Colonization of Cereal and Noncereal Crop Residues by *Fusarium* spp. in Southeast Saskatchewan

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Abstract

In July of 2000 and 2001, residues of wheat, barley, oat, canola, flax, lentil and pea crops were sampled from over 300 fields in southeast Saskatchewan. The noncereal crops sampled had been preceded by a cereal crop, whereas the cereal crops sampled had been preceded in most cases by a noncereal crop the previous year, and by another cereal crop one to three years previously. Residues were surface-disinfested and plated on nutrient agar for fungal identification. The most commonly isolated *Fusarium* species was *F. avenaceum*. Among those at lower levels were *F. acuminatum*, *F. equiseti*, *F. culmorum* and *F. graminearum*. Based on total fungal isolations, the relative percent isolation of most *Fusarium* spp. was similar for all residue types. However, the actual percent isolation of *Fusarium* spp. from canola residues was lower than from the other residue types. *F. avenaceum* was found at the highest levels in lentil, pea and flax residues. All *Fusarium* spp. found in/on residues were also previously isolated from wheat and barley heads affected by fusarium head blight (FHB) in Saskatchewan, although at different relative frequencies. Colonization of canola, flax, lentil and pea residues by *Fusarium* spp. commonly associated with FHB and root rot of cereals suggests that rotations with these noncereal crops might not be an effective control strategy against cereal diseases caused by *Fusarium* spp. in Saskatchewan. This is the first report of isolation of *F. graminearum* from residues of the most commonly-grown noncereal crops in western Canada.

Introduction

Crop residues are the main source of inoculum for some of the most important root, leaf and head/seed pathogens of cereals. In addition to colonizing host tissue, some cereal pathogens have also been isolated from living plants and residues of noncereal crops (Fernandez, 1991; Fernandez et al., 1993).

Fusarium head blight (FHB) is an important cereal disease in North America, affecting primarily wheat and barley (McMullen et al., 1997). *Fusarium* spp. are also important components of the root/crown rot complex of wheat and barley in Saskatchewan (unpublished). Some of the most common *Fusarium* spp. associated with FHB and root rot of cereals in Saskatchewan are also pathogenic on noncereal species. Pulse, oilseed and forage crops are susceptible to *F. avenaceum* (Bhalla et al., 1984; Hwang et al., 1994; Lager, 2002), *F. culmorum* (Lager, 2002), *F.*

graminearum (Chongo et al., 2001; Clarkson, 1978), and *F. poae* (Madia et al., 1997), all of which have been reported to be common FHB pathogens (Fernandez et al., 2002).

Whether plant tissue is colonized through parasitism during plant development or saprophytism after harvest, fungal growth on/in residues of alternative crops planted in rotation with cereals might allow wheat and barley pathogens to be carried from one season to the next. This would guarantee their survival, and possibly multiplication, and could result in the infection of subsequently-grown cereal hosts.

The objective of this study was to compare colonization by *Fusarium* spp. of residues of cereal and noncereal crops commonly grown in southeast Saskatchewan, and to compare fungal populations in crop residues with those in barley and wheat heads affected by FHB.

Materials and Methods

Fungi associated with FHB were assessed in spring common and durum wheat and barley fields across Saskatchewan from 1999 to 2001. Heads from 50 plants, between milk and dough stages, were collected randomly from each field. Glumes/kernels from heads with FHB symptoms were surface-disinfested in 10% Javex, and plated on potato dextrose agar (PDA) for identification of *Fusarium* spp. The percent isolation of each *Fusarium* species was calculated based on the total number of isolates of all *Fusarium* spp.

