Impact of Tillage System, Rotation and Fungicide Application on Field Crop Production 1998-2001

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Abstract

The impact of tillage, rotation, and fungicides on diseases and seed yield of wheat, barley, field pea, flax and canola was determined in the second cycle of 3, 4-year rotations at Melfort between 1998 and 2001. A 4-replicate split-split plot design was used with tillage systems (conventional, minimum and zero) as main-plots, three rotations (1 - canola, wheat, barley, barley; 2 - canola, barley, pea, wheat; and 3 - canola, pea, flax, barley) as sub-plots and fungicide treatments (treated or untreated) as sub-sub plots. Tillage system had little impact on diseases of any crop, although yield was greater under zero tillage than conventional or minimum tillage for most crops in the drought year of 2001. Rotation was not a major factor in disease severity of any of the crops except barley in Rotation 1, where it was grown for two consecutive years. Rotation did have an impact on yield of barley, which followed flax in Rotation 3 due to the water use of flax in 2000, which reduced barley yield in the drought year of 2001. Fungicide application had the greatest impact on disease control and yields although benefits varied among crop species and environments.

Introduction

Producers have been aggressively increasing the numbers of broadleaf crops in rotations and at the same time adopting reduced tillage practices. These practices are expected to increase economic returns, reduce costs, conserve soil moisture and increase soil health. However a number of concerns have been raised such as the possibility of greater crop disease problems, due to increased amounts of crop residue left on the soil surface and a greater probability of sclerotinia stem rot, due to increased cultivation of susceptible broadleaf crops. The objective of this study was to evaluate effects of various tillage systems on diseases and seed yield of 3, 4-year rotations consisting of increasing numbers of broadleaf crops. The impact of foliar fungicides was also examined for each crop within each tillage and rotation treatment.

Experimental Method

The experiment was located at Melfort on a Black silty clay loam soil from 1994 to 2001. The trial was a split-split plot design, with four replications and each phase of each rotation occurring every year. Main plots were tillage systems (conventional tillage – fall and spring tillage with harrow and packing of the seed bed; minimum tillage – spring tillage with harrow and packing of the seed bed; zero tillage – no fall or pre-seeding tillage), conducted with a medium duty

cultivator with 28 cm sweeps on 20 cm shank spacing. Sub-plots were rotations selected for increasing amounts of broadleaf crops (1: canola-wheat-barley-barley, 2: canola-barley-field pea-wheat, 3: canola-field pea-flax-barley). Sub-sub-plots were fungicide treatments (treated or untreated). Quadris (azoxystrobin) was applied at early flower in field pea to control mycosphaerella blight [*Mycosphaerella pinodes* and *Phoma medicaginis* var. *pinodella*] and at the 2-6 leaf stage of canola for blackleg [*Leptosphaeria maculans*]. Ronilan (vinclozolin) was applied at 20-30% bloom of canola to control sclerotinia stem rot [*Sclerotinia sclerotiorum*]. Tilt (propiconazole) was applied at the flag leaf stage to control leaf spot diseases in cereals. In 2000 and 2001 Kumulus (sulphur) was applied to flax at early flower to control powdery mildew (*Oidium lini*).

In the second cycle of the study (1998-2001) the cultivars were AC Oxbow barley, AC Barrie wheat, Exceed canola, Swing (1998-99) and Highlight (2000-01) field pea and Normandy flax. All crops were seeded with a 3.7 m pneumatic plot seeder and fertilizer was side-banded at seeding. All treatments had 100 kg/ha of 14-20-10-10 blended fertilizer. Nitrogen rates were calculated by target rate minus soil residual N. The target rates were 80 kg N/ha for barley and wheat, 90 kg N/ha for canola, and 60 kg N/ha for flax. Nitrogen fertilizer was not added to field pea plots.

Diseases were assessed on treated and untreated areas of each sub-plot for all crops. Barley and wheat were rated for leaf spots (25 plants per plot) using a whole plant rating scale (0-11). Canola was assessed for incidence (% of plants infected) of blackleg and sclerotinia on 100 plants per plot. Field pea and flax was assessed on a 0-9 scale based on amount of stem and leaf area infected of 10 plant vines per plot of field pea and 50 plants per plot for flax.

Results and Discussion

Tillage systems

There were few impacts on crop diseases in this study that could be attributed to use of a particular tillage system (Tables 1-5). The most important impact of tillage system on crop yield occurred in the drought year of 2001. Without exception for each crop the trend was to greater yield with zero tillage and lower yield under conventional tillage.

