

# Miscanthus Blight, A New Foliar Disease of Ornamental Grasses and Sugarcane Incited by *Leptosphaeria* sp. and Its Anamorphic State *Stagonospora* sp.

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## ABSTRACT

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Leaf spot and leaf blight were observed on the ornamental grass *Miscanthus sinensis* during the late summer and fall of 1993, 1994, and 1995 in three counties in Maryland. Severe disease symptoms occurred on residential landscape plants, nursery container stock, and commercial plantings of *Miscanthus sinensis*, *M. s.* var. *gracillimus*, *M. s.* var. *variegatus*, and *M. s.* var. *zebrinus*. The disease is characterized by reddish brown spots to oval streaks on leaves and sheaths. Leaf margins, leaf tips, and older leaves become necrotic. Younger plants become completely necrotic. Pycnidia and conidia of a species of *Stagonospora* with a *Leptosphaeria* teleomorph were observed on naturally infected necrotic *Miscanthus* leaves. The fungus was readily isolated in pure culture from affected plant parts. The fungus is homothallic, and both the anamorphic and teleomorphic states were produced on inoculated *Miscanthus* and sugarcane foliage, and on autoclaved sugarcane leaves. The anamorph may be morphologically distinct from other *Stagonospora* pathogens described from sugarcane, but the teleomorph is similar to *Leptosphaeria taiwanensis* (anamorph *Stagonospora tainanensis*), cause of sugarcane leaf blight. In growth chamber inoculations, conidia produced by the *Miscanthus* fungus and by *S. tainanensis* from sugarcane were highly virulent and caused similar blight symptoms on four *Miscanthus* varieties and six sugarcane clones. Sugarcane leaf blight is a serious disease in Taiwan but has not been reported from the United States. The name proposed for the new disease on *Miscanthus* is *Miscanthus* blight, caused by *Leptosphaeria* sp. and its conidial state *Stagonospora* sp.

Additional keywords: sugarcane, sugarcane leaf blight

During late summer and fall of 1993, 1994, and 1995, leaf spot and leaf blight symptoms were observed in field and residential plantings of *Miscanthus* spp. Five varieties exhibited severe symptoms: *Miscanthus sinensis* Anderss., *M. s.* var. *gracillimus* Hitchc., *M. s.* var. *variegatus* Beal, *M. s.* var. *zebrinus* Beal, and *M. s.* var. *strictus*. Native to the Far East, varieties of *Miscanthus* are attractive, low-maintenance xerophytes that have become popular ornamental plants in commercial and residential landscapes. At least 31 varieties have become available commercially in Maryland and Virginia since their introduction in 1985. Since 1991, local nurseries have become concerned about losses in quality of mature stock and death of plants in seedling plantings due to an unknown disease.

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This disease was of interest, not only because it is destructive to *Miscanthus*, but also because the disease is similar to sugarcane (*Saccharum* spp.) blight, which is endemic in the Philippines, Japan, and Taiwan (1,13), and which is caused by *Leptosphaeria taiwanensis* Yen & Chi (anamorph *Stagonospora tainanensis* Hsieh). In 1968, a sugarcane leaf blight epidemic occurred in Taiwan, infecting more than 3,000 ha, 3.5% of the commercial cane area (5). Attempts to control the disease in Taiwan included screening for resistant cultivars and the use of oil sprays (5,6). This disease has not been reported on any host in the United States, but it must be considered a potential threat to the domestic sugarcane crop. The present study was undertaken to determine the etiology of the *Miscanthus* disease and to compare the diseases caused by the *Miscanthus* fungus and the sugarcane leaf blight pathogen on species of *Miscanthus* and sugarcane cultivars grown in the United States.

