Response of cultivars and breeding lines of *Phaseolus vulgaris* L. to the new alpha-Brazil race of *Colletotrichum lindemuthianurn* in southwestern Ontario

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Fifty commercial cultivars and 34 breeding lines of white and colored beans were tested for resistance to the alpha-Brazil race of *Colletotrichum lindemuthianum* (Sacc. & Magn.) Briosi. & Cav. Among the 84 tested, 55 had disease ratings between 0 (fully resistant) and 4 (moderately susceptible). There were 15 lines or cultivars of white beans and 19 of colored beans with ratings between 0 and 1 which appear to be excellent sources of resistance.

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Cinquante cultivars commerciaux et trente-quatre lignées généalogiques de haricots blancs et de haricots colorés ont subi un test de resistance a la race alpha-Brazil *de Colletotrichum lindemuthianum* (Sacc. & Magn.) Briosi. & Cav. De ce nombre, cinquante-cinq présentaient une resistance à la maladie se situant entre 0 (entièrement resistants) et 4 (modérément sensibles). Quinze cultivars ou lignées de haricots blancs et dix-neuf de haricots colores se sont classes entre 0 et 1, ce qui semble indiquer qu'ils soient d'excellentes sources de résistance.

Introduction

Bean anthracnose [*Colletotrichum lindemuthianum* (Sacc. & Magn.) Briosi & Cav.] is an important disease of white beans (*Phaseolus vulgaris* L.). In 1976, bean anthracnose became epidemic in southern Ontario (Tu and Aylesworth, 1979) and was caused largely by race delta and to a lesser extent by race lambda (Wallen, 1976; 1979; Tu, 1988). In 1977, a backcross program was initiated at the Harrow Research Centre, Agriculture and Agri-Food Canada, to transfer a resistant gene (Are) from PI 326418 (Cornell 49-242) to the recommended cultivars, because at that time, all recommended Ontario bean cultivars were susceptible to both races.

In addition, a strict program of seed treatment with benzimidazoles (Edgington and MacNeill, 1978), and field inspections of all pedigreed seed plots for zero anthracnose tolerance was instituted in Ontario. The disease mainly caused by the alpha and/or delta races was last observed in commercial fields during the 1983 growing season (Tu *et al.,* 1984).

During surveys of field trials in the summer of 1993, anthracnose was found in 6 of 9 locations in southwestern Ontario (Tu, 1994a). Various bean lines, including those carrying the Are gene for resistance were severely affected. Bean cultivars or lines that carry the Are gene should have been resistant to alpha, beta, gamma, delta, lambda and epsilon races (Tu *et al.,* 1984). The occurrence of the anthracnose in these lines suggested two possibilities: first that the Are lines are not homogenous for resistance to anthracnose and the genes are segregating Are/are; and second that the causal agent may be a new race of *C.lindemuthianum.*

Subsequent investigations have revealed that the 1993 anthracnose disease was caused by a new alpha-Brazil race introduced into Canada from Michigan (Tu, 1994b). The arrival of this new race necessitated a reevaluation of all existing cultivars as well as lines that are currently in variety trials for their susceptibility to the new race. This report shows that a range of resistant plant materials are available that would be a benefit to the Ontario growers and ones that will provide parental lines for bean breeders.

Materials and methods

The cultivars and breeding lines of white and colored bean that were submitted to the Ontario Cooperative Bean Variety Trial were sown in 10-cm pots with four pots per test and 5 seeds/pot. All pots were kept in a growth chamber at 21 ± 1°C on a 14-h photoperiod with a light intensity of 4.7 $\mu Mm^{-2}s^{-1}$. At the primary-leaf-stage the bean seedlings were inoculated with a spore suspension of the race

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alpha-Brazil of *C.lindemuthianum* from 3-week old colonies cultured on Mathur's agar (MA) (Champion *et al.,* 1973). Five mL of sterilized distilled water was added to each plate and the surface of the culture was scraped to dislodge the spores. The spore suspensions derived from several plates were pooled, filtered through cheese cloth and the spore concentration used in this experiment was determined with a haemacytometer. Unless stated otherwise, the spore concentration was adjusted to 10^7 spores/ml H_2O.