Rotations

In all rotations each crop species appeared only once, except for Rotation 1 where barley was grown for 2 consecutive years. Except for barley in Rotation 1 plant disease problems were not observed as a result of rotation (Tables 2-5). There was a concern that Rotation 3 (3 broadleaf crops and 1 cereal crop) might have a greater risk of sclerotinia stem rot in field pea and canola crops, however this did not occur. In Rotation 1, in 1998 and 1999 the second barley crop had greater foliar disease than the first barley crop (Table 1). This was expected as residue from the first crop likely harbored disease inoculant that put the second crop more at risk of diseases. Either barley crop in Rotation 1 yielded less than the barley crop in Rotation 2 or 3 in 1998 and

1999. The same trend occurred in 2000 although there was little difference in yield between barley crops in Rotation 1 in that year. In 2001 drought was the factor that had the greatest impact on crop yield. Disease severity was very low in 2001 in barley. Yield of barley was greatly reduced in Rotation 3 compared to other rotations because it followed flax in the rotation. Flax was adept at extracting moisture from the soil in the 2000 crop year, leaving the soil depleted, which reduced water availability to the subsequent barley crop.

Fungicide use

Barley diseases were identified as net blotch [*Pyrenophora teres*] and spot blotch [*Bipolaris sorokiniana*]. These diseases were reduced in every year by application of Tilt (Table 1). Yield was increased by 13-20% in 3 of 4 years. No yield increase was detected in 2001 due to the drought conditions. The percentage yield increase was similar among the rotations even though Rotation 1 was at greater risk of leaf spot diseases due to the inclusion of 2 barley crops within that rotation. However total yield was usually greater in Rotations 2 and 3 than in Rotation 1. The main diseases of wheat were septoria leaf blotch [*Stagonospora nodorum* and *Septoria tritici*]. Tilt decreased disease symptoms in every year and increased yield by 9-19% in 3 of 4 years (Table 2). Mycosphaerella blight of field pea was observed in all years of the test (Table 3). However a yield increase due to application of Quadris fungicide was detected in only 2 years. A 32% yield increase was observed in 1998 and 16% in 2000. In 1998 and 1999 powdery mildew was observed on flax. In 2000 and 2001 Kumulus fungicide was applied to sub-sub-plots but did not increase yield in either year (Table 4). The major diseases on canola were sclerotinia stem rot and blackleg although incidence of these diseases was usually low to moderate (Table 5). The application of Quadris and Ronilan fungicides usually reduced incidence of both diseases and increased yield in 2 of 4 years. However, the yield increases were small (<165 kg/ha) and therefore fungicide application in canola was not economically beneficial.

In summary tillage system and rotation had little impact on crop diseases or productivity under 4-year rotations. The rotation that included a single crop species for 2 consecutive years of 4 did result in greater disease severity and lower yield than rotations where the crop was included only once in a 4 years. The zero tillage system had a definite benefit in terms of increased crop yield under the drought conditions present in 2001. Fungicides had the most obvious impact on crop diseases and yield, although the benefit of fungicide application depended on the crop and the environment.

Table 1. Effect of TILT fungicide, tillage system (ZT-zero-till, MT – minimum tillage, CT – conventional tillage), and rotation (C – canola, W – wheat, B – barley, P – field pea , F – flax) on leaf spot disease rating (DR) and yield of AC Oxbow barley.

	1998		1999		2000		2001	
Practice	DR (0-11)	Yield (kg/ha)	DR (0-11)	Yield (kg/ha)	DR (0-11)	Yield (kg/ha)	DR (0-11)	Yield (kg/ha)
Control	5.8	4447	6.4	2679	9.1	3648	3.1	1945
Fungicide	4.8	5312	4.7	3021	8.5	4179	2.4	2023
$Lsd_{(0.05)}$	0.4*	96*	0.4*	69*	0.2*	104*	0.3*	230
ZT	5.3	4890	5.9	2913	8.5	3842	3.9	2624
MT	5.4	4851	5.5	2822	8.9	4041	2.5	1943
CT	5.3	4897	5.2	2816	8.8	3859	2.3	1386
$Lsd_{(0.05)}$	0.7	236	0.9	363	0.7	272	1.0	429*
C-W-B*-B	5.4	4739	5.3	2798	9.2	3625	2.8	1940
C-W-B-B*	5.3	4418	6.5	2424	8.6	3883	3.6	2449
C-B-P-W	5.3	5185	5.2	2988	8.5	4004	2.2	2207
C-P-F-B	5.4	5175	5.3	3192	8.8	4143	2.5	1341
$Lsd_{(0.05)}$	0.5	217*	0.6*	228*	0.5*	259*	0.4*	408*

Table 2. Effect of TILT fungicide, tillage system (ZT-zero-till, MT – minimum tillage, CT – conventional tillage), and rotation (C – canola, W – wheat, B – barley, P – field pea , F – flax) on leaf spot disease rating (DR) and yield of AC Barrie wheat.

