Colletotrichum gloeosporioides causing anthracnose of *Lavatera* sp.

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A Colletotrichurn gloeosporioides was isolated from severe disease symptoms on *Lavatera* sp., cultivar 'Mont Blanc', planted in flower beds at Indian Head Experimental Farm in the summer of 1989. By late July the disease had killed all plants of 'Mont Blanc'. The disease was also observed on another cultivar 'Silver Cup' but to a lesser degree. Laboratory tests indicated that this fungus was similar in host range to *Colletotrichurn gloeosporioides* f. sp. *rnalvae* from round-leaved mallow. However, disease symptoms differed in that *C. gloeosporioides* from *Lavatera* sp. was most severe on leaves, whereas, *C. gloeosporioides* f. sp. *rnalvae* is a stem pathogen. Although severe on *Lavatera* sp. it did not kill weedy *Malva* species.

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Colletotrichurn gloeosporioides fut isolé de l'espece *Lavatera* un cultivar « Mont Blanc » présentant des symptbmes d'infection severes. Ce cultivar a ete produit dans des plate-bandes a la ferme experimentale d'Indian Head durant l'ete 1989. À la fin juillet, la maladie a détruit tous les plants « Mont Blanc ». La maladie fut observee aussi sur un autre cultivar, le « Silver Cup », mais a un degre plusfaible. Les tests en laboratoire ont indique que ce champignon était similaire a la lignee du *Colletotrichurn gloeosporioides* f. *sp. malvae* de la mauve a feuilles rondes. Quoi qu'il en soit, les symptbmes de la maladie se sont averes differents puisque ceux-ci démontrèrent des symptbmes foliaires plus severes pour *C. gloesporioides* de l'espece *Lavatera* que pour *C. gloeosporioides* f. sp. *rnalvae. C. gloeosporioides* f. sp. *rnalvae* est un pathogene s'attaquant plus a la tige du plant. Bien que la maladie fut severe sur l'espece *Lavatera*, le pathogene n'a pas tue les especes *Malva.*

Introduction

Anthracnose symptoms were observed on *Lavatera* sp. cultivar 'Mont Blanc' in flower beds at Agriculture Canada, Experimental Farm, Indian Head, Saskatchewan. By late July, nearly all 'Mont Blanc' plants were killed in the flower beds. Another cultivar 'Silver Cup' was also attacked, but to a much lesser degree. A *Colletotrichumsp.* was consistently isolated from diseased plant tissue, and produced anthracnose symptoms when inoculated back on plants. The purpose of these studies was 1) to identify the species of *Colletotrichum,* 2) determine the source of the disease, 3) compare the fungus to *Colletotrichumgloeosporioides* (Penz.) Sacc. f. sp. *rnalvae* (C.g.m.) from round-leaved mallow *(Malvapusilla* Sm.) (Mortensen 1988) in terms of host range, since *Lavatera* is also a Malvaceae, and 4) determine its pathogenicity on weedy *Malva* spp. that C.g.m. does not control satisfactorily (Mortensen 1988), to see if it would be of potential as a bioherbicide.

Materials and methods

Seed of *Lavatera* sp., cultivar 'Mont Blanc' and 'Silver Cup', used for planting at Indian Head, were obtained from Jack Van Klaveren Ltd.[2], in April 1989 (Lawrence Kattler, personal communication). Additional seed of both cultivars were obtained for further testing in December 1989 from the same company. Diseased plant material of *Lavatera* 'Mont Blanc' was collected from flower beds at the Experimental Farm, Indian Head, surface sterilized in 0.6% sodium hypochlorite (10% Javex® solution) for 1 min, rinsed in sterile water and plated out on potato dextrose agar (PDA) and on moist filter paper in a petri dish. Infected material plated out was incubated For 6 to 8 days at 24°C during a 12 h light cycle of fluorescent light (28 μMol.m^{-2}.s^{-1}) and 20°C for 12 h in the dark. Developing fungi were isolated and single spore cultures were increased on PDA, and inoculated on *Lavatera* plants to confirm pathogenicity.

To check if *C. gloeosporioides* was seed-borne, seed of *Lavatera* cultivar 'Mont Blanc' and 'Silver Cup' were planted in metal flats (28 cm by 50 cm) in a soil mixture (3:2:1 (v/v) autoclaved soil:peat moss:vermiculite), and grown on greenhouse benches at 23±4°C during a 16 h day extended with fluorescent and incandescent light (280 μMol.m^{-2}.s^{-1}). Isolations were made from diseased seedlings in these flats. Seed in one flat was surface sterilized in a 20% Javex® solution for 3 min and rinsed in sterile water for 3 rnin, seed in another flat was rinsed in sterile water for 6 min before planting. The experiment consisted of 50 seeds per flat; 2 flats with surface sterilized seed and 2 flats with seed only rinsed in water each of 'Mont Blanc' and 'Silver Cup' (100 seeds per cultivar per treatment).

