Distribution and severity of Stewart's bacterial wilt of dent corn in Ontario, 1985

T.R. Anderson and R.I. Buzzell

Stewart's bacterial wilt was observed on dent corn in seven counties in 1985. Disease severity ranged from severe to minor in Ontario Corn Performance Tests in Essex and Wellington counties, respectively. Symptoms were limited to late season, foliar infections. The majority of hybrids in the Performance Test at Malden were considered to be susceptible. Isolates of the pathogen differed in virulence following inoculation of seedlings in the greenhouse.

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En 1985, l'on a observe la flétrissure bactérienne de Stewart sur le maïs a grains dentés dans sept comtés. La sévérité de la maladie variait de sévère à secondaire dans les tests ontariens de performance du maïs, dans les comtés de l'Essex et de Wellington, respectivement. Les symptômes ont été limités a des infections foliaires de fin de saison. La majorité des hybrides du test de performance à Malden ont été classes comme susceptibles. Les isolats du pathogene ont démontré une virulence variable au cours d'inoculation de plantules en serre.

Introduction

Stewart's bacterial wilt of corn (*Zea mays* L.) caused by *Erwinia stewartii* (Smith) Dye was first reported at several locations in Ontario in 1932. The disease was severe on sweet corn and was observed on dent corn in Essex, Kent and Norfolk counties (2). Stewart's bacterial wilt has apparently caused little or no damage to dent corn in Ontario since it was first reported. The disease was reported on sweet corn in Essex and Kent counties in 1953 (4). In 1985, Stewart's bacterial wilt was the most common disease on dent corn in the Ontario Corn Performance Tests (OPT) in Essex County and it was observed in the cooler areas of the province (1).

The disease can be transmitted on infected seed but the most important means of dissemination and overwintering is considered to be the corn flea beetle (*Chaetonema pulicularia* Melch) (6). A forecasting system has been developed in the United States that successfully predicts wilt severity on dent and sweet corn (3). Average monthly temperatures in December, January and February are summed to determine a winter temperature index (WTI). A low WTI indicates reduced winter survival of the beetle vector. This system has not been evaluated under Ontario conditions.

The following report describes the symptoms, distribution and severity of the disease in southwestern Ontario in 1985.

Material and methods

Isolation and identification of the pathogen: Corn leaves with symptoms of Stewart's bacterial wilt were collected at several locations in southwestern Ontario. Leaves were surface disinfested by swabbing both surfaces with 70% ethyl alcohol. Sections of tissue with water-soaked elongate lesions were placed in sterile distilled water for 15-30 minutes. A loop of the resultant suspension was streaked on nutrient agar (NA) (Difco). Plates were incubated at 28°C for 4 days. Individual colonies were transferred to yeast-dextrose-calcium carbonate medium (YDC) for storage. Two dent cultivars (3707 and 3780A from Pioneer Hi-Bred Ltd.) and a sweet corn cultivar (Golden Cross Bantam) were used in greenhouse pathogenicity trials. The method of inoculation described by Lockwood *et al.* (5) was modified in this study. Inoculum of each isolate tested for pathogenicity was increased in nutrient broth in shake culture for 48 h at 28°C. Culture solutions were diluted by 50% prior to use as inoculum and contained 1×10^7 to 1×10^8 viable cells/ml. The shoots of 10 day old plants were excised 5 mm above the epicotyl and inoculum was applied to the cut surface with a sponge or pipette. Five seedlings were inoculated per treatment in each replicate. Treatments were replicated four times. Observations of symptom development were made 7 and 10 days after inoculation. Tests were conducted twice.

Four hundred seeds from each of two entries in the OPT at Malden were surface disinfested in 20% sodium hypochlorite for 5 minutes and plated on NA. Plates were incubated at 28°C for 4-5 days. Colonies of yellow bacteria were transferred to YDC agar and subsequently tested for pathogenicity on greenhouse seedlings.

Field observations: General observations on the incidence of wilt in Ontario were made during late summer and Sept. 16-17, 1985. Entries in the OPT at Malden were rated for disease severity on Sept. 20. Ratings were made on 4 replicates by observing all plants in each single row plot and assigning a value from 0 to 5 based on foliar disease severity where 0 = lesions absent, 1 = several lesions/row, 2 = 1-3 small lesions/plant, 3 = several large lesions/plant, 4 = numerous large lesions/plant, 5 = numerous lesions, leaves shredding and prematurely senescing.