The spore suspension was brushed gently onto the upper- and lower-surfaces of the primary leaves and the hypocotyl with a camel hair brush. The inoculated seedlings were then covered with a transparent plastic bag (Tu and Aylesworth, 1979) and the open end of the bag was fastened to the pot with an elastic band. In general, the inoculated seedlings were kept under the plastic cover for 4 days at 20°C in a growth chamber with 14 h light. The light source was a row of cool white fluorescent lamps supplemented with incandescent lamps. The light intensity was 4.7 $\mu Mm^{-2}s^{-1}$ at bench level. Upon removal of the plastic bags, the plants were kept in the same growth chamber for symptom development. The percentage of leaf area diseased was scored 6 days after inoculation using a 0-9 scale where 0 = no disease, 1 = < 10% of leaf vein with symptoms, 2 = 10-19% .... and 9 = leaf dead. Thus, a score of 0 is considered resistant and scores between 1 and 9 show various degrees of susceptibility. The experiment was repeated once.

Results and discussion

Fifty-five commercial cultivars and breeding lines had a disease severity rating of 0 to 4 indicating a high to moderate resistance to the disease caused by race alpha-Brazil in southwestern Ontario (Table 1 and 2). Among these resistant cultivars seventeen are currently recommended cultivars and could be adopted readily into commercial production in Ontario while the breeding lines could be used by breeders in the development of resistance to this disease.

These results should be helpful to growers, breeders, seed companies, and the Ontario bean industry.

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Literature cited

1. Champion, M.R., Brunet, D., Maudalt, M.L. and Ilami, R. **1973.** Methode de contrôle de la resistance des varietes de haricots à l'anthracnose ***(Colletotrichum lindemuthianum*** [Sacc. & Magn.] Briosi & Cav.) C.R. Hebd. Seances Acad. Agric. France 12:951–958.
2. Edgington, L.V. and MacNeill, B.H. **1978.** Control of bean anthracnose by seed treatment with systemic fungicides. Phytopathol. News 12:235.
3. Tu, J.C. 1994a. Recurrence of anthracnose disease on field bean in southwestern Ontario in **1993.** Can. Plant Dis. Surv. 74:96.
4. Tu, J.C. 1994b. Occurrence and characterization of the alpha-Brazil race of bean anthracnose ***(Colletotrichum lindemuthianum)*** in Ontario. Can. J. Plant Pathol. 16:129–131.
5. Tu, J.C., Sheppard, J.W. and Laidlaw, D.M. **1984.** Occurrence and characterization of the epsilon race of bean anthracnose in Ontario. Plant Dis. 68:69–70.
6. Tu, J.C. **1988.** Control of bean anthracnose caused by the delta and lambda races of ***Colletotrichum lindemuthianum*** in Canada. Plant Dis. 72:5–8.
7. Tu, J.C. and Aylesworth, J.W. **1979.** An Effective method of screening white (pea) bean seedlings (***Phaseolus vulgaris*** L.) for resistance to ***Colletotrichum lindemuthianum.*** Phytopathol. *Z.* 99:131–137.
8. Wallen, V.R. **1976.** Anthracnose on field beans in Ontario. Can. Plant Dis. Surv. 56:109.
9. Wallen, V.R. **1979.** The Occurrence of the lambda race of bean anthracnose in Ontario. Can. Plant Dis. Surv. 59:69.

