Screening of field pea cultivars for resistance to fusarium root rot under field conditions in Alberta

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Field trials were conducted at sites near Vegreville and Namao, Alberta, to evaluate pea cultivars for their resistance to fusarium root rot. At Vegreville, significantly greater disease severities and lower seed yields were observed in Fusarium solani f. sp. *pisi*-inoculated plots than in noninoculated (control) plots. At both Vegreville and Namao, no significant differences in root rot reaction were observed. All cultivars evaluated were found to be susceptible to this disease. There were considerable variatlions among cultivars for seed yield in both 1992 and 1993.

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Des essais au champ ont ete menés dans des sites situés à proximite de Vegreville et Namao, en Alberta, afin d'évaluer la resistance de cultivars de pois au pourridie fusarien. À Vegreville, une virulence sensiblement plus élevée et un rendement grainier plus faible ont été observes dans les parcelles inoculées a l'aide de Fusarium solani f. sp. pisi comparativement aux parcelles témoins non inoculées. A Vegreville tout comme a Namao, nous n'avons pas observe de differences marquees dans les reactions au pourridie. Tous les cultivars évalués se sont révélés sensibles à cette maladie. La récolte des semences a varié considerablement d'un cultivar a l'autre autant en 1992 qu'en 1993.

Introduction

Field pea (*Pisum sativum* L. var. *arvense* (L.) Poir.) is well-adapted to temperate climates and can withstand considerable frost. In recent years, the acreage of field pea in north-central Alberta has increased dramatically. Fusarium root rot, caused by Fusarium *solani* (Mart.) Sacc. f. sp. *pisi* (F.R. Jones) W.C. Snyder & H.N. Hans. is a world-wide disease of considerable economic significance. It can seriously reduce the yield and quality of the crop (Kraft and Roberts, 1969). Surveys conducted in 1988 in north-central Alberta showed that the mean incidence of this disease for each of the fields examined was 31% (Hwang and Chang, 1989). With repeated cultivation of the field pea, it is anticipated that populations of *F. solani* f. sp. *pisi* will build up in the soil and cause significant yield losses in subsequent crops. Moreover, fusarium root rot may suddenly become more serious because of the introduction of new susceptible cultivars, and, consequently, some fields could be abandoned simply because pea production is no longer profitable. Although the use of disease-resistant cultivars offers a very economical control method, current knowledge of sources and stability of resistance to fusarium root rot in field pea is limited because no cultivars have recently been evaluated in Alberta. The objectives of this research were: i) to evaluate the effect of fusarium root rot on seed yield, and ii) to screen existing and promising new pea cultivars for resistance to this disease.

Materials and methods

Preparation of grain inoculum

Three single-spored isolates of Fusarium *solani* f. sp. pisi (F-19, F-24, and F-32) were obtained from symptomatic roots of field pea seedlings and maintained on potato dextrose agar slants at 5°C. Three to five 4-mm-diameter agar discs of each isolate were placed in (1 L) screw-top jars, which had been half-filled with moist rye grain (120 g grain + 200 mL water) and autoclaved twice for 60 min. The inoculated jars were incubated at room temperature in natural light for two weeks and shaken periodically to ensure complete colonization of the graini. After incubation, infested grain was removed from the jars, air-dried in a laminar-flow microbial transfer hood for two days, and stored at 4°C until needed. The colonized grain of each of the F. solani f. sp. *pisi* isolates was mixed at 1:1:1 (v/v/v) and used as inoculum. A rate of 20 mL/row was applied at seeding.