Results

Stewart's bacterial wilt was first observed at the Research Station in mid-July on sweet corn planted adjacent to the dent corn breeding nursery. Elongate necrotic and chlorotic streaks with irregular margins occurred on the mid and upper leaves. Wilted or dead plants were not observed. Foliar lesions were observed on early dent inbreds approximately one week later.

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Lesions on dent corn were similar to those on sweet corn but frequently eliptical lesions ressembling northern leaf blight were present. Typical water soaked streaks were visible extending from the tips of older eliptical lesions. Lesions on a number of lines were surrounded by a red-brown margin. Foliar disease became more severe throughout the nursery during August. Some early inbreds senesced prematurely and produced small shrivelled cobs with few seeds. Infection on most late inbreds in the nursery was restricted to a few lesions on upper leaves.

Microscopic examination of infected leaf sections revealed non-motile bacteria flowing from cut veins. Yellow, gram negative bacteria were isolated from all leaves with symptoms of Stewart's bacterial wilt. Inoculation of dent and sweet corn seedlings in the greenhouse resulted in a range of symptoms from typical necrotic streaking with some isolates to general chlorosis and wilting of plants with other isolates. Average disease severity rating increased significantly ($P = 0.01$) from 2.1 to 2.8, 7 and 14 days after inoculation, respectively. In addition, average disease severity ratings of Golden Cross Bantam (2.6), 3707 (2.5) and 3708A (2.2) differed significantly ($P = 0.01$). The results of the seedling inoculation did not correspond to field ratings for 3707 (1.5) and 3780A (4.5). Isolates of *E. stewartii* from several locations differed significantly in virulence following inoculation of corn seedlings (Table 1). Rating disease severity on inoculated seedlings was difficult because of the range of symptoms produced by different isolates. Some isolates caused chlorosis of leaves emerging from the whorl and limited necrotic flecking on older leaves. In addition, symptoms varied with cultivar. Symptoms on Golden Cross Bantam and 3707 were frequently restricted to chlorosis of new tissue. Necrotic streaks were common symptoms on 3780A. A yellow bacterium was consistently reisolated from plants with symptoms of wilt.

Disease severity in Performance Tests ranged from severe on the majority of entries at Malden to absent on the majority of entries at Elora (Table 2). Severe disease was associated with a higher WTI in Essex County than in Wellington County (Table 3).

Disease severity ratings of the 72 entries in the OPT at Malden ranged from 1.1 to 5.0 (Table 4). The majority of the entries were considered to be susceptible to the disease. Entries with ratings of 4.6 to 5.0 may have sustained yield loss because of premature senescence or reduced leaf area. Entries with only a few lesions apparently possessed considerable resistance.

Entries with resistant ratings included Dekalb DK 496 (1.5), Pioneer 3707 (1.5) and Pioneer 3732 (2.0). Entries with susceptible ratings included Limagrain LG22 (4.8), Pride K4423 (4.8) and Renk RK 24 (4.8).

Incidence of *E. stewartii* in seed was related to foliar disease rating in the field. *E. stewartii* was isolated from 4/400 seeds of Pioneer 3780A that had a field rating of 4.5. The pathogen was not detected in seed of Pioneer 3707 that had a field rating of 1.5.

Discussion

Although Stewart's bacterial wilt was evident in corn trials and breeding nurseries in Essex and Kent Counties the disease did not appear to cause economic losses in commercial crops. Because most of the hybrids recommended for Essex County were rated as being susceptible in the Malden OPT, disease incidence in the area should be monitored on an annual basis. Since a large proportion on Ontario's seed corn industry is located in Essex and Kent Counties seed transmission is an important aspect of the disease. Although the possibility of disseminating the disease on seed is low (6) the pathogen was isolated from seed in this study. It it also important to eliminate the disease from breeding nurseries to allow use of winter nurseries in countries with restrictions on the importation of seed that might contain Stewart's bacterial wilt.

Table 1. Virulence of *Erwinia stewartii* isolates on corn seedlings[a] 14 days after inoculation.

