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Host Range of *Itersonilia perplexans* and Management of *Itersonilia* Petal Blight of China Aster

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Abstract

Isolates of *Itersonilia perplexans* were tested for pathogenicity on 14 different plant species. Isolates from China aster and sunflower were each pathogenic to the other host and both isolates were pathogenic to chrysanthemum and gerbera, causing moderate to high incidences of flower or seedling blight in these hosts. China aster and sunflower isolates were not pathogenic to burdock, but an isolate from burdock was pathogenic to florists' chrysanthemum and gerbera. In a survey of weed species near a cut-flower production facility in southwest Florida, *I. perplexans* was found in only one weed species, *Emilia fosbergii*. However, two isolates from this weed host produced severe petal blight symptoms when inoculated onto China aster. Myclobutanil, potassium bicarbonate, and propiconazole were highly effective in reducing disease severity of petal blight in China aster, while azoxystrobin reduced disease moderately in fungicide evaluation trials.

Introduction

Itersonilia perplexans Derx is a dimorphic basidiomycete that has yeast and hyphal phases, produces ballistospores (Fig. 1) that are forcibly ejected and disseminated by air movement, and may produce chlamydospores (8,19). Morphological (presence or absence of chlamydospores) and host range variation within the fungus led some researchers to establish two additional species, *I. pyriformans* Nyland and *I. pastinacae* Channon (6,19). However, genetic and nutritional similarities, and mating compatibility among such isolates argue against taxonomic separation (3,4,24). Growth, sporulation, and infection processes of *I. perplexans* are favored by abundant rainfall, high relative humidity (> 70%), and cool temperatures (10 to 15°C) (5,12,14).

Fig. 1. Germinating ballistospores of *Itersonilia perplexans*.

Itersonilia has been detected in Australia, Austria, Canada, Great Britain, Greece, Japan, New Zealand, Netherlands, Portugal, Uruguay, and the United States (2,3,10,13,21,23,25). It causes flower blight in anemone, dahlia, florists' chrysanthemum, and globe artichoke, and various other symptoms including seedling blight, leaf spots/necrosis, and/or root cankers in dill, edible burdock, parsnip, and sunflower (2,4,7,9,11,13,18, 20,21,25,26). However, isolates exhibit some host specificity with two groups of isolates reported: those causing floral blight in chrysanthemum and other related species and those infecting dill, carrot, parsley, and parsnip (3,4,6,15).

Outbreaks of *Itersonilia* petal blight occurred at a cut-flower production site in Southwest Florida during 1997 through 1999 resulting in extensive post-harvest losses in China aster (*Callistephus chinensis* (L.) Nees) and sunflower (*Helianthus annuus*) (16,22) (Figs. 2 and 3). Because petal blight can develop between 1° and 21°C (14), post-harvest damage from *I. perplexans* may occur in cut-flowers held under refrigeration. In addition, low temperatures did not halt growth or sporulation; infected inflorescences of chrysanthemum were found after 31 days of frosts (11). Interestingly, the disease was previously detected in florists' chrysanthemum at the same production facility in 1973 (17). *Itersonilia perplexans* has been reported to survive between crops on plant debris, as well as saprophytically on many weeds and cultivated plants especially in the Asteraceae in Great Britain (11) and on many different plant families in the Netherlands (3). Singh and Milne (23) evaluated fungicides for control of chrysanthemum petal blight (involving other pathogens in addition to *I. perplexans*) in New Zealand. No recent reports have assessed fungicide efficacy in reducing disease caused by *I. perplexans*.

Fig. 2. China aster with symptoms of *Itersonilia* blight.

Fig. 3. Sunflower with symptoms of *Itersonilia* blight.

The objectives of our research were identification of potential inoculum reservoirs through weed surveys and host range studies, comparison of the pathogenicity of *I. perplexans* from multiple hosts, and evaluation of fungicides including new reduced-risk materials for control of *Itersonilia* petal blight.

Experimental Host Range of *Itersonilia perplexans*

The experimental host range of *I. perplexans* isolates from China aster (98-592), sunflower (99-1051), and edible burdock (IB9602) was tested using 14 different plant species selected primarily from the Apiaceae and Asteraceae families (Table 1). Five to six seedlings or two to six flowers were inoculated by atomizing them with a 1 ml suspension containing 1×10^4 ballistospores/ml suspension from 2- to 4-week-old fungus cultures grown on ¼-strength acidified potato dextrose agar (¼ APDA). An equal number of seedlings and flowers sprayed with water served as non-inoculated controls. Inoculated specimens and controls were enclosed in plastic bags and held at 15°C for 9 to 11 days. Following incubation, pathogenicity was recorded based on symptom incidence. Incidence on various hosts is summarized in Table 1 in categories of 0%, 0 to 30%, 30 to 60%, > 60% disease incidence. Host range tests were completed two times.

Table 1. Host range of three *Itersonilia perplexans* isolates.