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Field trials

Field experiments were conducted in the spring of 1992 and 1993 near Namao and Vegreville, Alberta. A pre-emergence herbicide, Edge 5G (ethalfluralin 5% GR), was incorporated into the soil at a rate of 16 kg/ha along with 60 kg/ha fertilizer (8-36-15-5, N-P-K-S). At Vegreville, a split-plot randomized complete block design with four replications was employed. Inoculation with *F. solani* f. sp. *pisi*-infested grain or sterile grain served as main plots and 20 field pea cultivars were seeded in four 6 m row subplots with 20 cm between rows. Seeds were planted 4 cm deep with a grain drill at 100 seeds/row, and peat-based root-nodule bacteria inoculant was sprinkled in the rows. The replicate main plots were separated by 2 m borders and the subplots by 1 m. At Namao, 20 cultivars of field pea were seeded with *F. solani* f. sp. *pisi*-infested grain inoculum in a randomized complete block design with four replications. Four weeks after sowing, the number of emerged seedlings in a 2 m length of the two middle rows of each subplot was counted in 1992 and 1993 at Vegreville. At both sites, 10 plants from each subplot were randomly sampled 4 and 8 wk after seeding in 1992 and after 8 wk in 1993. Roots were washed and root rot severities were assessed on a scale of 0 to 4, where 0 = healthy, 1 = 1—10% root discoloration, 2 = 11—25%, 3 = 26—50%, and 4 = 51—100% (Fig. 1). Cultivars with mean scores between 0 and 1.0 were considered to be highly resistant, 1.1 and 2.0 moderately resistant, 2.1 and 3.0 moderately susceptible, and 3.1 and 4.0 highly susceptible. At maturity, plants in a 2 m^2 area from each subplot or plot were swathed, threshed and the seeds were dried to 16% moisture content and weighed.

Data analysis

Data were subjected to an analysis of variance and means were compared using Duncan's Multiple Range or LSD Tests at the $P \leq 0.05$ level of significance on SAS software (SAS Inst. Inc, 1985). Separate analyses were performed for each year and location.

Results and discussion

At Vegreville, no significant differences in number of emerged seedlings occurred between control and *Fusarium*-inoculated treatments in both 1992 and 1993 (Table 1). However, significantly greater disease severities and lower seed yields were observed for the *Fusarium*-inoculated plots. For all cultivars, greater disease severity was observed 8 wk after seeding compared to 4 wk.

In 1992, the cultivars Trump and Tipu were moderately susceptible and the other 18 cultivars were moderately resistant to fusarium root rot 4 wk after seeding at Namao (Table 2). At Vegreville, all cultivars were moderately resistant 4 wk after seeding (Table 2). By 8 wk after seeding, disease severities varied from 3.1 to 3.9 at both sites, resulting in susceptible disease ratings for all cultivars.

In 1993 at Namao, cultivars Century, Bohatyr and Stehgolt had the least disease, with severity ratings of 2.5 to 2.6, whereas Princess and Titan had the highest ratings at 3.9 and 3.8, respectively (Table 3). The disease severity ratings of the rest of the cultivars were between 2.7 and 3.7; therefore, all cultivars were considered to be either moderately susceptible or susceptible. At Vegreville, all cultivars were moderately susceptible, with the exception of Titan, which was susceptible.

In 1992 at Namao, the highest average seed yields between 157 and 180 g/plot were recorded for cvs. Bohatyr, Miranda, Orb, SVG 14936, Danto and LU-SIB; and the lowest average seed yield values of 57 to 67 g/plot were recorded for Titan, Century and Trapper (Table 4). Average seed yields for the remaining 11 cultivars were between 87 and 147 g/plot. Average seed yield at Vegreville in 1992 varied from 137 to 227 g/plot. The best yielding cultivars included Orb, Stehgolt, Miranda, Topper and Bohatyr, which had yields equal to or greater than 200 g/plot. The poorest yielding cultivars included Tipu, Trapper, LU-SIB, Tara and Century, which had average yields equal to or less than 137 g/plot. In both 1992 and 1993, there were considerable variations among cultivars for seed yield and some of the higher yielding cultivars in 1992 would rank among the lower yielding cultivars in 1993. In part the differences in yields for the two years were due to some higher yield values in 1993 than in 1992 (Table 4).

This is the first report describing the reaction of pea breeding lines or cultivars to root rot caused by *F. solani* f. sp. *pisi* in north-central Alberta. All tested cultivars were considered to be moderately susceptible or susceptible. Significant differences in root rot severity and seed yield occurred between inoculated and noninoculated plots. These data suggest that fusarium root rot can seriously reduce yields of field pea and from visual observations it appeared that the seed from the inoculated plots were lower in quality. The use of cultivars resistant to this disease can offer a very effective method for the control of this disease control. The use of resistant cultivars could provide a way to maintain or increase crop production without increased land demands or adverse environmental consequences. More field pea breeding lines and plant introductions should be screened to identify high levels of genetic resistance to fusarium root rot and for suitable adaptation to growing conditions in Alberta which would enhance the desirability of growing field pea as an alternative cash crop.

