Effects of seed infection by *Ascochyta* spp., fungicidle seed treatment, and cultivar on yield parameters of field pea under field conditions

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Field trials were conducted to determine the effects of seed infection by Ascochyta spp., fungicide seed treatment, and cultivar on seed yield and nutrient composition of field pea seed. Emerged seedling number and bushel weight of harvested seed were significantly reduced for seed with high Ascochyta spp. infection and also for the pea after pea site. Seed yields, however, were not affected by high or low levels of seed infection. No significant differences were observed for seed yield and nutrient content amongst the fungicide seed treatments. Cultivar SS7 consistently out-yielded cv. Tipu by approximately 25%. In a cultivar trial, significant differences were observed among cultivars for seed yield and resistance to Ascochyta blight.

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Des essais au champs furent effectues afin de determiner les effets de l'infection des semences par Ascochyta spp., les traitements fongicides des semences, le rendement des semences et la composition des substances nutritives des cultivars de semences de pois de grande culture au champs. Le nombre des jeunes plants emerges du sol et le poids des boisseaux de semences recoltees furent significativement reduits pour les semences ayant une infection élevée avec Ascochyta spp. ainsi que les pois cultives une seconde fois sur la même parcelle. Les rendements de semences, quoi qu'il en soit, ne furent pas affectes par des niveaux élevés ou bas d'infection de semence. Aucune difference significative ne fut observée pour le rendement des semences et le contenu des substances nutritives parmis les traitements fongicides des semences. Le cultivar SS7 a regulierement donne un rendement approximatif de 25 % superieur compare au cultivar Tipu. Dans un essai de cultivars, des differences significatives furent observees parmis les cultivars pour le rendement des semences et la resistance a la brûlure Ascochyta.

Introduction

Ascochyta blight of field pea (*Pisum sativum* var. arvense L.) is a disease complex comprising three distinctly recognizable symptoms, each associated with a different species of Ascochyta: leaf and pod spot caused by A. *pisi* Lib., foot-rot caused by A. pinodella Jones, and seedling blight caused by A. *pinodes* (Bark. and Blox.) Jones (5,8,13,14). The importance of this disease complex on field pea is well documented (13,14). The disease complex is usually most severe in areas of high rainfall (12). Primary inoculum of these pathogens can be either seed-borne or stubble-borne (5,8,12). Ascochyta-infected seeds usually have low germination and poor emergence (2,8). Effective seed treatments reduce the seed-borne inoculum and slow introduction of the pathogens to new areas (4,8,9,12,15). The dramatic increase in acreage devoted to field pea production in the prairies in recent years (1,6) prompted this study to assess the importance of fungicide seed treatment and cultivar on seed yield. The objectives of this study were: 1) to evaluate the effects of fungicide seed treatments and levels of seed infection on seed yield and on crude protein and phosphorus contents; and 2) to compare the yield of different pea cultivars and their resistance to Ascochyta blight under field conditions.

Materials and methods

Effects of seed infection and fungicide seed treatments. Experimental field plots were established at two sites near Barrhead in the spring of 1988: Site I, pea grown after barley and Site II, pea grown after pea. At each site, Treflan (trifluralin) was incorporated into the clay loam soils at a rate of 2.5 L/ha as a pre-emergence herbicide. A split-plot randomized complete block design with three replications was employed. The level of seed infection (SI) by Ascochyta spp. served as main plots, this tieing cv. SS7 seed with high SI (27.5%) and low SI (<0.5%), and cv. Tipu seed with low SI (<0.5%). Fungicide seed treatments served as subplots; these were Agrosol (thiram 0.40 g + thiabendazole 0.06 g a.i./kg seed), Apron 69T (metalaxyl 0.69 g + thiabendazole 0.35 g a.i./kg seed), Captan (captan 1.8 g a.i./kg seed), Thiram (thiram 0.90 g a.i./kg seed), UBI 2521 (carbathiin 0.55 g + thiabendazole 0.35 g a.i./kg seed), and a control. Seeds were treated in a cement mixer and planted 5 cm deep with a grain drill at a rate of 18 seeds/m. Each subplot consisted of 150 45-m rows, with 18 cm row-spacing. Adjacent subplots were separated by 1.5 m guard strips of barley; replicates were spaced 9 m apart. Peat-based inoculant was used as a source of root-nodule bacteria.