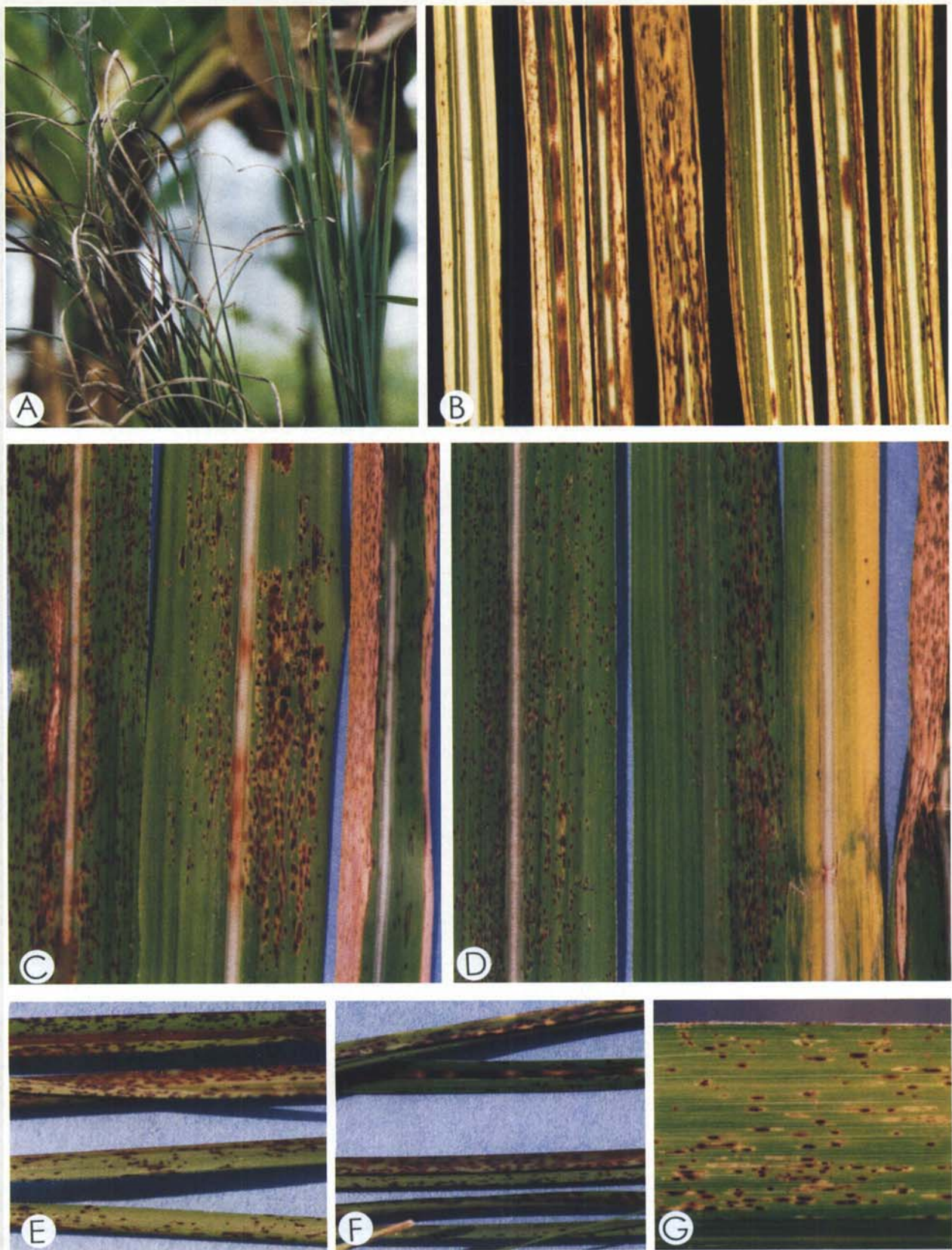
## MATERIALS AND METHODS

**Isolation and preservation of the fungi.** During the falls of 1993 and 1994, we conducted a survey of commercial nurseries and residential landscapes in Montgomery, Prince Georges, and Howard

counties in Maryland. Grasses exhibiting disease symptoms were collected from seven sites. Isolations were made from leaf and sheath samples of four grasses: *M. sinensis*, *M. s.* var. *gracillimus*, *M. s.* var. *zebrinus*, and *M. s.* var. *variegatus*. Isolations from field samples and from greenhouse inoculations were made by washing excised leaves with tap water, cutting tissue that was either necrotic or green with small lesions into small (<3 mm) pieces, and surface disinfecting the pieces for 2 min in 1.5% sodium hypochlorite containing one drop Tween 20 per 500 ml of sterile distilled water. Pieces of tissue were rinsed twice in sterile distilled water, cut in half across lesions, and placed on potato-dextrose agar (PDA) plates amended with streptomycin sulfate and chlorotetracycline (Sigma Chemical Co., St. Louis, MO) at 100 mg/liter. Ten pieces were placed on each petri plate, and three plates were prepared per grass sample. Plates were incubated at 23°C with a 12-h day under fluorescent illumination. After 24 h of incubation, hyphae growing from leaf pieces were transferred to petri plates containing either PDA or half-strength oatmeal agar (OA). Untreated necrotic leaf pieces were also placed in a moist chamber (petri dish with moist filter paper) to induce maturation and sporulation of fungi present in these tissues. After 24 h, leaf pieces exhibiting mature pseudothecia were taped to the inside upper lid of a petri dish containing PDA amended as above. Single-ascospore cultures were obtained from these plates within 24 h. Spores suspensions obtained from single spore subcultures were maintained on silica gel crystals at 4°C.

Isolates of two pathogens of sugarcane were obtained from the American Type Culture Collection. These are *S. tainanensis* (teleomorph *L. taiwanensis*) isolate ATCC 38204, cause of leaf blight of sugarcane, and *Leptosphaeria bicolor* Hawksw. (anamorph *Stagonospora bicolor*) isolate ATCC 42652, cause of leaf scorch of sugarcane. Cultures of *S. sacchari* Lo & Ling (teleomorph unknown), cause of a disease also known as leaf scorch of sugarcane, were unavailable (7,9). Herbarium specimens of other similar fungi were also examined. A type specimen of *L. taiwanensis* was examined (USDA, ARS, Systematic Botany and Mycology Laboratory).

**Morphology, cultural characterization, and growth rate.** Fungal structures



**Fig. 1.** Symptoms of *Miscanthus* blight and sugarcane leaf blight from natural infection and growth chamber inoculations. (A) Diseased and healthy foliage of *Miscanthus sinensis* var. *gracillimus* naturally infected with *Stagonospora* sp. (B) Typical symptoms of *Miscanthus* blight on *M. s.* var. *variegatus* taken from field plantings. (C) Leaf blight symptoms on sugarcane inoculated with leaf blight pathogen *Stagonospora tainanensis* isolate ATCC 38204. (D) Symptoms on sugarcane inoculated with *Stagonospora* sp. isolate N194 from *Miscanthus*. (E) Disease symptoms on *M. s.* var. *gracillimus* inoculated with *S. tainanensis* isolate ATCC 38204 from sugarcane. (F) Symptoms on *M. s.* var. *gracillimus* inoculated with *Stagonospora* sp. isolate N194 from *Miscanthus*. (G) Chlorotic halo surrounding lesions on one of the six sugarcane clones tested for susceptibility to *Stagonospora* sp. from *Miscanthus*.



were observed from inoculated live or autoclaved sugarcane and *Miscanthus* leaves incubated under fluorescent illumination (16-h photoperiod) at 23°C. Gross cultural characteristics were determined from cultures grown on PDA or OA under fluorescent illumination (16 h/day) at 23°C. To determine whether the *Miscanthus* fungus was homo- or heterothallic, 30 single ascospore isolates and 30 single conidial isolates were inoculated onto autoclaved sugarcane leaf pieces and to OA. Plates were incubated for 2 weeks and examined daily for the presence of pycnidia and perithecia.