The crop residue study was conducted in southeast Saskatchewan because of the presence of FHB in previous years. A total of 148 fields in 2000 and 193 fields in 2001 were sampled in late July to early August for residues of crops grown the previous year. In 2000, crop residue samples consisted of 65 canola, 15 flax, 11 lentil, 15 pea, 18 wheat, 12 barley, and 12 oat; and in 2001, of 77 canola, 10 flax, 7 lentil, 36 pea, 43 wheat, 12 barley, and 8 oat. Residues were collected from the soil surface following a large circular pattern. In all cases, a wheat or barley crop was being grown the year of sampling. The noncereal crops sampled had been preceded the previous year by a cereal crop, whereas the cereal crops sampled had been preceded in most cases by a noncereal crop the previous year and by a cereal crop up to three years previously. About 30 pieces (2 cm each) were cut from each residue sample, washed thoroughly under tap water, surface disinfested in 10% Javex, rinsed, and plated on modified PDA (Burgess et al., 1988). After incubation for about a week, fungi were identified and percent isolation of each *Fusarium* species was calculated based on the total number of isolates of all fungal species observed in each sample. Data were analyzed using ANOVA. When F values were significant ($P<0.05$), LSDs were calculated.

Results and Discussion

Table 1 summarizes the percent isolation of *Fusarium* spp. from kernels/glumes of spring common and durum wheat and barley showing FHB symptoms, sampled across Saskatchewan from 1999 to 2001. Overall, the most common fungi in both wheat and barley were *F. poae* and *F. sporotrichioides*, followed by *F. avenaceum* and *F. graminearum*.

Fusarium spp. were also isolated from all crop residue types (Table 2). The overall percent isolation of these species was higher in 2001 than in 2000. This could be attributed to differences in levels of *F. avenaceum,* which was the most commonly isolated *Fusarium* species.

Fusarium equiseti was present at lower levels, followed by *F. acuminatum*, *F. culmorum*, and *F. graminearum*. *Fusarium poae* and *F. sporotrichioides* contributed to less than 1% of total isolations.

The relative percent isolation of the most common *Fusarium* spp. was relatively similar in all crop residue types for both years combined; however, the actual percent isolation of total *Fusarium* spp. was lower in oilseed than in pulse or cereal crops (Table 2). Pulse crops had the highest level of *F. avenaceum*, whereas cereal crops had the highest levels of *F. culmorum* and *F. equiseti*. Mean percent isolation of *F. graminearum* was also higher for cereal than noncereal crops, although this difference was not statistically significant.

Table 1. Percentage of Fields where *Fusarium* spp. were Isolated from FHB-affected Spring Common/Durum Wheat and Barley Kernels/Glumes in Saskatchewan from 1999 to 2001.

Crop/year	Total No. of fields with FHB	*Fusarium* *avenaceum*	*culmorum*	*graminearum*	*poae*	*sporotrichioides*
		%				
common/durum wheat						
1999	106	56[1]	5	6	43	33
2000	128	43	4	19	41	76
2001	72	32	13	40	28	64
Total/mean:	306	35	9	26	42	51
barley						
1999	40	43	0	18	60	40
2000	47	34	6	11	51	77
2001	49	33	4	12	67	86
Total/mean:	136	28	3	15	65	56

Table 2. Percent Isolation of *Fusarium* spp. from Residues of Cereal, Oilseed and Pulse Crops, Sampled in Southeast Saskatchewan in 2000 and 2001.

Year/ Crop type	No.of fields	*Fusarium* *acuminatum*	*avenaceum*	*culmorum*	*equiseti*	*graminearum*	*poae*	*sporotrichioides*	Total *Fusarium* spp.
		%							
Year									
2000	148	2[1]	17 b[2]	2	6 a	1	<1	<1	29 b
2001	193	2	29 a	1	3 b	2	<1	<1	38 a
Crop type									
oilseed	167	4	22 b	<1 b	2 b	1	<1	<1	26 b
pulse	69	3	36 a	<1 b	3 b	<1	<1	<1	43 a
cereal	105	1	19 b	4 a	9 a	5	1	<1	42 a

[1] Percent fungal isolation based on the total number of isolates observed in each sample.
[2] Values in columns followed by a different letter are significantly different at P<0.05, by LSD.

When crop species were analyzed individually, the percent isolation of total *Fusarium* spp. from canola residues was lower than from any of the other crop residue types, including flax, in both

2000 and 2001 (Table 3). Overall, the percent isolation of *F. avenaceum* from flax, lentil and pea residues was higher than from the other residue types. Although present at lower levels, the percent isolation of some of the other *Fusarium* spp., including *F. culmorum* and *F. graminearum*, from residues of one or more of the cereal crops was higher than from residues of the noncereal crops. *Fusarium culmorum* and *F. graminearum* are primarily cereal pathogens (Wiese, 1987).