Plant	Family	Pathogenicity rating		
		98-592 (China aster)	99-1051 (Sunflower)	IB9602 (Edible burdock)
<i>Alcea rosea</i> (Hollyhock), S ^x	Malvaceae	— ^y	—	—
<i>Anethum graveolens</i> (Dill), S	Apiaceae	—	—	—
<i>Arctium lappa</i> (Edible burdock), S	Asteraceae	—	—	+++
<i>Callistephus chinensis</i> (China aster), F	Asteraceae	++	++	—
<i>Chrysanthemum morifolium</i> (Florists' chrysanthemum), F	Asteraceae	+++	++	+
<i>Coriandrum sativum</i> (Parsley), S	Apiaceae	—	—	—
<i>Coriandrum sativum</i> (Cilantro), S	Apiaceae	—	—	—
<i>Cynara cardunculus</i> (Globe artichoke), S	Asteraceae	—	—	—
<i>Daucus carota</i> (Carrot), S	Apiaceae	—	—	—
<i>Daucus carota</i> (Queen Anne's Lace), S	Apiaceae	—	—	—
<i>Gerbera jamesonii</i> (Gerbera), F	Asteraceae	+++	+++	+++
<i>Helianthus annuus</i> (Sunflower), S	Asteraceae	++	++	—
<i>Lactuca sativa</i> (Lettuce), S	Asteraceae	—	—	—
<i>Pastinaca sativa</i> (Parsnip), S	Apiaceae	—	—	—
<i>Tagetes patula</i> (Fr. marigold), S	Asteraceae	—	—	—
<i>Zinnia violacea</i> (Zinnia), S	Asteraceae	—	—	—

^x S = seedling, F = detached flower

^y —, +, ++, +++ = 0%, 0 to 30%, 30 to 60%, > 60% disease incidence, respectively.

The *I. perplexans* isolates from China aster and sunflower were pathogenic to the reciprocal hosts and pathogenic to chrysanthemum and gerbera, causing moderate to high incidences of flower or seedling blight in these hosts, but were not pathogenic to burdock (Table 1). The burdock isolate caused a high incidence of seedling blight in that host, caused flower blight in chrysanthemum and gerbera at low and high incidences, respectively, but did not produce petal blight in China aster or seedling blight in sunflower. Severe petal blight symptoms in gerbera caused by *I. perplexans* are illustrated in Fig. 4.

Fig. 4. Gerbera with symptoms of *Itersonilia* blight.

Survey and Pathogenicity of *Itersonilia perplexans* from Weed Species

A survey was conducted during February and March 2000, of weeds adjacent to the cut-flower production facility in Southwest Florida with a history of severe outbreaks of *Itersonilia* petal blight. Petals from eight wild plant species exhibiting flower lesions or blighting were surface disinfested in 0.5% NaOCl for 20 s, rinsed twice in sterile deionized water for 2 min, suspended over ¼-strength APDA, and incubated at 15°C for 6 to 8 days. All weeds surveyed were negative for *I. perplexans*, except *Emilia fosbergii* (red tassel-flower) which was found to be infected at an incidence of 20% (Table 2) (Fig. 5).

Fig. 5. *Emilia fosbergii* with blight symptoms and signs of *Itersonilia perplexans*.

Table 2. Survey for *Itersonilia perplexans* in weeds at a cut-flower production site in Southwest Florida, February and March 2000.

Weed ^x	Number of plants sampled	<i>I. perplexans</i> recovery (%)
<i>Bidens bipinnata</i>	18	0
<i>Eclipta prostrate</i>	7	0
<i>Emilia fosbergii</i>	10	20
<i>Gaillardia</i> sp.	4	0
<i>Lepidium virginicum</i>	10	0
<i>Ludwigia</i> sp.	6	0
<i>Rudbeckia</i> sp.	10	0
<i>Sonchus</i> sp.	43	0

^x Flowers exhibiting petal spots, blight, or necrosis were sampled.

The pathogenicity of two *I. perplexans* isolates (E-1, E-2) recovered from the weed *E. fosbergii* was tested using detached flowers of the weed and China aster. Single isolates of the fungus from China aster (98-592) and sunflower (99-1051) were also used to inoculate flowers of *E. fosbergii* and China aster. Flower peduncles were placed in flasks containing sterile, deionized water. Flowers of *E. fosbergii* and China aster were inoculated with 0.25 and 1.0 ml, respectively, of a suspension containing 1×10^4 /ml suspension of *I. perplexans*. Flowers were enclosed in plastic bags and held at 15°C for 6 to 8 days. After incubation, flowers were examined for *Itersonilia* petal blight, and the fungus was reisolated as previously described. The pathogenicity of *I. perplexans* isolates from *E. fosbergii* were tested on China aster and *E. fosbergii* two and three times, respectively. The pathogenicity of *I. perplexans* isolates from China aster and sunflower were tested on China aster and *E. fosbergii* one and two times, respectively.