The radial growth of isolates from *Miscanthus* and of *S. tainanensis* from sugarcane were determined on PDA and OA. Two-mm-diameter disks were taken from the colony margins of *Miscanthus* isolates N194, N294, N394, N494, and ATCC isolate 38204, and one disk was placed in the center of each of five replicate plates per isolate. Plates were incubated at 23°C, and colony diameters were determined every 24 h for 10 days. The experiment was repeated twice.

**Plant material.** Large field samples of *M. sinensis* (PI 387879), *M. s. var. gracillimus* (PI 414060), *M. s. var. variegatus* (PI 414061), and *M. s. var. zebrinus* (PI 414062) were dug from a 1980 field planting, and each sample was divided into approximately 30 pieces. Pieces were planted in individual 15-cm pots containing a 50/50 mixture of peat moss and soil and grown for 2 months. Six sugarcane clones, CP92-629, CP86-1633, CP77-310, LCP86-454, CP82-1172, and CP92-607, were obtained from the National Germplasm Resources Laboratory, Beltsville, MD. These were interspecific hybrids of *Saccharum* spp., three of which (CP86-1633, LCP86-454, and CP82-1172) are commercially planted in Florida and Louisiana. Cane pieces were planted in 7.6-liter pots and grown for 5 months. Four varieties of *M. sinensis* were obtained from a local nursery's container stock, divided, replanted in several 15-cm pots, and grown in the greenhouse for 4 months.

**Pathogenicity tests.** Pathogenicity tests were conducted by leaf assay and by whole-plant inoculations. In one experiment, 8- to 25-cm sections of healthy sugarcane or *Miscanthus* leaves were placed on filter paper in petri dishes or in plastic boxes. The center of each leaf half was inoculated with a 2-mm-diameter disk of inoculum from an OA or PDA culture. Sufficient sterile water was added to the filter paper to keep it moist. The boxes and petri dishes were sealed and incubated at 23°C with a 16-h light period. The plants were observed daily for symptom development.

*Miscanthus* and *Saccharum* disease susceptibility evaluations were conducted with whole container-grown plants. Conidial inoculum of *Stagonospora tainanensis*

(ATCC 38204) and of the fungus from *Miscanthus* (N194) were spray-inoculated onto *M. s. var. gracillimus*, *M. s. var. variegatus*, *M. s. var. zebrinus*, and six sugarcane clones. Inoculum was prepared by scraping 10-day-old cultures on OA with a glass rod after adding sterile distilled water containing 1 drop of Tween 20 per 500 ml. Conidia were released from pycnidia within a few minutes of exposure to water. The conidial suspension was filtered through a single layer of cheesecloth. The inoculum concentration was adjusted to  $3.6 - 4.1 \times 10^4$  spores per ml.

Three pots of each *Miscanthus* variety and two pots of each of six sugarcane clones were inoculated with each isolate. Control pots were treated with water containing Tween 20. Spore suspensions were sprayed onto leaf surfaces until runoff. Pots were immediately placed in a mist chamber for 60 h at 23°C, and returned to a growth chamber at 23°C with a 16-h photoperiod. The plants were observed daily for symptom development. Sugarcane plants were evaluated for the number of leaves exhibiting more than 50% chlorosis and/or necrosis, the percent leaf area affected on the third through the seventh leaf from the apex, the size of foliar lesions, and the presence or absence of chlorotic halos surrounding lesions. Susceptibility of *Miscanthus* varieties was determined by rating 20 leaves of each plant for percent leaf area exhibiting symptoms. The experiment was conducted twice, and results from the second experiment are reported. Inoculation and incubation of plant material were conducted in isolated growth chambers, and plant material was autoclaved prior to disposal.

## RESULTS

**Symptomatology.** Symptoms and natural disease progression of foliar infections on varieties of *M. sinensis* were observed in mature field plantings established in 1979 and 1980 and in nursery stock from August to November 1993, 1994, and 1995. Foliar symptoms ranged from very small brown spots to complete blighting and necrosis (Fig. 1A and B). Lesions were initially very small and reddish brown to dark brown, and appeared on both surfaces of the leaf or leaf sheath. Spots developed principally on leaf blades below the third or fourth leaf of each tiller. Lesions developed into oval to spindle shaped spots, coalescing into irregular blotches. Mature lesion color varied between bright red, reddish yellow, red brown, and dark brown, depending on the *Miscanthus* variety and the age of the leaf. Lesion margins were either sharp or blurred, with little or no chlorosis at the margin. Lesions in emerging spindle leaves developed more slowly than those in mature leaves. Severely affected tissue was straw colored, and the entire leaf blade became blighted. During later stages of the disease, upper

leaf tips and margins, and entire lower leaves become completely necrotic and dry. Marginal necrosis was especially characteristic on *M. s. var. variegatus* (Fig. 1B). Black dots embedded in these leaves were either dark brown pycnidia or in late fall were larger, darker pseudothecia. Young plants were sometimes completely killed. The midrib exhibited reddish brown lesions with indefinite margins, often becoming completely blighted with a red to reddish yellow color. The achlorophyllous areas of variegated, banded, or streaked varieties exhibited more lesions than the chlorophyll-containing areas. The size of lesions and degree of chlorosis varied with the cultivar, number of lesions on the leaf, and age of the leaf. Larger, older leaves exhibited larger lesions.

**Isolation and identification of the pathogen.** Single-spore isolations were made from pycnidia embedded in naturally infected necrotic leaf margins that had been incubated for 24 h in a moist chamber. Colonies of a *Stagonospora* sp. grew from 85% of the excised, green symptomatic *Miscanthus* leaf pieces. Pure cultures were obtained from hyphae growing from lesion margins on green leaf pieces incubated 24 h. Pycnidia formed on OA in which conidia were produced, both of which were similar morphologically to those found on diseased tissue. Single spore cultures were obtained from *M. s. var. variegatus*, and isolate N194 was used for studies of pathogenicity.