The above observations agree with previous reports that the most important *Fusarium* species associated with FHB could also be isolated from living plants and residues of both cereal and noncereal crop species (Fernandez, 1991; Fernandez et al., 1993; Sturz and Bernier, 1987). However, in our study the overall relative percent isolation of these fungi differed markedly between heads and residues. In particular, *F. poae* and *F. sporotrichioides* were among the fungi most commonly isolated from wheat and barley kernels/glumes but were present at low levels in all residue types. This might be related to the poor competitive saprophytic ability of these fungi (Butler, 1953).

Table 3. Percent Isolation of *Fusarium* spp. from Residues of Three Cereal (Barley, Oat and Wheat), two Oilseed (Canola and Flax) and two Pulse (Lentil and Pea) Crops, Sampled in Southeast Saskatchewan in 2000 and 2001.

Year/Crop	No.of fields	*Fusarium* *acuminatum*	*avenaceum*	*culmorum*	*equiseti*	*graminearum*	*poae*	*sporotrichioides*	Total *Fusarium* spp.
		%							
<u>2000</u>									
oilseed									
canola	65	1[1] cd[2]	11 b	1 bc	3 c	1	<1 bc	<1	17 b
flax	15	<1 d	34 a	1 bc	7 a-c	<1	<1 bc	0	43 a
pulse									
lentil	11	2 b-d	32 a	1 bc	7 a-c	1	1 ab	0	44 a
pea	15	1 cd	29 a	0 c	5 bc	<1	0 c	0	36 a
cereal									
barley	12	4 bc	11 b	4 ab	11 a	2	0 c	<1	33 a
oat	12	8 a	10 b	6 a	11 ab	1	1 a	0	38 a
wheat	18	4 b	18 b	3 a-c	8 a-c	3	<1 bc	<1	38 a
<u>2001</u>									
oilseed									
canola	77	<1 c	25 d	<1 c	<1 c	<1 cd	<1 b	0 b	27 c
flax	10	3 b	47 ab	0 c	0 c	1 cd	<1 b	1 a	53 a
pulse									
lentil	7	2 bc	53 a	<1 bc	0 c	<1 cd	<1 b	0 b	56 a
pea	36	3 b	37 bc	<1 c	1 c	0 d	<1 b	<1 ab	41 b
cereal									
barley	12	6 a	10 e	4 b	19 a	12 a	1 b	<1 ab	54 a
oat	8	9 a	20 de	13 a	6 b	4 bc	4 a	0 b	59 a
wheat	43	2 bc	26 cd	2 bc	5 b	5 b	<1 b	<1 b	42 b

[1] Percent fungal isolation based on the total number of isolates observed in each sample.
[2] Values in columns followed by a different letter are significantly different at $P<0.05$, by LSD.

Even though the sporulation potential of the *Fusarium* spp. was not measured, fungal colonization of residues almost a year after harvest of the crops indicates their ability to survive, and potentially increase, in those tissues over time. This might explain the lack of a significant effect of crop rotation with noncereal crops on the development of FHB in wheat in the same area where this study was conducted (Fernandez et al., 2004). The noncereal crops tested might thus be a source of inoculum for head and/or root infection of subsequently grown cereal crops, especially in areas where environmental conditions are more conducive to FHB than where the present study was conducted.

Conclusions

Based on this research we conclude that growing lentil, pea, canola or flax in rotation with cereal crops in southeast Saskatchewan will not result in a significant reduction or eradication of *Fusarium* spp. pathogenic to cereals. This could be attributed to the wide host range of the fungi and/or their ability to colonize nonhost plant residues. In particular, *F. avenaceum* would be expected to be present at higher levels in residues of the noncereal (except for canola) than the cereal crops examined. However, fungi that are considered primarily cereal pathogens would likely be present at lower levels on noncereal than cereal residues.

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