Test plants for the host range study (Table 3) were planted in 15-cm pots in a soil mixture as above and grown in growth chambers with a 16 h day at 24±0.5°C and a light intensity of 280 μMol.m^{-2}.s^{-1} from fluorescent and incandescent light and an 8 h dark period at 20±0.5°C. Seed for

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Table 1. Severity of disease symptoms on ***Lavatera*** sp. inoculated with ***Colletotrichum gloeosporioides.***

		Disease rating *			
		after 7 days		after 14 days	
Cultivar	No. of plants	leaves	petioles	leaves	petioles
'Silver Cup'	23	5.7 (3–8)**	3.2 (1–5)	8.7 (7–9)	8.4 (6–9)
'Mont Blanc'	25	4.4 (3–6)	2.0 (0–5)	7.3 (5–9)	6.6 (1–9)

* Scale (0–9): 0 = no symptoms and 9 = > 90% of plant material wilted.
** Average disease rating of 9 replications in 4 trials; range of disease ratings in brackets.

test plants were obtained from commercial seed sources where possible. The test plants were inoculated in the 4- to 6-leaf stage (3-wk-old plants) by spraying a spore suspension (concentration about 4 x 10^6 spores/ml) until runoff, using an airbrush. Inoculated plants were incubated in a dew chamber for 24 h in the dark at 18±1°C, then returned to the growth chamber. Disease severity was estimated visually at both seven and 14 days after inoculation using a scale from 0-9, where 0=immune and 9=causing more than 90% of plant material to wilt (Mortensen 1988). Host range tests were repeated once for species in the Malvaceae, and the disease rating in Table 3 is given as an average of both trials 14 days after inoculation.

Results and discussion

The *Colletotrichum* sp. isolated from diseased plant material of Lavatera cv. 'Mont Blanc' was pathogenic on both cultivars, 'Mont Blanc' and 'Silver Cup'. The symptoms were irregular necrotic lesions especially on the leaves (Fig. 1), but lesions were also observed on the leaf petioles and stems. Seven days after inoculation disease ratings were higher on leaves than on petioles, but after 14 days lesions on petioles and stems had also developed so the differences in ratings became less and about 75 to 80% of the plants were killed (Table 1). This Colletotrichum sp. was different from C.g.m. (Mortensen 1988), in culture on PDA it produced slightly more aerial mycelium and did not sporulate as readily as C.g.m. A culture of this Colletotrichum sp. was submitted to Biosystematics Research Institute, Agriculture Canada, Ottawa, and identified as *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc. in Penz. "species group" (Daom No. 211155).

C. gloeosporioides has not previously been reported from Lavateraspp. (Conners 1967, Farr etal. 1989, Ginns 1986, and Sutton 1980). Thus, this is the first record of C. *gloeosporioides* causing anthracnose of Lavatera spp. in North America.

Out of the non-surface sterilized seeds of 'Mont Blanc' planted in flats, 86% produced seedlings. Of the 34 showing seedling blight, C. *gloeosporioides* was isolated from 15. Out of non-surface sterilized seeds of 'Silver Cup', 51% produced seedlings. Of the 5 showing seedling blight, *C. gloeosporioides* was isolated from one (Table 2). This indicates that C. *gloeosporioides* is seed-borne, and the anthracnose disease in the flower beds at Indian Head originated from infected seeds. The very low infection level of 'Silver Cup' agrees with the low incidence of the disease observed on 'Silver Cup' plants in the flower beds (Lawrence Kattler, personal communication). The number of diseased seedlings was reduced considerably from surface sterilized seeds, and C. *gloeosporioides* was not isolated from surface sterilized seeds (Table 2). This indicates that *C. gloeosporioides* can be eliminated by surface sterilizing seeds. However, the 20% Javex® solution had some detrimental effect on germination, especially of the cultivar 'Mont Blanc', where emergence were reduced from 86% to 72%. Therefore, a fungicide seed treatment might be a better solution.

Table 2. The number of emerged seedlings and seedlings with disease symptoms caused by ***Colletotrichum gloeosporioides*** of ***Lavatera*** sp. planted from seeds under greenhouse conditions.

		Seedlings emerged **	Number of seedlings with	
Cultivar	Treatment *	%	symptoms	***C. gloeosporioides***
'Mont Blanc'	SD	72	7	0
	NSD	86	34	15
'Silver Cup'	SD	52	2	0
	NSD	51	5	1

* SD = surface sterilized and NSD = non-surface sterilized.
** Total of 100 seeds per treatment per cultivar.

Table 3. Pathogenicity of *Colletotrichum gloeosporioides* on selected plant species.