Pseudothecia were observed on naturally infected *Miscanthus* tissue obtained later in the season (October to November 1993 to 1995). Single ascospore isolates were obtained by recovering ascospores dropped from leaves onto an agar surface. Mature pseudothecia and ascospores were produced on both live and autoclaved sugarcane and *Miscanthus* leaves but did not form in culture on PDA or OA. The morphology of the teleomorph was similar to *L. taiwanensis* from the type herbarium specimen (Figs. 2 and 3).

**Cultural characteristics, morphology, and growth rate.** Mature pycnidia followed by pseudothecia were produced on both autoclaved and living, detached sugarcane leaf sections inoculated with either single conidial or single ascospore isolates of the *Miscanthus* fungus. Cultures derived from either single spore state produced both anamorphic and teleomorphic states, indicating that the mycelium of the *Miscanthus* fungus is homothallic and associating both states with the disease. Ascospores and conidia produced from these inoculations were morphologically identical to those produced on naturally infected *Miscanthus* leaves.

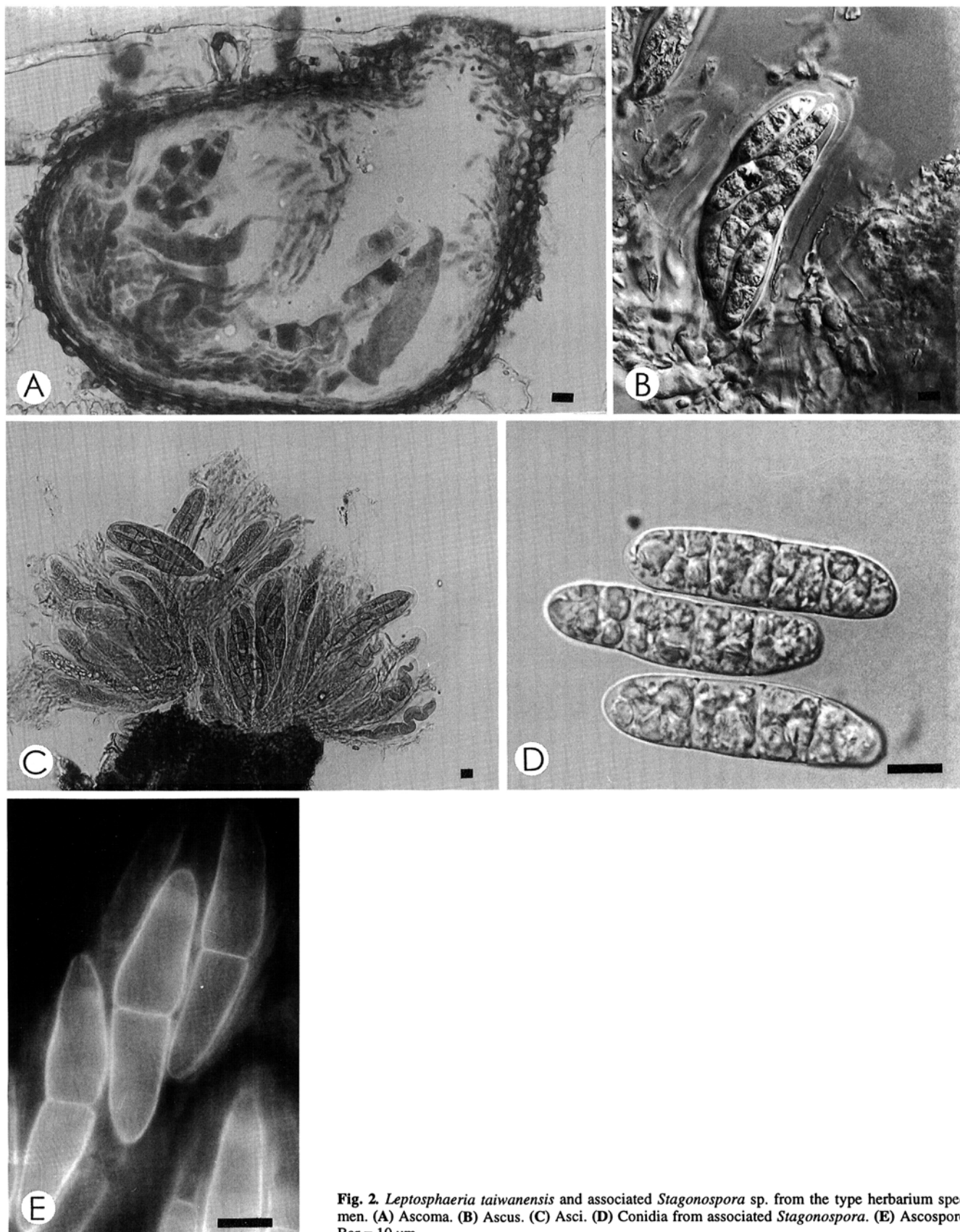
The cultural characteristics of single conidia and single ascospore colonies produced on artificial media were similar. Abundant grayish white mycelia were produced on both OA and PDA. Both fungi



produced pycnidia and conidia within 7 days on OA. Pseudothecia were not produced on PDA, OA, sugarcane leaf decoction agar, or *Miscanthus* leaf decoction agar. When autoclaved sugarcane leaves

were inoculated with isolate N194 from *Miscanthus*, immature pycnidia were observed within 10 days. Mature conidia were present after 13 days. Immature perithecia were present 16 days after in-

oculation and bore mature ascospores by 21 days. *S. taiwanensis* produced pycnidia within 10 days, but pseudothecia rarely formed and were observed only after 32 days.



**Fig. 2.** *Leptosphaeria taiwanensis* and associated *Stagonospora* sp. from the type herbarium specimen. (A) Ascoma. (B) Ascus. (C) Asci. (D) Conidia from associated *Stagonospora*. (E) Ascospores. Bar = 10 μm.