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Table 1. Effects of ***Fusarium solani*** f. sp. *pisi* inoculation on mean number of seedlings, disease sewerii and seed yield in field pea grown at Vegreville, Alberta in 1992 and 1993.

Treatment	1992				1993			
	# of seedlings per 2 m of row	Root rot severity** 4wk	Root rot severity** 8wk	Seed yield g/m²	# of seedlings per 2 m of row	Root rot severity 4wk	Root rot severity 8 wk	Seed yield (g/m²)
Control	18 a*	1.0 b	2.9 b	202 a	20 a	1.1 b	1.4 b	280 a
Inoculated	17 a	1.6 a	3.4 a	179 b	19 a	1.9 a	2.6 a	243 b

* Values are the means of four replicate main plots. Means in the same column followed by the same letter are not significantly (P = 0.05) different using Duncan's Multiple Range Test.

** Ratings of root rot severity: 0 = healthy, 1 = 1—10% root discoloration, 2 = 11—25%, 3 = 26—50%, and 4 = 51—100%. Data collected 4 and 8 weeks after seeding.

Table 2. Comparative root rot disease severity among 20 field pea cultivars grown in fields artificially infested with *Fusarium solani* f. sp. *pisi* at Namao and Vegreville, Alberta, in 1992. Values for disease severity are averages of 10 plants per subplot.

Cultivar	Namao				Vegreville			
	Severity* (4 wk)	Disease reaction	Severity (8 wk)	Disease reaction**	Severity (4 wk)	Disease reaction	Severity (8 wk)	Disease reaction
AC Tamor	1.7	MR	3.5	S	1.9	MR	3.5	S
Bohatyr	2.0	MR	3.6	S	1.3	MR	3.5	S
Century	1.9	MR	3.3	S	1.4	MR	3.3	S
CL-85-13	1.7	MR	3.6	S	2.0	MR	3.2	S
Danto	1.6	MR	3.4	S	1.7	MR	3.2	S
Express	1.6	MR	3.5	S	1.5	MR	3.6	S
LU-SIB	1.9	MR	3.7	S	2.0	MR	3.5	S
Miranda	1.6	MR	3.4	S	1.5	MR	3.2	S
Orb	2.0	MR	3.6	S	1.7	MR	3.9	S
Patriot	1.5	MR	3.2	S	1.3	MR	3.5	S
Princess	1.6	MR	3.7	S	1.4	MR	3.7	S
Radley	1.1	MR	3.5	S	1.3	MR	3.1	S
SVG 14936	1.7	MR	3.5	S	1.9	MR	3.7	S
Stehgolt	1.7	MR	3.6	S	1.5	MR	3.5	S
Tara	1.7	MR	3.2	S	1.5	MR	3.3	S
Tipu	2.4	MS	3.5	S	1.5	MR	3.4	S
Titan	1.8	MR	3.6	S	1.8	MR	3.5	S
Topper	1.9	MR	3.6	S	1.9	MR	3.6	S
Trapper	1.4	MR	3.3	S	1.1	MR	3.5	S
Trump	2.2	MS	3.4	S	1.7	MR	3.6	S
LSD (0.05)	0.7		0.4		0.6		0.3	

* Ratings of root rot severity: 0 = healthy, 1 = 1—10% root discoloration, 2 = 11—25%, 3 = 26—50%, and 4 = 51—100%. Data collected 4 and 8 weeks after seeding.

** Disease reaction: R (resistant) = root rot severity of 0 to 1.0, MR (moderately resistant) = of 1.1 to 2.0, MS (moderately susceptible) = of 2.1 to 3.0, S (susceptible) = 3.1 to 4.0.

Table 3. Comparative root rot disease severity among 20 field pea cultivars grown in fields artificially infested with *Fusarium solani* f. sp. *pisi* at Narnao and Vegreville, Alberta, in 1993. Values for disease severity are averages of 10 plants per subplot.