Back transmission of isolates E-1 and E-2 to *E. fosbergii* resulted in an 88.7% and 75.1% incidence of petal blight, respectively. The aster and sunflower isolates of *I. perplexans* also infected *E. fosbergii* and produced petal blight incidences of 66.0% and 68.8%, respectively. All four isolates produced severe petal blight in China aster at an incidence of 100%.

Evaluation of Fungicides for Control of Petal Blight

Fully-open flowers of China aster 'Matsumoto Blue' were cut to leave 2.5 to 5.0 mm stem segments. The stems were then immersed in sterile deionized water and placed within a moist chamber (bell jar). Enclosed flowers were maintained in a controlled environment chamber at 15°C with a 12-h photoperiod. Each treatment (fungicide) or control (water) was replicated three times using a randomized complete-block design; five flowers in each moist chamber served as a treatment replication. Fungicides evaluated included two new reduced-risk materials, Armicarb 100 (potassium bicarbonate; 4.2 lb/100 gal) and Heritage (azoxystrobin; 2.0 oz/100 gal), which were compared with two standard compounds, Systhane WSP (myclobutanil; 4 oz/100 gal) and Banner Maxx (propiconazole; 5 fl oz/100 gal). Fungicides were applied to run-off using a hand-operated hydraulic sprayer 24 h before inoculation with a 1-ml suspension of 1×10^4 ballistospores/ml of *I. perplexans* isolate 98-592 (China aster). Disease severity (flower blight percentage) was estimated 5, 7, and 9 days after inoculation, and the area under the disease (severity) progress curve (AUDPC) was calculated. Treatment means were separated using Fisher's Protected LSD following appropriate data transformation. The experiment was conducted twice.

Systhane WSP, Amicarb 100, and Banner Maxx significantly reduced *Itersonilia* petal blight severity in both experiments compared to the non-treated control (Table 3). Heritage reduced disease severity only in experiment two. All fungicides significantly reduced the progress of petal blight (AUDPC), with Systhane WSP, Amicarb 100, and Banner Maxx as the most effective.

Table 3. Effect of fungicides on *Itersonilia* petal blight in China aster 'Matsumoto Dark Blue.'

Treatment	Final disease severity (%) ^x		AUDPC	
	Experiment 1	Experiment 2	Experiment 1	Experiment 2
Control	48.6 a ^y	48.3 a	173.9 a	165.0 a
Heritage	33.3 a	20.3 b	75.8 b	65.1 b
Systhane WSP	4.6 b	5.8 c	18.6 b	20.8 c
Armcarb 100	2.6 b	2.0 d	13.0 b	9.2 c
Banner Maxx	2.7 b	1.2 d	12.0 b	5.2 c

^x Arc sine square root transformation of percentage data was performed prior to data analysis; non-transformed means are presented.

^y Means within columns followed by different letters are significantly different ($P \leq 0.001$) by Fisher's Protected LSD.

Management Implications for *Itersonilia* Petal Blight in Cut-Flower Production

Isolates of *Itersonilia perplexans* from China aster and sunflower did not infect seedlings of parsnip, dill, or other plant species but did cause disease in flowers of chrysanthemums and gerbera. This finding suggests that isolates from China aster are similar to chrysanthemum isolates in that they infect floral parts of plants in the Asteraceae but do not infect plants in the Apiaceae (dill, parsnip, etc.) (6). The isolate from sunflower was originally reported for the first time to cause post-harvest petal blight in sunflowers (22). Because these isolates can infect other hosts which may be produced in the same facility and because the fungus can survive on senescent tissue and plant debris even at low temperatures (11), the use of effective sanitation methods is critical in controlling outbreaks of petal blight.

Itersonilia perplexans was found in only one weed, *E. fosbergii*, when weeds near the production facility were surveyed. However, two isolates from *E. fosbergii* were capable of causing severe disease when inoculated onto China aster. Outbreaks of *Itersonilia* petal blight have recently occurred in chrysanthemum cut-flower production facilities in Hawaii (Jane Trollinger, *personal communication*), and it is interesting to note that *E. fosbergii* also occurs naturally in Hawaii (1). In a previous study, McGovern and Seijo (16) found that *I. perplexans* could experimentally infect *Bidens bipinnata* L., although the fungus was not found occurring naturally in this plant species around the production facility. In both studies, the surveys for infected or colonized weeds were done after the outbreak of disease. Weed control in and around production facilities may help limit initial inoculum during cut-flower production, particularly when environmental conditions are favorable for outbreaks of petal blight (cool, wet weather).

Myclobutanil Systhane WSP), potassium bicarbonate (Armcarb 100), and propiconazole (Banner Maxx) were highly effective in reducing disease severity of petal blight in China aster, while Heritage reduced disease moderately in these trials. Potassium bicarbonate (Armcarb 100) is a reduced risk fungicide which has a zero-day pre-harvest interval on many crops. These findings provide some effective disease management measures for outbreaks of *Itersonilia* petal blight.

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