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Emerged seedlings were counted in 10 1-m^2 quadrants along a W-pattern transect through each subplot one month after sowing, and the mean number of plants per 1 m length of rows was calculated. At maturity, plants from each subplot were swathed and combined. Seeds were dried to 16% moisture content and weighed. Crude protein and phosphorus contents were determined using a near infrared reflectance spectrometer (11); bushel weight was determined at 10% moisture content.

Comparisons of pea cultivars. One field plot was established in the spring of 1988 near Westlock, Alberta. A pre-emergence herbicide, Edge (ethalfluralin), was incorporated into the soil at a rate of 1.6 kg/ha along with 60 kg/ha fertilizer (8-36-15-5, N-P-K-S). Twenty-four field pea cultivars were seeded in a randomized complete block design with three replications. Each single cultivar plot consisted of thirty-two 45-m rows spaced 15 cm apart. There were 30 cm between treatments and 15 m between replicates. Seeding rate and inoculant were as described above. Towards the end of the growing season, equal numbers of leaflets were removed from the upper, middle, and lower parts of the stem and arranged in sets of three leaflets each. The percentage of leaf area affected by ***Ascochyta*** spp. was determined using the disease assessment key designed by James (7) for Stemphylium leaf spot of red clover. One hundred and twenty sets of leaflets were rated for each plot. In addition, 20 plants from each plot were selected randomly, and the lengths of the blue-black lesions on their lower stems were measured and averaged. Seed yields were determined after harvesting the plots.

Data analysis. Analysis of variance and Student-Newman-Keuls' test were used to statistically analyze the data on number of emerged seedlings, disease severities, seed yield, and seed crude protein and phosphorus contents.

Results

Effects of seed infection. At both Sites I and II, seedling number and bushel weight of pea cv. SS7 with low seed infection significantly exceeded those of cv. SS7 with high seed infection (Table 1). The percentages of crude protein and phosphorus, and seed yield of cv. SS7, did not differ significantly between low and high seed infection. Seed crude protein content, seed yield, and bushel weight of cv. SS7 with low seed infection was significantly greater than that of cv. Tipu with low seed infection.

Effects of fungicide seed treatments. At Site I, no significant differences occurred among treatments in number of emerged seedlings, percentage of seed phosphorus, and bushel weight (Table 2). Significantly greater seed yield, however, was observed for the Agrosol treatment relative to other treatments, and in the Thiram treatment, the percentage of crude protein was significantly higher than in the Apron 69T treatment. At Site II, none of the fungicide treatments had any significant effect on seedling number, seed yield, bushel weight, and percentages of seed crude protein and phosphorus.

Comparison of pea cultivars. Greatest seed yield (4098 to 4470 kg/ha) was observed for cvs. Express, SS5, and Tara, compared with Banff, Meteor, PF70, Poppet, Puget, Scout, Signet, and Trojan, which yielded the least (1844 to 2891 kg/ha). Yield of the remaining 11 cultivars was intermediate (3000 to 3936 kg/ha) (Table 3). All cultivars were affected to varying degrees by Ascochyta blight (Table 3). Lowest percentages of infected leaf area were observed for cvs. Alaska, Jasper, Maple, Miranda, Princess, Rhonda, Signet, SS3, SS5, SS7, and Tara (11 to 13%), whereas greatest infection levels were observed for Sunset 85 and Victoria (31 and 32%, respectively). Infected leaf areas of remaining cultivars were intermediate (16 to 22%) infection. Of twenty-four cultivars examined for stem lesions,

Table 1. Effects of different levels of Ascochyta seed infection (SI) on field pea emergence, yield, and nutrient content at two sites with different cropping histories in central Alberta, Canada.

