Response of cultivars and breeding lines to the disease complex of fusarium wilt and root rot of green peas in southwestern Ontario

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Each year from 1984 to 1987, between 150 and 200 commercial cultivars and breeding lines of green pea were tested for specific resistance to fusarium wilt (*Fusarium oxysporum* Schlecht. f. sp. *pisi* Snyd. & Hans.) and non-specific resistance to fusarium root rot (*F. solani* (Mart.) Appel & Wr. f. sp. *pisi* (F.R. Jones) Snyd. & Hans.), in a field severely infested with these fungi. The different degrees of susceptibility and resistance of these cultivars and lines were scored and presented herewith.

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Chaque année de 1984 à 1987, on a procédé à des essais de 150 à 200 cultivars commerciaux et lignées généalogiques de petits pois pour évaluer leur résistance spécifique à la flétrissure fusarienne (*F. oxysporum* Schlecht. f. sp. *pisi* Snyd. et Hans.) et non spécifique au pourridié fusarien (*F. solani* (Mart.) Appel et Wr. f. sp. *pisi* (F.R. Jones) Snyd. et Hans.) dans un champ gravement infecté par ces champignons. L'auteur cote et présente les divers degrés de sensibilité et de résistance de ces cultivars et lignées.

Introduction

Root rots were severe constraints to pea production in southwestern Ontario prior to 1984 (McNeil and Howard, 1959; Reyes, 1980). A survey of 550 ha of pea fields in Essex and Kent counties in 1983 and 1984 showed that an average of 26% of the plants had root rot (Tu, 1986, 1987). In the 1983 growing season, a total of 782 fungal cultures were isolated from pea plants from diseased fields. These isolates were identified and categorized. The frequencies of isolation of *F. solani*, *F. oxysporum*, *Aphanomyces euteiches* Drechs. and *Pythium* spp. were 7:4:1:1 (Tu 1987). Disease severity of each root rot was determined on a scale of 0 to 9, where 0 = <10% of root with symptoms, 1 = 10-19%, 2 = 20-29% etc. and 9 = plant dead.

The severity of disease caused by *F. solani* (root rot), *F. oxysporum* (wilt), *Pythium* and *Aphanomyces* averaged 3.2, 8.7, 2.6 and 4.0, respectively. Plants with fusarium wilt usually died, while those with fusarium root rot showed various degrees of stunting and yellowing but rarely died. Pythium and Aphanomyces root rots were observed to be minor problems in peas in Ontario. Based on this information, a disease damage index (DDI) was developed to rank the relative importance of these four root rots. The DDI of a root rot equaled the total amount of root rot (26%) × the frequency of occurrence of each fungus × the severity of disease caused by each fungus. The DDIs for *F. solani*, *F. oxysporum*, *Pythium* spp. and *A. euteiches* were 45, 71, 5 and 8, respectively. Therefore, fusarium wilt was found to be the most damaging disease, followed by fusarium, pythium and aphanomyces root rots, respectively.

The present trial was conducted to test for specific resistance to fusarium wilt (*F. oxysporum* f. sp. *pisi* race 1 and race 2) and non-specific resistance to fusarium root rot (*F. solani* f. sp. *pisi*) in a heavily infested field.

Materials and methods

A field with severe root rot infestation, having a typical disease ratio of fusarium wilt to fusarium root rot of approximately 7:4, was selected for testing cultivars and breeding lines for disease resistance. The test site was located in a field near the town of Tecumseh, on Brookston clay, a fine textured soil classed as an Orthic Humic Gleysol, one of the most widely distributed soil types in southwestern Ontario. This type of soil has poor drainage and is easily compacted (Bolton *et al.* 1982) which predisposes plants to root rots. The majority of peas in southwestern Ontario have been planted in this type of soil.

Cultivars and breeding lines were tested for specific resistance to fusarium wilt and non-specific resistance to *Fusarium solani* every year for a period of 4 years from 1984 to 1987.

Cultivars of peas were obtained from various research organizations, seed companies and processors. Each year, between 150 and 200 cultivars and lines were tested in 4 replications, each with randomized single rows and each grown on naturally infested soil. Root rot severity was rated on a 0-9 scale in the last week of June, with 20 plants examined in each row.

Results and discussion

The results (Tables 1 and 2) showed that many commercial cultivars and breeding lines had a disease severity rating of 0 to 4 indicating a high to moderate resistance to the disease complex of fusarium wilt and root rot in Ontario.

