-infrared radiation on violent spore release by *Drechslera turcica* and other fungi. Phytopathology 65:1303-1312.
11. Leach, C. M. 1980. Influence of humidity and red-infrared radiation on spore discharge by *Drechslera turcica*—additional evidence. Phytopathology 70:192-196.
12. Leach, C. M., Fullerton, R. A., and Young, K. 1977. Northern leaf blight of maize in New Zealand. Release and dispersal of conidia of *Drechslera turcica*. Phytopathology 67:380-387.
13. Ledingham, R. J., and Chinn, S. H. F. 1955. A flotation method for obtaining spores of *Helminthosporium sativum* from soil. Can. J. Bot. 33:298-303.
14. Meredith, D. 1963. Further observations on the zonate eyespot fungus, *Drechslera gigantea* in Jamaica. Br. Mycol. Soc. Trans. 46:201-207.
15. Meredith, D. 1965. Violent spore release in *Helminthosporium turcicum*. Phytopathology 55:1099-1102.
16. Meredith, D. 1966. Airborne conidia of *Helminthosporium turcicum* in Nebraska. Phytopathology 56:949-952.
17. Morrison, R. H. 1981. Leafspot of Kentucky bluegrass in Minnesota: Misidentification of *Drechslera poae* as *D. dictyoides*. Pages 113-119 in: Advances in Turfgrass Pathology. P. O. Larsen and B. G. Joyner, eds. Harcourt Brace Jovanovich, Duluth, MN. 197 pp.
18. Nutter, F. W., Cole, H., and Schein, R. D. 1982. Conidial sampling of *Drechslera poae* from Kentucky bluegrass to determine role of mowing in spore dispersal. Plant Dis. 66:721-723.
19. Vargas, J. M., and Wilcoxson, R. D. 1969. Some effects of temperature and radiation on sporulation by *Helminthosporium dictyoides* on agar media. Phytopathology 59:1706-1712.