Fusarium Species in Underground Tissue of Pulse, Oilseed and Cereal Crops Grown in Southeast Saskatchewan

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Abstract

A total of 643 cereal, oilseed and pulse crops were sampled in southeast Saskatchewan in 2000 and 2001 for *Fusarium* populations in underground living tissue. Many of the *Fusarium* spp. isolated from discolored roots/subcrown internodes had also been isolated from cereal heads affected by fusarium head blight (FHB) in Saskatchewan. The most abundant *Fusarium* spp. were *F. avenaceum* and *F. equiseti*. *F. avenaceum* was present at the highest level in pulse, particularly lentil. Other species present at lower levels in both cereal and noncereal tissue were *F. acuminatum, F. culmorum*, *F. graminearum* and *F. sporotrichioides*. When fungal populations in discoloured subcrown internodes of wheat and barley were analyzed according to crop history, it was found that a preceding noncereal crop did not change the percent isolation of most species, including the cereal pathogens *F. culmorum* and *F. graminearum*. Furthermore, in most cases the percent isolation of total *Fusarium* spp., particularly that of *F. avenaceum*, was higher when wheat or barley were preceded by a noncereal crop than when preceded by another cereal crop or summerfallow. This is the first report of isolation of *F. graminearum*, the main causal agent of FHB in North America, from roots of field-grown pulse and oilseed crops in western Canada.

Introduction

Fusarium spp. have been isolated from roots of a variety of noncereal crops commonly grown in rotation with cereal crops in western Canada and other regions (Bailey et al., 2000; Berkenkamp and Vaartnow, 1972; Clarkson, 1978; Hwang et al., 1994). Many of the *Fusarium* species associated with root lesions of noncereal crops also cause fusarium head blight (FHB) (Fernandez et al., 2001; 2002) and root rot (unpublished) in wheat and barley, and have been isolated from residues of cereal and noncereal crops (Fernandez et al., 2003) in Saskatchewan.

Root colonization of noncereal crops by *Fusarium* spp. might serve as a source of inoculum for infection of roots/crowns and heads of cereal crops subsequently grown in the same field.

The objective of this study was to identify and quantify *Fusarium* spp. in underground tissue of noncereal and cereal crops grown in southeast Saskatchewan; and to compare *Fusarium*

populations in subcrown internodes of spring wheat and barley grown after different crops or summerfallow.

Materials and Methods

In late July to early August, 35-50 plants were carefully pulled at random from wheat, barley, canola, flax, lentil and pea fields in Crop Districts 1B and 5A, in southeast Saskatchewan. The number of fields sampled was 253 in 2000 and 348 in 2001. Discolored root/subcrown internode tissue was taken from each affected plant, surface-disinfested, and plated on modified potato dextrose agar (Burgess et al., 1988) for pathogen identification. Percent isolation of each fungus was calculated based on the total number of isolates in each field. Before plating, wheat and barley subcrown internodes were rated for discoloration on a 0-3 scale, based on the total surface area covered with lesions.

Results

Fusarium spp. in underground tissue of cereal and noncereal crops. Overall, *Fusarium* spp. were more frequently isolated in 2001 than in 2000 (Table 1).

Similar *Fusarium* spp. were isolated from underground tissue of all crop species sampled (Table 1). The most common *Fusarium* species isolated from roots of noncereal crops was *F. avenaceum*, followed by *F. equiseti*, whereas both these species had the highest percent isolation from subcrown internodes of cereals. Comparison among crop species indicated a higher percent isolation of *F. avenaceum* from pulse than oilseed or cereal crops, with the latter having the lowest levels. In addition, this pathogen was most commonly isolated from lentil than pea roots. Other species, including *F. culmorum* and *F. graminearum*, were less common in all crops. *Fusarium culmorum* was more frequently isolated from cereal than noncereal crops.

Association between percent isolation of *Fusarium* spp. from wheat/barley subcrown internodes and crop history. The severity of subcrown internode discoloration in wheat and barley was in most cases either similar or lower when these crops were preceded by a cereal than when preceded by a noncereal crop or summerfallow (Table 2). In most cases, the percent isolation of total *Fusarium* spp., including *F. avenaceum,* from subcrown internodes of wheat and barley was higher when these cereal crops were preceded by a pulse crop than when preceded by other crop types or summerfallow, except for oilseed. *Fusarium culmorum* had the lowest percent isolation when wheat was preceded by summerfallow, and the highest when barley was preceded by a pulse crop.

Cochliobolus sativus, the most common pathogen in cereal subcrown internodes (Table 2), had a higher percent isolation when wheat or barley were preceded by summerfallow than when they were preceded by any crop.

Table 1. Percent Isolation of *Fusarium* spp. from Discolored Roots of Noncereal Crops and Subcrown Internodes of Cereal Crops Sampled in Southeast Saskatchewan in 2000 and 2001.

Year/ crop	# of fields sampled	*Fusarium*							
		acuminatum	*avenaceum*	*culmorum*	*equiseti*	*graminearum*	*oxysporum*	*sporotrichioides*	total
		%							
2000									
canola	21	1	12	2	6	<1	0	<1	22
flax	11	<1	9	1	7	0	1	0	17
Oilseed	**32**	**1**	**11**	**1**	**6**	**<1**	**<1**	**<1**	**20**
lentil	8	1	54	0	15	0	0	0	69
pea	16	<1	38	1	7	0	0	1	47
Pulse	**24**	**<1**	**44**	**<1**	**10**	**0**	**0**	**1**	**55**
Wheat	134	1	4	2	5	<1	1	<1	14
barley	63	1	5	4	7	1	0	1	18
Cereal	**197**	**1**	**5**	**3**	**6**	**<1**	**<1**	**<1**	**16**
2001									
canola	59	1	23	1	13	<1	<1	<1	39
flax	22	1	15	<1	7	<1	0	<1	24
Oilseed	**81**	**1**	**21**	**1**	**12**	**<1**	**<1**	**<1**	**35**
lentil	5	3	52	0	16	0	9	0	81
pea	20	1	51	<1	6	<1	1	2	61
Pulse	**25**	**1**	**52**	**<1**	**8**	**<1**	**3**	**1**	**65**
Wheat	192	1	9	2	7	<1	1	1	21
Barley	50	<1	5	4	13	1	<1	<1	24
Cereal	**242**	**1**	**8**	**2**	**8**	**1**	**<1**	**1**	**22**