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Table 1. Response of cultivars to the disease complex of fusarium wilt and root rot of peas in southwestern Ontario.†

Root rot severity Index‡ (0-9 scale)	Cultivar*							
0-1.0	Perfection WR[1]							
1.1-2.0	Parlay[2]	Early Perfection[2]	RS-7[3,4]	Green Giant 531 (Nuttall selection)[1]				
2.1-3.0	New Season[2]	Anoka[2]	Novella[2]	Almotto[2,4]	Puget[2]	Bolero[5,8]	Medalist[6]	M140[2]
	Early Perfection 3040[2,4]		Home Guard[1]					
3.1-4.0	Frontier[7]	Parlay[8]	Alaska 423[9]	Early Frosty[2]	Mini[2]	SN4[2,4]	Maro[2]	Little Sweetie[11]
	Jade[2]	M-129[1]	Olympia[12]	Mercurio[10]	Massette[10]			
4.1-5.0	Alpha I[13]	Min 375[2]	Alaska[2]	Mars[8]	Frosty[12]	Pomak[2]	M163[13]	Trident[2]
	Pomak[2]	Patriot[11]	Mitzi[14]	New Era[2,4]	Early Snap[11]	Kosta[15,19]	512 GG[16]	Green Arrow[11]
	Dual[2]	Target[8]	Aldot[2]	Lowata[10]	Alsweet af[17]	Legio Novella[10]		70A[2]
5.1-6.0	Midget[13]	Novella II[8]	M410[2,4]	Sun Valley[15]	Kriter[13]	Novella[3,8]	RS-4[3]	Sparkle[16]
	381 GG[16]	Venus[2]	Opal[12]	Early Sweet II[2]		Salvo[3]	Rally[5,6,8]	Scout[2]
	Signet[2]	451 GG[16]	Abador[6,15]	Dryad[2]	313 GG[16]	Viking[2]	Progress #9[11]	
	Early Perfection 8221[7]		Variegated Little Marvel[3]		Dark Skninned Perfection[2,4]			
6.1-7.0	Tilma[2]	Ronds[11]	Trend[7]	Knight[11]	Dawn[6]	Ganada[15,19]	Bountiful[2]	Early Sweet[18]
	235 GG[16]	Spring[2]	Banquet[2]	Greater Progress[11]				
7.1-8.0	Early Sweet 7[2]	Spring[6]	RS-4(Parent)[4]	Improved Laxton Progress[11]				

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

‡ Based on a 0-9 scale, where 0 = < 10%, 1 = 10-19% of root with symptoms, 2 = 20-29% ... and 9 = plant dead. Thus, a score of 0 to 4.0 is considered to have high to moderate levels of resistance and a score of 4.0 to 9.0 to have moderate to high levels of susceptibility.

* The superscripts following each cultivar indicate the suppliers of seeds: 1, Mr. V.W. Nuttall (deceased), Harrow Research Station, Ontario; 2, Dr. Howard, Alberta Horticultural Research Centre, Brooks; 3, Dr. Reiling, Pillsbury Co. Le Sueur, MN.; 4, Dr. Kraft, Irrigated Agriculture Research and Extension Center (IAREC), WN.; 5, Libby Co., Ontario; 6, Asgrow Seed Co., MI; 7, Canadian Canners Ltd., Ontario; 8, Roger Bros. Seed Co., Ontario; 9, Dr. Reyes, Vineland Research Station, Ontario; 10, Del Monte, CA; 11, Stokes Seeds Ltd., Ontario; 12, Harris Moran Co. Seed, Ontario; 13, Campbell Soup Co., Ontario; 14, Gallatin Valley Seed Co., Ontario; 15, Omstead Food Ltd., Ontario; 16, Pillsbury Canada, Ontario; 17, Canners Seed Co. ID; 18, Columbia Seed Co., Alberta; 19, Crites Moscow Growers' Inc., ID.

Table 2. Response of breeding lines to the disease complex of fusarium wilt and root rot of peas in southwestern Ontario.†