Isolate	Origin	Disease rating[b]
ES85-1	Woodstock	4.2[c]
ES85-3	Woodstock	4.2
ES85-4	Woodstock	3.7
ES85-11	Elora	2.2
ES85-12	Fingal	2.2
ES85-13	Innerkip	1.8
ES85-14	Guelph	3.6
ES-2	Cottam	2.2
Check		1.0
	$LSD_{0.05}$	**0.4**

[a] Corn cultivars included sweet corn (Golden Cross Bantam) and dent corn (P3707 and P3780A).
[b] Disease rating based on scale of 1-5 where 1 = no disease, 2 = lesions on 1 of 2 inoculated leaves, 3 = lesions on both inoculated leaves, 4 = inoculated leaves wilted or dead, emerging leaves chlorotic, 5 = seedling dead.
[c] Means of 3 cultivars, 2 trials and 4 replicates with 5 seedlings per replicate.

Table 2. Distribution and severity of Stewart's bacterial wilt in 8 Ontario Corn Performance Tests, 1985.

Test site	County	Heat Unit Rating[a]	Disease Incidence[b] on entries
Malden	Essex	3500	slight to severe
Woodslee	Essex	3400	slight to severe
Ridgetown	Kent	3250	absent to moderate
Wyoming	Lambton	3050	absent to slight
Fingal	Elgin	3000	absent to slight
Nairn	Middlesex	2900	absent to slight
Innerkip	Oxford	2800	absent to slight
Elora	Wellington	2550	absent to trace

[a] Brown D.M. 1978. Heat units for corn in southern Ontario. OMAF. AGDEX 111/31. 4pp.
[b] absent = no foliar lesions; trace = 1 or 2 lesions per row; slight = 1-2 lesions on several plants within a row; moderate = numerous lesions on all plants in a row; severe = numerous lesions, leaves shredded, premature senescence on all plants in a row.

Table 3. Winter temperature indices 1984-85 and range of disease severity observed at 4 locations in southern Ontario, 1985.

Location	Mean Monthly Temperature in °F and (°C)			Winter Temperature Index[a]	Disease rating[b]
	Dec.	Jan.	Feb.		
Harrow	34.5 (1.4)	20.7 (-6.3)	21.7 (-5.7)	76.9	slight-severe
Ridgetown	34.2 (1.2)	19.8 (-6.8)	23.0 (-5.0)	77.0	absent-moderate
London (Nairn)	30.7 (-0.7)	18.3 (-7.6)	20.3 (-6.5)	69.3	absent-slight
Guelph (Elora)	30.9 (-0.6)	16.3 (-8.7)	19.8 (-6.7)	67.0	absent-trace

[a] WTI was derived from degrees Celsius by the formula $\Sigma[(-17.7^{\circ}C - \text{mean monthly temperature } ^{\circ}C) \times -1.8]$
[b] Rating system where; trace = 1 or 2 lesions/row; slight = 1-2 lesions on several plants within a row; moderate = numerous lesions on all plants in a row; severe = numerous lesions, leaves shredding and prematurely senescing on all plants in a row.

Table 4. Frequency distribution of dent corn hybrids in Stewart's bacterial wilt severity classes, Ontario Corn Performance Test, Malden, 1985.

Disease severity rating[a]	Number of hybrids in class
0 - 0.5	0
0.6 - 1.0	0
1.1 - 1.5	2
1.6 - 2.0	1
2.1 - 2.5	3
2.6 - 3.0	9
3.1 - 3.5	17
3.6 - 4.0	23
4.1 - 4.5	14
4.6 - 5.0	3

[a] 0 = lesions absent; 1 = 1 or 2 lesions/row; 2 = 1-3 small lesions or most plants; 3 = several large lesions/plant; 4 = numerous, large lesions/plant; 5 = numerous lesions, leaves shredding and prematurely senescing.

Systems based on WTI have been used successfully in the United States to predict wilt. The most recent system predicts severe disease on dent corn at indices greater than 90 and only trace amounts of disease at indices less than 80 (3). Disease severity in Essex was greater than expected based on the WTI of 76.9 for Harrow. Research is needed on factors affecting the survival of the flea beetle vector in Ontario. If Stewart's wilt occurs annually in Ontario studies on the epidemiology of disease will be necessary to control the disease.

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