Site Treatment	Number of Seedlings (per m)	Seed Yield (kg/ha)	Crude Protein (%)	Phosphorus (%)	Bushel Weight (kg/bu)
I (Pea after Barley)					
cv. ss7 Low SI	19.7a*	4689.1a	21.9a	0.40a	29.9a
cv. SS7 High SI	17.2b	4516.0a	21.7a	0.39a	29.2b
cv. Tipu Low SI	18.6a	3608.3b	19.8b	0.39a	29.1b
II (Pea after Pea)					
cv. ss7 Low SI	17.2a	4103.8a	22.3a	0.38a	29.3a
cv. SS7 High SI	13.7b	4126.0a	22.4a	0.37a	28.8b
cv. Tipu Low SI	16.8a	3135.0b	21.2b	0.37a	28.7b

* Values in the same column within a site followed by the same letters are not significantly different at the 5% level using Student–Newman–Keuls' test.

Table 2. Effect of fungicide seed treatments on field pea emergence, yield, and nutrient content at two sites with different cropping histories in central Alberta, Canada.

Site Treatment	Number of Seedlings (per m)	Seed Yield (kg/ha)	Crude Protien (%)	Phosphorus (%)	Bushel Weight (kg/ha)
I (Pea after Barley)					
Agrosol	18.4a*	4484a	21.0ab	0.39a	29.0a
Apron 69T	17.8a	4269b	20.9b	0.40a	29.5a
Captan	18.0a	4302b	21.0ab	0.40a	29.6a
Thiram	19.1a	4238b	21.4a	0.39a	29.2a
UBI 2521	19.0a	4150b	21.1ab	0.40a	29.6a
Control	8.8a	4184b	21.2ab	0.39a	29.6a
GRAND MEAN	8.5	4271	21.1	0.39	29.4
II (Pea after Pea)					
Agrosol	5.7a	3709a	21.7a	0.38a	28.8a
Apron	15.9a	3805a	21.8a	0.38a	29.0a
Captan	16.0a	3754a	21.9a	0.37a	28.7a
Thiram	16.4a	3831a	22.1a	0.38a	29.0a
UBI 2521	15.9a	3788a	22.2a	0.37a	29.1a
Control	15.5a	3842a	22.1a	0.37a	28.9a
GRAND MEAN	15.9	3382	22.0	0.37	28.9

* Values in the same column within a site followed by the same letters are not significantly different at the 5% level using Student–Newman–Keuls' test.

twenty-one were classified as intermediate in disease resistance. Banff was the most resistant cultivar; whereas Century and Sunset 85 were the least resistant (Table 3).

Discussion

Previous studies reported that seed can become infected by mycelial growth through the pod wall when prolonged periods of precipitation occur before harvest (5,8,9,10). Seed infected by *Ascochyta* spp. usually has lower germination and poorer plant emergence in the field than does healthy seed (2,3,8,9). This is especially noticeable when seed is planted under environmental conditions adverse to rapid germination, such as low soil temperature and high moisture content (8). The results of the present study support these observations. The proportion of emerged cv. SS7 seedlings from the seed lot with a high rate of seed infection was 15% (Site I) and 26% (Site II) less than that of low SI. Therefore, it is important to use seed with a minimal level of seed infection.

The severity of Ascochyta blight fluctuates from year to year, depending upon weather conditions. The hot, dry weather experienced in 1988 would have been severely limiting to disease development and may explain some of the lack of significance among fungicide seed treatments. However, there is no doubt that pathogen populations can increase quickly and spread rapidly when environmental factors favour their development, especially where peas have been intensively cropped (14,15). The use of resistant cultivars is a highly desirable method of disease control. Results of this study demonstrate that even when environmental factors are unfavourable for disease development, the disease severity (based on percent leaf area infected and basal stem lesion length) varies among pea cultivars. This confirms previous work (2,3,13,15) which suggested that cultivars possessing a high level of genetic resistance to Ascochyta blight could be made available after an extensive breeding program.

Table 3. Comparative seed yield and Ascochyta disease severity among twenty-four field pea cultivars grown under field conditions in central Alberta, Canada.