Ascospores of the *Miscanthus* fungus typically germinated from all four sections of the spore, and frequently two germ tubes were produced from one section. One of the larger, middle-cell sections became light brown upon germination, and the emerging germ tube was also light brown. Conidia germinated from a swollen, brown middle cell, immediately producing a dark brown appressorium.

The growth rates of four *Miscanthus* isolates were similar. *S. tainanensis* (38204) from sugarcane and *Stagonospora* sp. isolate N194 from *Miscanthus* grew more rapidly on OA than PDA, reaching colony diameters of 85 mm on OA by 10 days. Isolate N194 grew more slowly on PDA than did *S. tainanensis*. Both isolates produced pycnidia on OA. Pycnidia were arranged in concentric rings, corresponding

to the 12-h diurnal light cycle. Growth on PDA was slower, and fewer pycnidia were produced. Variations in cultural morphology among causal agents of sugarcane leaf blight have been reported (14). The pycnidia produced by isolate N194 appeared either submerged or just below the agar surface and were irregularly shaped with multiple ostioles. Pycnidia produced by isolate 38204 were more regularly

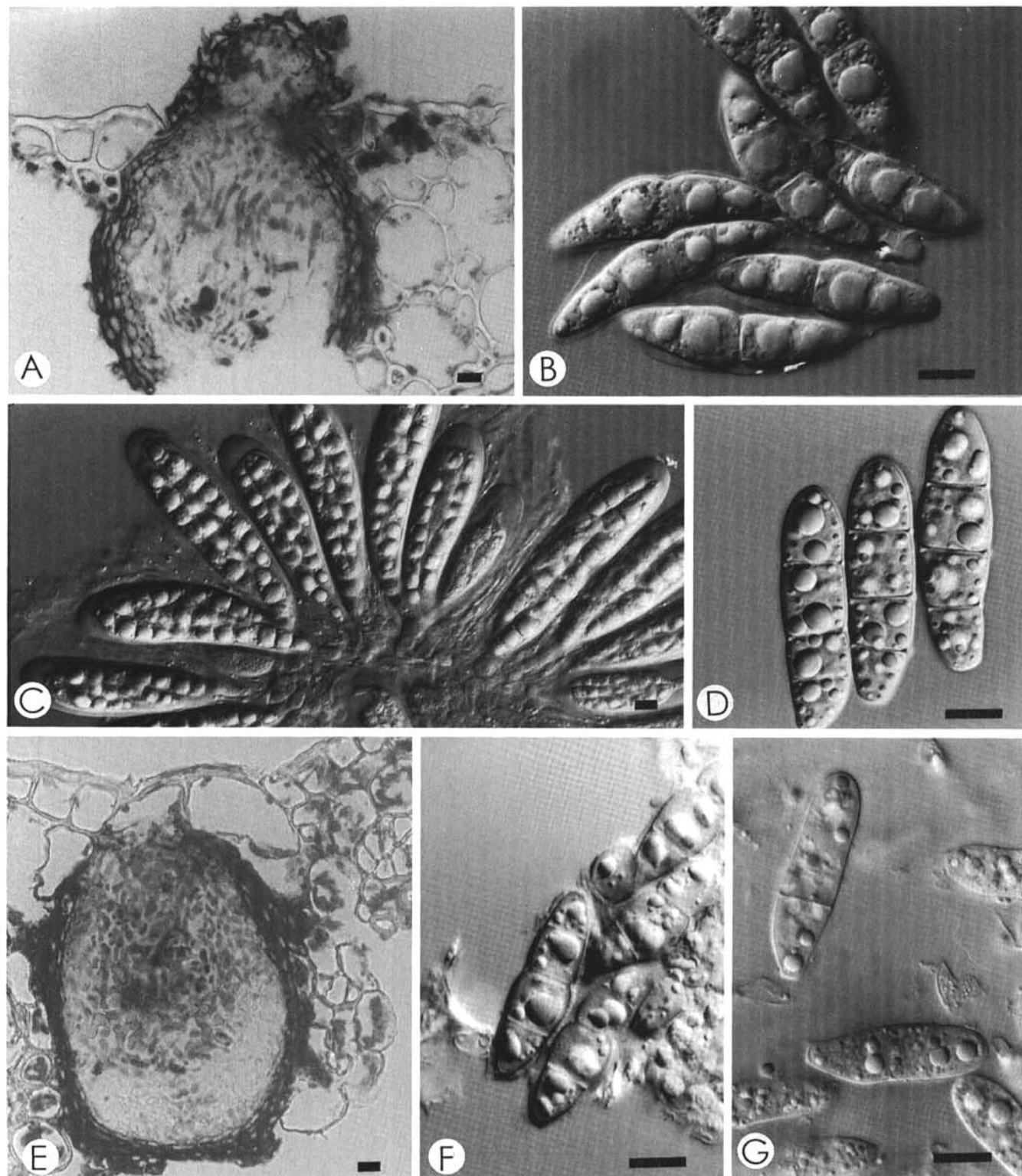


Fig. 3. *Leptosphaeria* from *Miscanthus*. (A) Ascoma. (B) Ascospores. (C) Asci. (D) Conidia. *Stagonospora tainanensis*. (E) Ascoma. (F) Ascospores. (G) Conidia. Bar = 10 µm.

shaped and produced elongated ostioles.

The dimensions of conidia from isolates N194 and 38204 were determined and compared several times during this study. Conidia of each isolate were examined from each inoculum preparation, from pycnidia recovered from live or autoclaved cultivars of either sugarcane or *Miscanthus*, and from cultures derived from re-inoculations of inoculated tissues. In all cases, conidial dimensions of the *Miscanthus* fungus were distinguishable from isolate 38204, and from other *Stagonospora* species examined or reported on sugarcane or *Miscanthus*, by their shape or consistently larger size (Table 1).