	1998		1999		2000		2001	
Practice	DR (0-11)	Yield (kg/ha)	DR (0-11)	Yield (kg/ha)	DR (0-11)	Yield (kg/ha)	DR (0-11)	Yield (kg/ha)
Control	6.7	3265	8.3	2023	9.4	3282	3.7	1776
Fungicide	5.5	3873	5.4	2277	7.7	3575	3.1	1810
$Lsd_{(0.05)}$	0.3*	173*	0.6*	132*	0.7*	87*	0.3*	187
ZT	6.0	3504	6.7	2150	8.4	3378	3.3	2075
MT	6.0	3513	6.6	2138	8.7	3388	3.5	2015
CT	6.3	3690	7.1	2161	8.6	3519	3.4	1288
$Lsd_{(0.05)}$	0.5	140*	0.7	125	0.7	328	1.1	702*
C-W-B-B	6.0	3534	6.8	2087	8.5	3406	3.4	1912
C-B-P-W	6.1	3605	6.9	2213	8.7	3450	3.3	1673
$Lsd_{(0.05)}$	0.3	186	0.6	175	0.4	184	0.6	585

Table 3. Effect of QUADRIS fungicide, tillage system (ZT-zero-till, MT – minimum tillage, CT – conventional tillage), and rotation (C – canola, W – wheat, B – barley, P – field pea , F – flax) on mycosphaerella blight disease rating (DR) and yield of Swing (1998-99) and Highlight (2000-01) field pea.

	1998		1999		2000		2001	
Practice	DR (0-11)	Yield (kg/ha)	DR (0-11)	Yield (kg/ha)	DR (0-11)	Yield (kg/ha)	DR (0-11)	Yield (kg/ha)
Control	-	2462	3.1	2094	4.8	2003	3.8	2020
Fungicide	-	3237	3.0	2204	4.5	2317	3.8	1790
$Lsd_{(0.05)}$		239*	0.1	144	0.3	110*	0.2	135*
ZT	-	2827	3.1	2186	4.6	2288	3.8	2151
MT	-	3008	3.0	2160	4.8	2045	3.8	1919
CT	-	2713	3.1	2102	4.5	2148	3.8	1645
$Lsd_{(0.05)}$		607	0.2	311	0.2*	407	0.3	521
C-B-P-W	-	2729	3.0	2218	4.6	2196	3.7	2119
C-P-F-B	-	2969	3.1	2074	4.7	2125	3.9	1692
$Lsd_{(0.05)}$		259	0.1	234	0.5	297	0.2	225*

Table 4. Effect of KUMULUS fungicide (2000 and 2001) and tillage system (ZT-zero-till, MT – minimum tillage, CT – conventional tillage) on foliar diseases (pasmo and powdery mildew - DR) and yield of Normandy flax.

	1998		1999		2000		2001	
Practice	DR (0-9)	Yield (kg/ha)	DR (0-9)	Yield (kg/ha)	DR (0-9)	Yield (kg/ha)	DR (0-9)	Yield (kg/ha)
Control	-	-	-	-	5.5	2553	0	544
Fungicide	-	-	-	-	4.8	2675	0	372
$Lsd_{(0.05)}$					1.3	661		167*
ZT	-	1381	-	1008	5.0	2864	0	721
MT	-	1418	-	972	4.4	2644	0	408
CT	-	1291	-	929	6.1	2332	0	245
$Lsd_{(0.05)}$		214		243	2.6	1737		485

Table 5. Effect of both QUADRIS and RONILAN fungicides, tillage system (ZT-zero-till, MT – minimum tillage, CT – conventional tillage), and rotation (C – canola, W – wheat, B – barley, P – field pea , F – flax) on blackleg and sclerotinia incidence and yield of Excel canola.

Practice	1998			1999			2000			2001		
	Blackleg Incidence (%)	Sclerotinia stem rot Incidence (%)	Yield (kg/ha)	Blackleg Incidence (%)	Sclerotinia stem rot Incidence (%)	Yield (kg/ha)	Blackleg Incidence (%)	Sclerotinia stem rot Incidence (%)	Yield (kg/ha)	Blackleg Incidence (%)	Sclerotinia stem rot Incidence (%)	Yield (kg/ha)
Control	11.3	14.7	1784	55.1	12.7	1078	10.0	25.3	1631	10.8	0.5	1142
Fungicide	4.3	1.6	1852	47.5	11.8	1242	5.8	18.7	1753	4.8	0.3	1028
$Lsd_{(0.05)}$	3.0*	3.3*	70	4.7*	2.1	74*	2.2*	2.7*	66*	2.7*	0.4	109*
ZT	7.1	9.3	1817	43.1	11.6	1163	7.6	25.9	1631	8.9	0	1329
MT	6.2	7.1	1797	52.2	11.2	1156	5.8	18.7	1660	6.0	0.9	1042
CT	10.1	7.9	1840	58.7	13.9	1161	10.3	21.3	1785	8.5	0.3	885
$Lsd_{(0.05)}$	5.3	5.5	123	14.7	8.6	323	4.9	10.3	136*	6.7	1.2	149
C-W-B-B	7.1	8.6	1897	7.1	11.1	1132	8.5	20.3	1754	8.1	0.4	1212
C-B-P-W	8.2	8.9	1787	8.2	12.5	1140	7.7	25.7	1645	6.8	0.3	890
C-P-F-B	8.0	6.9	1770	8.0	13.0	1208	7.5	20.0	1677	8.5	0.5	1154
$Lsd_{(0.05)}$	2.3	2.9	68	2.3	3.1	156	2.9	4.7*	146	3.6	0.6	159*