Cultivar	Seed Yield (kg/ha)	Leaf area infected (%)	Stem lesion (cm)
Alaska 81	3068cdefg*	12c	2.3bc
Banff	2552fgh	22abc	1.oc
Century	3000cdefg	18abc	2.7b
Express	4470a	17abc	2.0bc
Jasper	3456abcdef	12c	2.3bc
Maple	3362bcdef	l l c	2.0bc
Meteor	1844h	22abc	2.0bc
Miranda	3149cdefg	12c	1.3bc
PF 70	2886defg	16bc	2.0bc
Poppet	2087gh	21abc	2.0bc
Princess	3142cdefg	l l c	2.0bc
Puget	2891defg	22abc	2.0bc
Rhonda	3866abcde	l l c	2.0bc
scout	2362fgh	18abc	2.0bc
Signet	2550fgh	12c	2.3bc
ss3	3258cdef	l l c	2.0bc
ss5	4319ab	13c	1.3bc
ss7	3936abcd	l l c	1.7bc
Sunset 85	3509abcdef	31ab	3.7a
Tara	4098abc	l l c	2.0bc
Tipu	3931abcd	18abc	1.7bc
Trapper	3082cdefg	16abc	1.7bc
Trojan	2610fgh	17abc	2.0bc
Victoria	3764abcde	32a	2.3bc

* Values in the same column followed by the same letters are not significantly different at the 5% level using Student-Newman-Keuls' test.

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Literature cited

1. Alberta Agriculture. 1980. Dry pea production in Alberta. Agrifax Agdex 142/20-6.
2. Ali, S.M., L.F. Nitschke, A.J. Dube, M.R. Krause and B. Camerson. 1978. Selection of pea lines for resistance to pathotypes of Ascochyta *pinodes,* A. *pisi* and Phoma *medicaginis* var. *pinodella.* Aust. J. Agric. Res. 29:841-849.
3. Ali-Khan, S.T., R.C. Zimmer and E.O. Kenaschuck. 1973. Reaction of pea introductions to ***Ascochyta pinodes foot-rot*** and powdery mildew. Can. Plant Dis. Surv. 53:155-156.
4. Beauchamp, C.J., R.A.A. Morrall and A.E. Slinkard. 1986. The potential for control of Ascochyta blight of lentil with foliar-applied fungicides. Can. J. Plant Pathol. 8:254-259.
5. Hare, W.W. and J.C. Walker. 1944. Ascochyta diseases of canning pea. Wis. Agric. Exp. Stn. Res. Bull. No. 150.
6. Hwang, S.F. and K.F. Chang. 1989. Root rot disease complex of field pea in northeastern Alberta in 1988. Can. Plant Dis. Surv. 69:139-141.
7. James, W.C. 1971. An illustrated series of assessment keys for plant diseases, their preparation and usage. Can. Plant Dis. Surv. 51:39-65.
8. Jones, L.K. 1927. Studies of the nature and control of blight, leaf and pod spot and foot-rot of peas caused by species of Ascochyta. N.Y. State Agric. Exp. Stn. Bull. No. 547.
9. Maude, R.B. 1966. Pea seed infection by Mycosphaerella pinodes and *Ascochyta pisi* and their control by seed soaks in thiram and captan suspensions. Ann. Appl. Biol. 57:193-200.
10. McKenzie, D.L. and R.A.A. Morrall. 1973. Diseases of three specialty legume in Saskatchewan in 1972: field pea, lentil and fababean. Can. Plant Dis. Surv. 53:187-190.
11. Pacific Scientific. 1988. Forage and Feed System User's Manual. Silver Spring, Maryland, U.S.A.
12. Skolko, A.J., J.W. Groves and V.R. Wallen. 1954. Ascochyta diseases of peas in Canada - with special reference to seed transmission. Can. J. Agric. Sci. 34:417-428.
13. Wallen, V.R. 1965. Field evaluation and the importance of the Ascochyta complex on peas. Can. J. Plant Sci. 45:27-33.
14. Wallen, V.R. 1974. Influence of three Ascochyta diseases of peas on plant development and yield. Can. Plant Dis. Surv. 54:86-90.
15. Wallen, V.R., T.F. Cuddy and P.N. Grainger. 1967. Epidemiology and control of A. pinodes on field peas in Canada. Can. J. Plant Sci. 47:395-403.