Discussion

The *Fusarium* species isolated from underground tissue of cereal and noncereal crops sampled in southeast Saskatchewan agree with those found in wheat and barley in the Black soil zone of the province in a survey conducted in 1998 and 1999 (unpublished).

The high percent isolation of *F. avenaceum* from discolored roots of noncereal crops agrees with reports indicating that this species was frequently associated with root rot and seedling blight of lentil (Hwang et al., 1994; Lin and Cook, 1977), pea (Clarkson, 1978), and canola (Berkenkamp and Vaartnou, 1972). The higher levels of *F. avenaceum* in roots of lentil than in roots of any other species agree with Hwang et al. (2000) who reported that lentil was more susceptible to this fungus than canola, barley, wheat, pea or oat in a greenhouse trial. *Fusarium avenaceum* isolates from roots of noncereal crops, including lentil, caused as much FHB on wheat as isolates from cereal heads (Fernandez, 2002).

Table 2. Severity of Subcrown Internode Discoloration, and Percent Isolation of *Cochliobolus sativus* and *Fusarium* spp. from Discolored Subcrown Internodes of Wheat and Barley Grown after an Oilseed, Pulse or Cereal Crop, or Summerfallow, in Southeast Saskatchewan in 2000 and 2001.

Crop/year/ preceding crop	# of fields	Moderate/severe subcrown internode discoloration	*C. sativus*	*F. avenaceum*	*F. culmorum*	*F. graminearum*	Total *Fusarium* spp.
		%					
Wheat:							
2000							
cereal	24	26[1]	36	5	4	1	17
oilseed	68	24	41	4	2	0	14
pulse	20	27	42	7	2	<1	14
summerfallow	15	26	58	2	<1	<1	9
Chi-square:		2.9ns	39.8***	10.9***	13.1***	12.1***	11.1***
2001							
cereal	51	31	38	6	2	<1	18
oilseed	77	23	35	10	2	<1	23
pulse	47	31	31	12	2	<1	23
summerfallow	12	28	61	5	0	0	19
Chi-square:		40.6***	72.7***	20.0***	6.0**	1.9ns	11.0***
Barley:							
2000							
cereal	24	42	51	3	2	1	14
oilseed	26	42	41	7	4	1	22
pulse	5	64	57	6	12	0	21
summerfallow	8	66	59	3	2	0	17
Chi-square:		34.5***	27.2***	13.1***	26.4***	4.2ns	16.0***
2001							
cereal	17	52	54	4	2	<1	16
oilseed	22	50	51	4	5	0	26
pulse	3	48	55	6	8	16	37
summerfallow	8	57	64	7	3	0	28
Chi-square:		2.8ns	9.2***	3.1ns	10.0***	153.5***	20.8***

[1] Percentage of plants with a moderate to severe discoloration rating, measured on a scale of 0-3.
*, ** and ***, significant at P<0.10, P<0.05, and P<0.01 based on chi-square tests; ns=not significant.

This first report of isolation of *F. graminearum* from roots of field-grown noncereal crops in western Canada agrees with a report by Chongo et al. (2000) who found that this fungus was pathogenic on the same crops when inoculated at seeding under controlled conditions.

Growing a noncereal crop or summerfallowing the previous year did not reduce the severity of subcrown internode discoloration in wheat or barley, but it affected the percent isolation of fungi. Previously-grown pulse or oilseed crops increased the percent isolation of *F. avenaceum* and total *Fusarium* spp. from subcrown internodes of wheat and barley, whereas summerfallowing resulted in higher levels of *C. sativus*. There was no apparent reduction in the isolation of the cereal pathogens *C. sativus*, *F. culmorum* or *F. graminearum* when wheat or barley were preceded by a noncereal than when preceded by another cereal crop.

Results from previous studies on the impact of growing a noncereal crop or summerfallowing on common root rot of cereals vary. Similar to our findings, root rot was found to be similar when wheat was grown after another cereal crop than when grown after canola or summerfallow (Chinn, 1976), or after a one year of flax (Conner et al., 1996). Growing wheat after flax was also reported to increase the incidence of *Fusarium* spp. in wheat roots (Bailey et al., 2001).

The association of *Fusarium* spp. with underground living tissue of cereal and noncereal crops agrees with the relative overall percent isolation of the same species from crop residues sampled in the same area (Fernandez et al., 2003), except that the levels of total *Fusarium* spp. in residues of cereal crops was as high as in residues of pulse crops. This might reflect saprophytic growth of these fungi after harvest.

Conclusions

The observations made in this study suggest that levels of *Fusarium* species, especially *F. avenaceum*, increased while those of the cereal pathogens *F. culmorum* and *F. graminearum* were maintained in underground tissue of noncereal crops grown in rotation with wheat and barley in southeast Saskatchewan. This could result in increased root rot caused by *Fusarium* spp. and in the development of FHB in subsequently-grown cereal crops.

This is the first report of isolation of *F. graminearum*, the main causal agent of FHB in North America, from roots of field-grown noncereal crops in western Canada.

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