Species	No. of plants	Disease rating*	
		leaves	stems
Malvaceae:			
Round-leaved mallow (*Malva pusilla* Sm.)	72	4.3	2.0
Small-flowered mallow (*M. parviflora* L.)	40	3.4	1.0
Common mallow (*M. neglecta* Wallr.)	58	3.2	0
Musk mallow (*M. moschata* L.)	25	3.2	3.4
M. alcea L. var. *fastigiata* (Cav.) C. Koch.	42	3.0	3.0
Hollyhock (*Althea rosea* (L.) Cav.)			
cv. 'Pinefore mixed'	2	2.0	0
cv. 'Charter's double mixed'	25	**3.5**	1.3
cv. 'Summer Carnival'	23	3.0	0
Prickly sida (*Sida spinosa* L.)	41	0.1	0
Spurred anoda (*Anoda cristata* (L.) Schlecht)	1	0	0
Velvetleaf (*Abutilon theophrasti* Medic.)	68	0.8	***0.5***
Scarlet mallow (*Malvastrum coccineum* (Purch) A. Gray)	9	0	**0**
Cotton (Gossypium *hirsutum* L.)			
cv. 'Stoneville 213'	**40**	0.3	**0**
cv. 'Pima S-5'	48	0.7	**0**
Flower-of-an-hour (*Hibiscus trionum* L.)	46	0.3**	**0**
Rose mallow (*Hibiscus* sp.)			
cv. 'Dixie Belle'	6	**0**	**0**
cv. 'Disco Belle'	20	**0**	**0**
cv. 'Southern Belle'	27	**0**	**0**
cv. 'Mallow Marvels'	2	**0**	**0**
Okra (*Abelmoschus esculentus* (L.) Moench.			
cv. 'Perkin's Mammoth Longpod'	18	0.6	**0**
cv. 'Blondy'	21	**0**	**0**
Non Malvaceae:			
Safflower (*Carthamus tinctorius* L.)			
cv. 'Girard'	13	1.3	1.0
cv. 'S208'	21	1.7	1.3
Cocklebur (*Xanthium strumarium* L	11	0.3	0
Purslane (*Portulaca oleracea* L.)	80	**0**	0
Field bindweed (*Convolvulus arvensis* L.)	10	**0**	0

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Table 3 continued.

Sugar beet (*Beta vulgaris* L.)			
cv. 'Betaseed 2644'	20	0.3	0
cv. 'Hilleshoeg Mono 1254'	27	0	0
Lentil (*Lens culinaris* Medic.)			
cv. 'Indian Head'	26	0	0
cv. 'Laird'	28	0	0
Flax (*Linum usitatissimum* L.)			
cv. 'Noralta'	23	0	0
cv. 'Vimy'	24	0	0
Wheat (*Triticum aestivum* L.)			
cv. 'Katepwa'	26	0	0
cv. 'HY320'	26	0	0

* Scale (0–9): 0 = no symptoms and 9 = > 90% of plant material wilted. Average disease rating of at least 2 trials.
** Cotyledons only.

The host range of *C.* gloeosporioides from Lavatera sp. in Table 3 is similar to that of C.g.m. from round-leaved mallow (Mortensen 1988). Only species in the Malvaceae became seriously infected. Some infection occurred on safflower, which also was the case for C.g.m. The symptoms of irregular necrotic lesions on the leaves, with less attack on the leaf petioles (Fig. 1), is different from C.g.m. which is primarily a stem pathogen, producing few leaf lesions (Mortensen 1988). Lavatera plants, cv. 'Silver Cup' inoculated with C.g.m. resulted in severe infections and plants were killed after eight days. The infections from *C.* gloeosporioides were most severe on the two Lavatera cultivars, resulting in almost total kill of the plants two weeks after inoculation.

Leaf lesions similar to those shown in Fig. 1 occurred on the three weedy Malva spp. (round-leaved mallow, common mallow, and small-flowered mallow) but not severe, with only a disease rating of 3 to 4 (Table 3). Some stem lesions occurred on all three Malva spp. but the lesions did not develop further and the plants outgrew them.

In conclusion, the two strains of C. gloeosporioides have similar host ranges on plant species in the Malvaceae, but they cause somewhat different disease symptoms; C.g.m. is mainly a stem pathogen, whereas C. gloeosporioides from Lavatera is mainly a leaf pathogen. The pathogenicity of C. gloeosporioides on weedy Malva spp. was not sufficient to warrant further studies on this fungus as a bioherbicide, because C.g.m. is more efficient on all three Malva spp. than what was found for *C.* gloeosporioides from Lavatera.

Fig. 1. Seedling of *Lavatera* sp. 'Mont Blanc' inoculated with a spore suspension of C. *gloeosporioides* under controlled conditions. Photograph showing healthy leaf in the center compared with typical leaf symptoms on either side 14 days after inoculation.

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