	Namao		Vegreville	
	Severity*	Disease reaction**	Severity	Disease reaction
AC Tamor	3.5	S	3.0	MS
Bohatyr	2.6	MS	2.2	MS
Century	2.5	MS	2.3	MS
CL-85-13	3.2	S	2.3	MS
Danto	3.2	S	2.8	MS
Express	2.8	MS	2.6	MS
LU-SIB	3.7	S	2.8	MS
Miranda	3.4	S	2.9	MS
Orb	2.9	MS	2.6	MS
Patriot	3.6	S	2.2	MS
Princess	3.9	S	2.7	MS
Radley	2.9	MS	2.0	MS
SVG 14936	3.5	S	2.7	MS
Stehgolt	3.4	S	2.3	MS
Tara	2.6	MS	2.8	MS
Tipu	2.8	MS	2.9	MS
Titan	3.8	S	3.1	S
Topper	3.3	S	2.9	MS
Trapper	2.7	MS	2.6	MS
Trump	3.5	S	2.7	MS
LSD (0.05)	0.7		0.6	

* Ratings of root rot severity: 0 = healthy, 1 = 1–10% root discoloration, 2 = 11–25%, 3 = 26–50%, and 4 = 51–100%. Data collected 8 weeks after seeding.

** Disease reaction: R (resistant) = root rot severity of 0 to 1.0, MR (moderately resistant) = of 1.1 to 2.0, MS (moderately susceptible) = of 2.1 to 3.0, S (susceptible) = 3.1 to 4.0.

Table 4. Comparative seed yield (g/m^2) among 20 field pea cultivars grown in fields artificially infested with *Fusarium solani* f. sp. *pisi* at Namao and Vegreville, Alberta, in 1992 and 1993. Values are the means of four replicate plots.

	1992		1993	
	Namao	Vegreville	Namao	Vegreville
AC Tamor	87	175	234	268
Bohatyr	180	200	284	305
Century	60	158	147	226
CL-85-13	103	177	303	389
Danto	159	18	259	232
Express	94	175	345	239
LU-SIB	157	153	272	237
Miranda	172	209	229	146
Orb	170	227	248	277
Patriot	93	181	302	258
Princess	141	166	177	117
Radley	147	161	239	199
SVG 14936	167	197	343	366
Stehgolt	139	212	268	163
Tara	125	192	377	262
Tipu	136	137	236	217
Titan	57	156	133	220
Topper	127	201	404	238
Trapper	67	152	287	255
Trump	131	161	311	227
LSD(0.05)	57	46	87	105

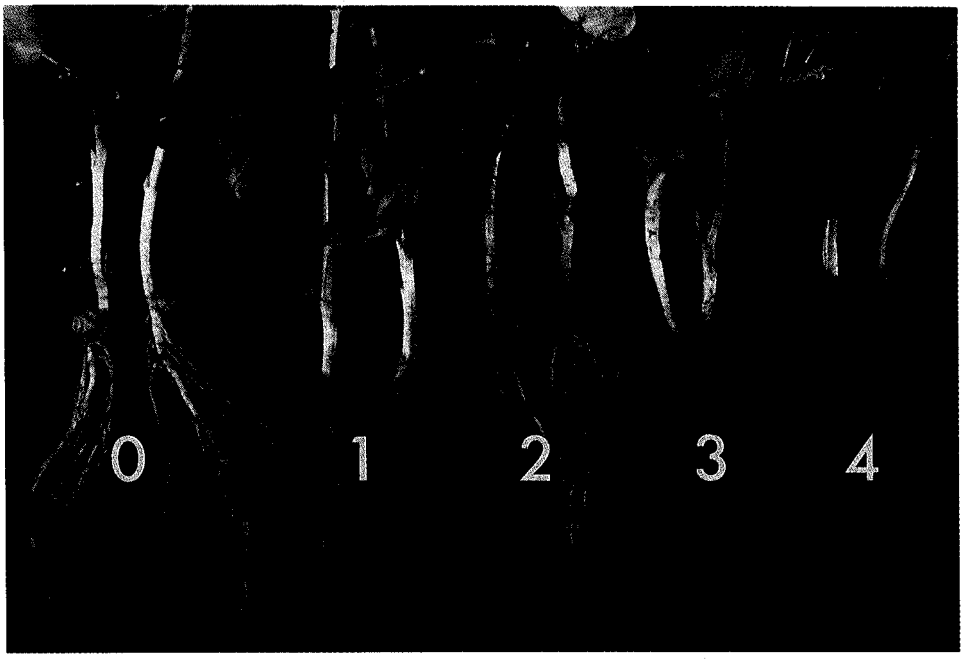

Fig. 1. Root rot severity rating of field pea on a scale of 0 to 4 where 0 = healthy, 1 = 1—10% root discoloration, 2 = 11—25%, 3 = 26—50%, and 4 = 51—100%.