Table 1. Reaction of white bean cultivars and lines to alpha-Brazil race of bean anthracnose in southwestern Ontario.†

Cultivar*	Disease severity Index‡ (0-9 scale)	Line*	Disease severity Index‡ (0–9 scale)
Ac Mariner[a]	6	GTS 525[e]	5
Shetland[a]	9	GTS 526[e]	0
OAC Cygnus[b]	0	HR43-1582[a]	5
Avanti[d]	7	HR44-1585[a]	4
Ex Rico 23[a]	8	HR46-1657[a]	5
OAC Sprint[b]	9	HR52-1712[a]	9
Centralia[a]	8	HR53-1712[a]	6
OAC Gryphon[b]	9	OAC 91-2[b]	0
Fleetside[e]	0	OAC 92-1[b]	0
Envoy[e]	0	OAC 93-1[b]	6
OAC Laser[b]	6	OAC 93-2[b]	4
OAC Speedvale[b]	0	OAC 93-3[b]	5
Vista[e]	8	OAC 93-4[b]	6
Dresden[a]	0	T9006[c]	0
Midland[c]	7	T9203[c]	0
Mitchell[a]	2	T9301[c]	5
Crestwood[e]	5	T9302[c]	4
Schooner[d]	0	T9303[c]	0
Stinger[c]	3	T9304[c]	0
OAC Seaforth[b]	4		
Wesland[c]	0		
Rocket[c]	0		
OAC Rico[b]	8		
Harowood[a]	7		

† This list may include some private cultivars and lines. Interested parties wishing to obtain seeds should write directly to the respective sources.

‡ Based on a 0–9 scale, where 0 = no disease, 1 = <10% of leaf vein with symptoms, 2 = 10–19% ... and 9 = leaf dead. Thus, a score of 0 is considered resistant and a score of 1 to 9 shows various degrees of susceptibility.

* The superscripts following each cultivar indicate the source of seeds: (a) Harrow Research Station; (b) Crop Science, University of Guelph, Ontario; (c) Thompson & Sons Ltd., Ontario; (d) Rogers N.K., Idaho; (e) Gentec Seeds, Ontario.

Table 2. Reaction of colored bean cultivars and lines to alpha-Brazil race of bean anthracnose in southwestern Ontario.†

Cultivar*	Disease severity Index‡ (0–9 scale)	Line*	Disease severity Index‡ (0–9 scale)
AC Darkid[a]	0	CCY0101[i]	7
AC Harblack[a]	6	CCY9103[i]	7
AC Litekid[a]	0	GTS 039[e]	2
Alphine[f]	7	GTS 103[e]	0
Aresteuben[a]	0	GTS 306[e]	1
Aztec[f]	6	GTS 1701[e]	0
Berna[h]	2	HR21 DL[a]	5
Blackjack[e]	8	HR33-941[a]	0
Calif. DRK[c]	0	HR41-923[a]	1
Calif. WK[c]	1	HR48-1290[a]	0
Calif. LRK[c]	0	HR49-1404[a]	4
Camelot[d]	2	HR50-1607[a]	9
Chinook[f]	0	HR54-1491[a]	0
Cran 34[e]	4	OAC 90-C1[b]	6
Cran 09[e]	6	SMV 37-16[g]	5
Drake[k]	1		
Foxfire[d]	6		
Lassen[g]	1		
Montcalm[f]	0		
OAC Tomahawk[b]	9		
Ouray[j]	0		
Pinray[e]	1		
Sacremento[g]	0		
SVM Taylor[g]	6		
T-39[c]	5		
UI-114[e]	9		

† This list may include some numbered cultivars, private breeding lines and PI accessions. Interested parties wishing to obtain seeds should write directly to the respective sources.

‡ Based on a 0–9 scale, where 0 = no disease, 1 = < 10% of leaf vein with symptoms, 2 = 10–19% ... and 9 = leaf dead. Thus, a score of 0 is considered resistant and a score of 1 to 9 shows various degrees of susceptibility.

* The superscripts following each cultivar indicate the source of seeds: (a) Harrow Research Station; (b) Crop Science, University of Guelph, Ontario; (c) Thompson & Sons Ltd., Ontario; (d) Rogers NK, Idaho; (e) Gentec Seeds, Ontario; (f) Dr. J. Kelly, Michigan State University; (g) Sacremento Milling Co., California; (h) Great Canadian Bean Co., Ontario, (i) Centralia College of Agriculture and Technology, Ontario; (j) Colorado State University and (k) Asgrow Seeds, Idaho.