**Pathogenicity.** *S. tainanensis* from sugarcane and *Stagonospora* sp. from *Miscanthus* were both highly pathogenic to sugarcane and *Miscanthus* (Table 2, Fig. 1C to F). Symptoms were similar in whole plant and detached-leaf inoculations. Small water-soaked necrotic lesions were visible on sugarcane lines and *Miscanthus* varieties within 48 h of inoculation. The lesions expanded rapidly and became spindle-shaped, similar to those reported for sugarcane leaf blight (15).

All *Miscanthus* varieties exhibited severe leaf symptoms from inoculations with isolates N194 and 38204. Symptoms on *Miscanthus* varieties were similar to those on naturally infected plants (Fig. 1A, E, and F). *M. s. var. variegatus* lesions were more reddish brown with no chlorotic ha-

**Table 1.** Comparisons of fungi similar to the fungus isolated from *Miscanthus*

	Ascospores				Conidia size
	Size <sup>a</sup>	Septation	Color	Arrangement	
<i>Leptosphaeria taiwanensis</i>					
Type description	39-46 × 11.5-12.5	3	Brown to chestnut brown	Multiseriate	
Shoemaker & Babcock	44-56 × 11-13	1	Hyaline	Multiseriate	
<i>Stagonospora tainanensis</i>					
Type description					28-40 × 11.6-16
From illustration	26 × 7.7	3	Brown	Biseriate	21-29 × 7
Our observations of type culture	26-39 × 8-12	3	Brown	Multiseriate	25-33 × 8-12
<i>Miscanthus</i> fungus	40-46 × 11-12	3	Brown	Multiseriate	35-48 × 12-16

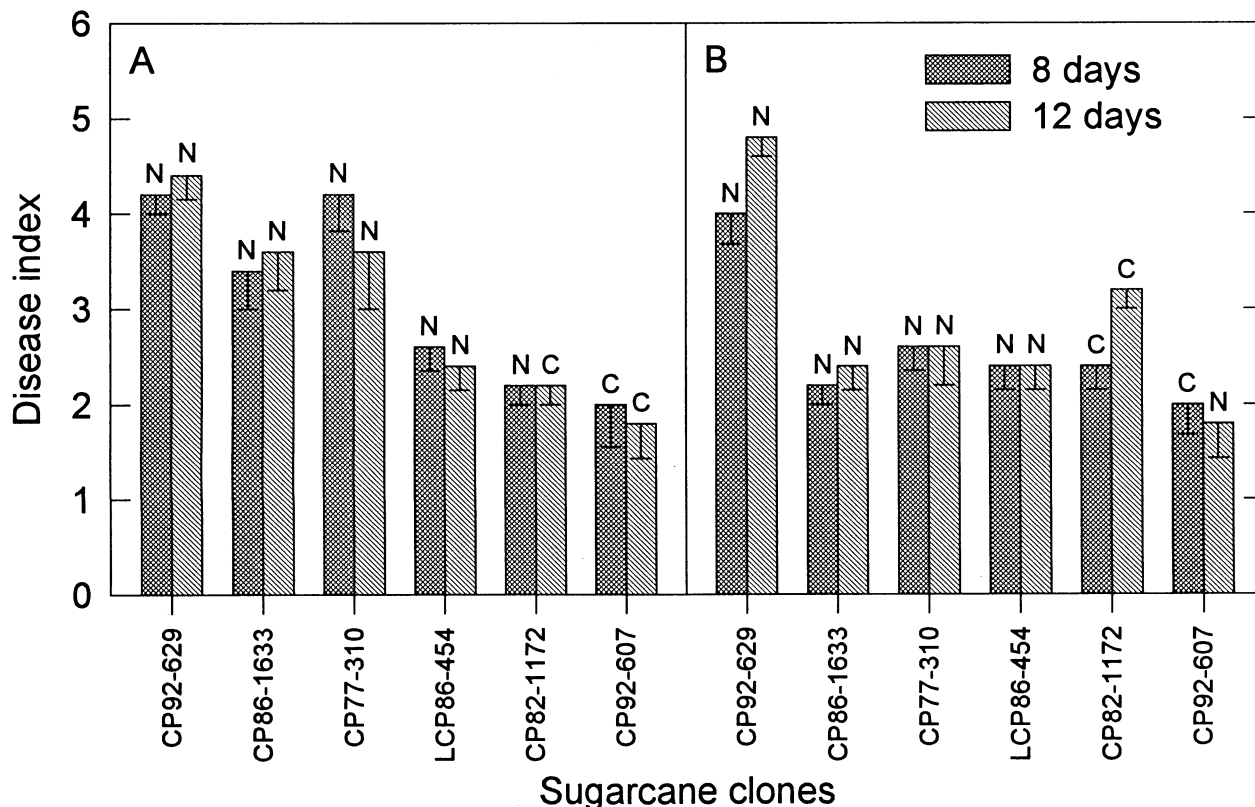
<sup>a</sup> All measurements are in µm.

**Table 2.** Evaluation of *Miscanthus* varieties for susceptibility to *Miscanthus* blight caused by inoculations with conidia of *Stagonospora tainanensis* isolate ATCC 38204 from sugarcane and *Stagonospora* sp. isolate N194 from *Miscanthus sinensis* var. *variegatus*

<i>Miscanthus</i> cultivar	Disease severity <sup>a</sup>			
	<i>S. tainanensis</i>		<i>Stagonospora</i> sp.	
	8 days	12 days	8 days	12 days
<i>M. s. var. gracillimus</i>	5.2 a <sup>b</sup>	5.3 a	5.1 a	5.1 a
<i>M. s. var. zebrinus</i>	3.7 b	3.9 b	3.6 b	3.6 b
<i>M. s. var. variegatus</i>	2.7 c	2.9 c	2.8 c	3.1 bc

<sup>a</sup> Mean percent leaf area affected based on assessment of 20 leaves per replicate 8 and 12 days after inoculation. Rating scale: 0 = no symptoms, 1 = 0 to 6%, 2 = 6 to 12%, 3 = 12 to 25%, 4 = 25 to 50%, 5 = 50 to 75% of the leaf area damaged.