Root rot severity Index‡ (0-9 scale)	Line*						
1.1-2.0	9602-10[a]	97067-1-5-1[a]					
2.1-3.0	80-717[c,d] 9601-3-7-2[a] 7601-2-1-4[a]	7710-4-1-2[a] 9816-14[a] X9725-8[a]	9731-3[a] 8221-5[a] X9504-2-3[a]	X9602-7[a] 9601-3-3[a] 74-SN5[b]	494-A11[b,c] C82-409[e] WSU R22[b,c]	7801-10-3[a] 9713-6-1[a] Minnesota 108[b,c,d]	X9500-1-1[a] 9713-30[a]
3.1-4.0	7705-7[a] 83-1356[f] WR 1158[f] 507-8[a]	X9727-10[a] 7712-10[a] X9726-2[a] 9716-1-1[a]	X9602-2[a] P.I.189171[b,c] 89171[b] OH69.22[g]	VR1492-1[b,c] 9406-1[a] 9889-2[a] 8615-3EP[a]	508-7[a] 9728-8[a] 9888[a] 74-SN4[b,c]	9603-10-12[a] 83-1392[f] PH14-119[b]	89617-EP[a] 7025[a] 7705-8[a]
4.1-5.0	79-2022[b,c] OH69.07[g] 9766-1[a] WR-1167[f]	9713-8[a] 7705-32[a] C80-211[e] 9728-2[a]	9220[a] P.I.242028[b,c] X9713-19[a] 7705-4[a]	9763-15[a] 776[h] 7705-11[a] 80-933[c,d]	9601-1-1[a] 512-2[a] 378A-3-G[d] C80-212[e]	77EP[a] X9713-9[a] 7705-39[a] 9220[a]	9731-4[a] 79-2024[d] PH91-3[b] FR 79152[e]
5.1-6.0	378A-3-W[d] OH69.08[g] PH-14-119[f]	X9713-8-1[a] 9716-1-2[a] P.I.140295[b,c]	C80-210[e] 74-1492-1[b,c] 80-1313[c,d]	517-2-4[a] 80-1077[c,d] 83-1163[f]	X9724-10[a] 9901[a] P.I.140165[b,c]	508-4-2-4[a] 44ES[a] 3702 Alaska-1[a]	C82-407[e] RR-1178[f]
6.1-7.0	8615-3[a]	P.I.257593[b,c]	2213-E-S[a]	9713-9-2[a]	WSU 23[b,d]		

† This list includes some numbered cultivars, private breeding lines and P.I. accessions. Interested parties wishing to obtain seeds should write directly to their respective sources.

‡ Based on a 0-9 scale, where 0 = < 10%, 1 = 10-19% of root with symptoms, 2 = 20-29% ... and 9 = plant dead. Thus, a score of 0 to 4.0 is considered to have high to moderate levels of resistance and a score of 4.0 to 9.0 to have moderate to high levels of susceptibility.

* The superscripts following each line indicate the suppliers of seeds: a, Dr. Polson, Canners Seed Co., ID; b, Dr. Howard, Horticultural Research Centre, Alberta; c, Dr. Kraft, Irrigated Agriculture Research and Extension Center (IAREC), WN.; d, Pillsbury Co. Le Sueur, MN.; e, Roger Bros. Seed Co., Ontario; f, U.S.D.A., Beltsville, MD.; g, Mr. V.W. Nuttall (deceased), Harrow Research Station, Ontario; h, Libby Food Co., Ontario.

These resistant cultivars (Table 1) could be adopted readily into commercial production in southwestern Ontario. Many of the resistant breeding lines (Table 2) could be developed into new cultivars by breeders or employed as resistant sources for breeding for disease resistance.

Unfortunately, few of these resistant cultivars (Table 1) had been grown in southwestern Ontario prior to 1984 when peas were severely affected by fusarium wilt and root rot, because the etiology of the disease complex was not fully understood.

In 1984, a pea root rot study resolved the etiology of the disease complex (Tu, 1987). Subsequently, a field that exhibited a typical infestation was selected for testing cultivars and breeding lines for specific resistance to *F. oxysporum* f. sp. *pisi* race 1 and race 2 and non-specific resistance to *F. solani* f. sp. *pisi*. Although some pathotypes of *F. solani* f. sp. *pisi* have been reported (Bolton *et al.* 1970), it is felt that the species is not yet highly specialized.

The present results should be helpful to growers, breeders and seed companies, as well as the pea industry at large.

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Literature cited

1. Bolton, A.T., A.G. Donaldson and V.M. Nuttall. 1970. Variation in isolates of *Fusarium solani* f. *pisi* collected from processing peas in Ontario. Can. Plant Dis. Surv. 50:108-109.
2. Bolton, E.F., V.A. Dirks and M.M. McDonnell. 1982. The effect of drainage rotation and fertilizer on corn yield. Plant height, leaf nutrient composition and physical properties of Brookston clay soil in southwestern Ontario. Can. J. Soil Sci. 62:297-309.
3. McNeil, B.H. and H. Howard. 1959. Near-wilt of peas in Ontario. Can. J. Plant Sci. 39:483-490.
4. Reyes, A.A. 1980. Pea root rot development and associated fungal pathogens in Ontario fields. Plant Dis. 64:392-393.
5. Tu, J.C. 1986. Incidence and etiology of pea root rots in southwestern Ontario. Can. Plant Dis. Surv. 66:35-36.
6. Tu, J.C. 1987. Integrated control of the pea root rot disease complex in Ontario. Plant Dis. 71:8-13.