<sup>b</sup> Values followed by the same letter are not significantly different ( $P = 0.05$ ) according to Duncan's multiple range test.



**Fig. 4.** Disease rating of sugarcane clones for reaction to infection caused by (A) *Stagonospora tainanensis* isolate ATCC 38204 and (B) *Stagonospora* sp. isolate N194 from *Miscanthus*, 8 and 12 days after inoculation. N indicates that symptoms were necrotic spots. C indicates that symptoms were necrotic spots associated with chlorosis. Rating scale: 0 = no symptoms, 1 = 0 to 6%, 2 = 6 to 12%, 3 = 12 to 25%, 4 = 25 to 50%, 5 = 50 to 75% of the leaf area damaged. Vertical lines represent standard errors of the mean.

los. *M. s. var. gracillimus* exhibited extensive discoloration, including a reddish brown midvein. Lesion length varied from 0.2 to 1 mm, covering more than 50% of the foliage with lesions. Severe symptoms were apparent by 8 days, with little disease progression evident from ratings taken from 8 to 12 days (Fig. 4). Tissue excised from these leaves and placed in a moist chamber produced immature pycnidia within 48 h. The symptoms on sugarcane clones caused by the *S. tainanensis* and the *Miscanthus* isolate were similar (Fig. 1C and D).

The virulence of the *Miscanthus* isolate and *S. tainanensis* on six sugarcane clones was similar (Fig. 4). The clones tested varied from very susceptible to moderately susceptible to each isolate. Lines CP92-

1172 and CP92-607 exhibited marked chlorosis associated with necrotic lesions, which were generally smaller than lesions produced on the other four clones (Fig 1G and Fig. 4). Sugarcane clone CP92-629 was most susceptible to both isolates. The least susceptible clone to both isolates was CP92-607.

Individual lesion dimensions on sugarcane clones ranged from 0.2 to 2.0 mm. By 4 days after inoculation, lower leaves of some lines were uniformly chlorotic (Fig. 5). This chlorosis progressed rapidly over 8 days, resulting in death of the entire leaf, and was not associated with coalescing lesions. Pycnidia with mature conidia and pseudothecia with mature ascospores were recovered from sugarcane leaves inoculated with either isolate, and morphological characteristics of these fungi were similar to the original isolates.

## DISCUSSION

Several species of *Stagonospora* and *Leptosphaeria* have been reported from sugarcane (1,3,4,13,14). Based on symptomatology and morphological characteristics (12,13), the species of *Leptosphaeria* isolated from *Miscanthus* is most similar to *L. taiwanensis*, which is reported to cause a leaf blight of sugarcane (10,16,17). *S. tainanensis* has been reported to be the anamorph of *L. taiwanensis* (2).

There are no reports of a leaf blight or leaf scorch disease on sugarcane or *Miscanthus* in the United States, and it is thus important that the identification of the *Miscanthus* fungus be well supported. In attempting to identify the *Miscanthus* fungus, two major problems were encountered: disagreement over the morphological characters of the type specimen of *S. tainanensis* and doubt about the relationship of *S. tainanensis* to *L. taiwanensis* (Table 1).

The original description of *L. taiwanensis* (16) and the accompanying illustrations described a fungus with multiseriate ascospores that were brownish when immature and dark brown when mature, 3-septate, and measured 39 to 46 × 11.5 to 12.5 μm. Similar characteristics were reported by Sivanesan and Waller (13) in their review of sugarcane diseases. In contrast, Shoemaker and Babcock (11), after examining the type of material of *L. taiwanensis* (BPI 621856), transferred it to the genus *Didymella* as *D. taiwanensis* (Yen & Chi) Shoemaker & Babcock. This decision was based primarily on the morphology of the ascospores, which they considered to be 1-septate, although at times appearing 3-septate from the separation of protoplasts. The ascospores were 44 to 56 × 11 to 13 μm and hyaline. In our observation of the type of *L. taiwanensis*, we were unable to find any discharged ascospores. Ascospores still in the ascus were always 1-septate (Fig. 2E), although as reported by Shoemaker and Babcock (11), they may appear to be 3-septate (Fig. 2B). The ar-

rangement of the ascospores in the ascus was multiseriate (Fig. 2C). The ascospores were hyaline. The differences in septation and color of the ascospores reported by Yen and Chi (16) and our observations and those of Shoemaker and Babcock (11) could be related to the maturity of the ascospores. However, the size difference suggests that this is not the case. The type collection also had abundant pycnidia of a *Stagonospora* with conidia (Fig. 2D) similar to those of the *Miscanthus* fungus.

Several papers have dealt with the supposed anamorph of *L. taiwanensis*. In the original description by Yen and Chi (16), the anamorph was identified as *Cercospora taiwanensis* Mat. & Yam. Knowledge of the anamorphs of *Leptosphaeria* suggest that the occurrence of a *Cercospora* anamorph is unexpected. This concept of *Leptosphaeria taiwanensis* with a *Cercospora* anamorph was promulgated in various papers dealing with sugarcane diseases (15).

In 1979, Hsieh (2) reported that the anamorph of *L. taiwanensis* was a species of *Stagonospora*. He isolated two types of cultures from diseased sugarcane tissue. Ninety-five percent of the isolates produced "large and loose" colonies in which the *Leptosphaeria* stage was produced, while the remainder were "small and compact" and produced *Cercospora* conidia. Healthy sugarcane leaves were sprayed with conidial suspensions from the *Cercospora* isolates and ascospore suspensions from the *Leptosphaeria* isolates. None of the leaves sprayed with conidial suspensions developed disease symptoms, whereas the leaves sprayed with the ascospores developed blight symptoms similar to those occurring in nature. Hsieh concluded that the *Cercospora* had no relation to *L. taiwanensis*. The *Leptosphaeria* isolates produced a *Stagonospora* anamorph described as *S. tainanensis* (2).

Hsieh illustrated the teleomorph of *S. tainanensis*, which he identified as *L. taiwanensis*, but provided no written description. Shoemaker and Babcock (11) noted some discrepancies between Hsieh's illustrations and their observation of the type of *L. taiwanensis*. The illustrations of Hsieh (2) show ascospores that are overlapping biseriata, brown, and 3-septate, whereas the ascospores of the type material examined by Shoemaker and Babcock (11) were multiseriate, hyaline, and 1-septate. These illustrations of Hsieh (2) also suggest that the ascospores are shorter and the asci longer and narrower than those seen by Shoemaker and Babcock (11).

The type herbarium specimen of *S. tainanensis* was not located. However, Hsieh did deposit a culture with the American Type Culture Collection. On inoculated sugarcane, the conidia of this isolate were hyaline, 1 to 3 septate, 25 to 33 × 9 to 12 μm, and guttulate (Fig. 3G). The ascospores were brown, 1 to 3 septate, and 29

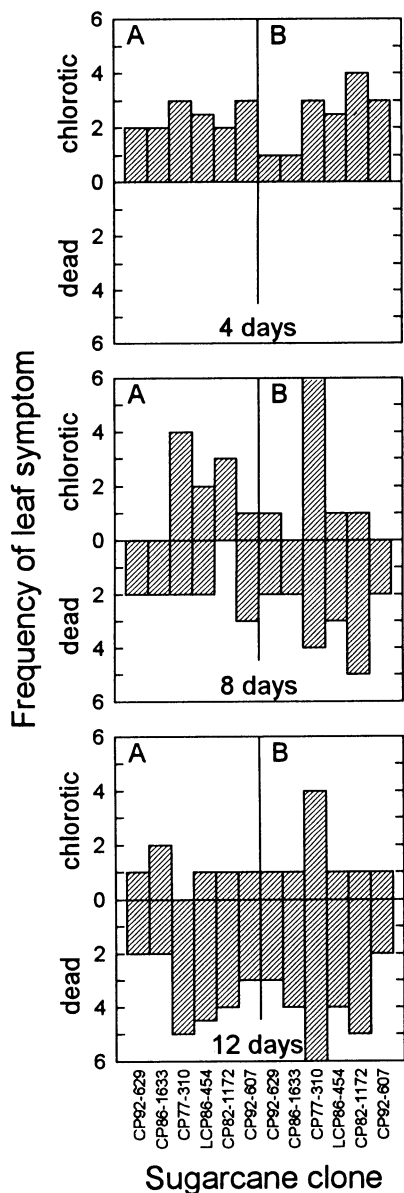


Fig. 5. Incidence of leaves of sugarcane lines exhibiting more than 50% leaf area chlorotic or dead 4, 8, and 12 days after inoculation with (A) conidia of *Stagonospora tainanensis* isolate ATCC 38204 or (B) *Stagonospora* sp. isolate N194.

to  $39 \times 8$  to  $12 \mu\text{m}$  (Fig. 3F). Thus, the teleomorph of *S. tainanensis* does not agree with the concept of *L. taiwanensis* proposed by Shoemaker and Babcock (11). The teleomorph is similar, with the exception of ascospore size, to the written description of *L. taiwanensis* by Yen and Chi. The ascospores from sugarcane inoculated with the ATTC isolate were smaller than those reported by Yen and Chi for *L. taiwanensis*, 29 to  $39 \mu\text{m}$  versus 39 to  $46 \mu\text{m}$ .

In comparing the inoculated sugarcane material of *S. tainanensis* with the *Miscanthus* fungus, the primary differences are in the sizes of the ascospores and conidia. We also found the conidia to be somewhat narrower than reported by Hsieh, (8 to  $12 \mu\text{m}$  versus 11 to  $16 \mu\text{m}$ ) and shorter (25 to  $33 \mu\text{m}$  versus 28 to  $40 \mu\text{m}$ ). The inoculation studies also demonstrated that *S. tainanensis* and the *Miscanthus* fungus can infect both *Miscanthus* and sugarcane. The ability to grow on both of these hosts is not unexpected since they are closely related genera classified in the *Andropogoneae* tribe of the *Poaceae*. Indeed, one sugarcane pathogen, *S. sacchari*, which causes a leaf scorch of sugarcane, has been reported to be a pathogen of *Miscanthus* (8). Based on symptomatology, host range, and morphology, the *Miscanthus* fungus and *S. tainanensis* are closely related. The differences in dimensions of ascospores and conidia indicate that they should be considered distinct taxa.

In conclusion, there are three fungi that apparently cause leaf blight of sugarcane: *L. taiwanensis*, *S. tainanensis*, and the *Leptosphaeria* we isolated from *Miscan-*

*thus*. The contention of Hsieh that *S. tainanensis* is the anamorph of *L. taiwanensis* is not supported by our observations and those of Shoemaker and Babcock (11). The *Leptosphaeria* on *Miscanthus* is similar to the description of *L. taiwanensis* by Yen and Chi (16). However, observations of the type material of this fungus by us and by Shoemaker and Babcock (11) revealed morphological features that do not match the written description. The true nature of *L. taiwanensis* is thus unknown, making comparison with the *Miscanthus* fungus impossible. To clarify this situation, additional collections of the common leaf blight fungus on sugarcane in Taiwan are needed. Further investigations are also needed to determine if the *Miscanthus* pathogen is present or could survive in sugarcane-growing areas of the United States, and whether the major commercial cultivars have resistance to this disease and to sugarcane leaf blight.

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