

COPY

Improving disease management in canola using "planned-limited tillage"

December 29, 2001

B. Irvine
C. Grant
D. McLaren
D. Derksen

Project # CARP 2000 - D3
Date Rec'd Sept. 2002
Researcher Irvine
Reviewed by X [Signature]
Date Reviewed Sept 19/2002

RECEIVED

SEP 19 2002

SASKATCHEWAN CANOLA
DEVELOPMENT COMMISSION

Summary

- 1) Prespray weed numbers were greater when high disturbance tillage occurred. Lowest residual weed numbers were found when the stubble had been heavy harrowed.
- 2) Prespray wild oat numbers and buckwheat numbers were lowest when tillage had occurred in the year prior to the current year. Tillage just prior to seeding resulting in the highest weed numbers prior to spraying.
- 3) Canola disease yields were low and disease yields on pea stubble were similar on flax and pea residue.
- 4) Soil moisture levels did not differ between high disturbance and low disturbance plots.
- 5) Canola yields were greater on flax than pea stubble but disease ratings indicated that this would not due to greater sclerotinia levels. While canola yields were similar on pea and flax stubble in 2000 the lack of a pulse effect differs from some previously published work.
- 6) Rain and wind prevented spraying as early as desired and thus crop yields may have been reduced.

Future direction

- 1) The increase in dandelion and other perennial broadleaf species would indicate the need for a change in products applied. Curtail M will be applied to wheat, Flax Max to flax and 2 applications of Liberty at the low rate to canola.
- 2) An preliminary trial will be conducted to determine the impact of tillage system on the impact of early weed removal. The hypothesis to be tested is that the higher weed numbers resulting from tillage require earlier removal in order to prevent yield loss.
- 3) Spraying will be done at night to increase the number of days when spraying is possible.

Crop Rotations and tillage treatments

Wheat-canola-pea

Wheat-canola-flax (flax straw is removed from all flax plots as is the normal farm practice in this area).

The following tillage system was applied to each rotation such that each phase of the rotation and all phases of each rotation are included in each season. However, it is not possible to have strategic tillage occur 0, 1 and 2 years previously until 2002. Therefore there are many more low disturbance plots in 2000 than will be the case in 2003 and beyond.

The code HD2*** indicates that high disturbance occurred in 2001 and the other letters indicate the crop. W=wheat, P=pea, F=flax, C=canola.

1. LD= Low disturbance (seeded with double shoot hoe opener with preceding Roundup for weed control)
2. HD = Planned-limited tillage with heavy duty cultivator in the spring (prior to each crop in the sequence, with low disturbance planting in the other 2 years)
3. HHLD=Planned-limited tillage (heavy harrows in the fall to stimulate residue decomposition and weed seed germination with cultivation or glyphosate prior to seeding to control weeds) done every year.
4. PHX=Phoneix rotary harrow in the fall to stimulate residue decomposition and weed seed germination with cultivation or glyphosate prior to seeding to control weeds) as #2 this will occur once in 3 years with low disturbance seeding in the remaining years. This change was made and used in the flax rotation only since heavy harrows tended to drag residue from the plots into the pathways and since flax residue is always removed the impact in this rotation would be less than if pea residue was removed. In addition flax is not a significant host for sclerotinia and thus more flax plots are desirable to ensure that direct and indirect tillage impacts can be determined. While efforts are made to replace residue on the plots there is a concern that an artifact could be created.

All seeding was conducted with "Conservapak" openers on 9" (22.7 cm) centers. Nutrient application and weed control measures were applied according to the best management practice for that crop. High disturbance plots were cultivated twice at a depth of 7-8 cm, in the spring, prior to seeding.

Ammonium sulfate was applied to all plots and weed control was accomplished using non residual products.

Diseases and Insects

Neither previous crop or tillage had significant impacts on disease levels. Sclerotinia levels were the same on pea as on flax stubble (Table 1). Blackleg levels were low due in part to the high level of genetic resistance. We have observed similar results in other trials with a 3 year rotation. There was significant insect damage to the pods but this did not appear to affect crop yields.

Weeds

Prespray weed numbers were higher after flax than pea due mainly to volunteer flax. Prespray weed numbers were greater in plots where tillage (heavy duty cultivar) had occurred in the spring 2001 (Table 4). Wild oat and wild buckwheat numbers were lower (over all crops) when tillage had occur in the year previous (Tables 5-6). We attribute this to the fact that wild oat numbers were greater where plots are tillage in the current season and hence many of wild oats which are viable and non dormant grew in the previous season reducing the numbers in the crop the growing season after spring tillage. Canada thistle, sowthistle and dandelion numbers prior to spraying were variable and not associated with a specific treatment (Tables 7-9)

Residual weed counts (weeds after spraying) were lowest in wheat and greatest in flax (Table 10). Plots where heavy harrowing or phoenix rotary harrows were used in the fall of 2000 had lower residual weed counts but the differences may not have been large enough to be of biological significance. Low disturbance seeding had similar or higher residual weeds counts to treatments where high disturbance had occurred in this or the previous season. Wild oat and wild buckwheat residual numbers were lower when tillage had occurred the previous season (Tables 11-12) There was a trend towards greater numbers of dandelions and Canada thistle in plots where there had been tillage in the year previous (Tables 13-15).

Yields

In 2000 yields of flax and wheat were lower on high disturbance than on low disturbance plots (Table 2). In 2001 only pea yields were lower when disturbance occurred (Table 3). Since there are more prespray weeds when high disturbance occurs it may be more important to control weeds early. Canola yields were similar on direct seeded and tilled areas in both years. Canola yields on flax residue averaged 7% greater than on pea residue in 2001 and similar in 2002 (Table 3). The "pulse crop benefit" was no evident in these trials. The lowest canola yields in the trial were when high disturbance occurred in 2000 on flax and when high disturbance occurred in 2001 on pea residue. Both of these results were due to high levels of Canada thistle which reduced canola yields in a single plot of each treatment.

Revised:
Sept 12,
2001

Table 1. Impact of previous crop and tillage on disease and insect incidence in canola

Rated: Aug 14, 2001

Growth stage: Preswath

Ratings given as the number of plants infected per 25 plants examined, except alternaria¹

Trtmnt	Sclerotinia				Blackleg		Alternaria Pod Spot ¹				Insect Damage ²		
	Main	Upper	Both	Total ³	Stem	Basal	Sum of 25 Plants	Incidence /25 Plants	Mean% /Inf Plants	Mean% /25 Plants	Thrips	Pod	RM
HD1wfc	2.3	1.0	0.5	3.8	1.3	1.3	3.3	2.8	1.2	0.1	1.8	9.8	1.0
HD1wpc	2.0	0.5	0.8	3.3	2.8	0.3	3.8	3.0	1.1	0.2	0.5	6.3	0.5
HD2wfc	1.8	0.8	1.0	3.5	1.3	0.8	2.3	2.3	1.0	0.1	0.5	7.5	0.8
HD2wpc	0.7	0.7	0.5	1.9	1.1	0.4	2.8	1.8	1.1	0.1	1.1	5.9	0.7
HD3wfc	3.7	0.4	0.1	4.2	1.3	0.4	3.7	3.5	1.0	0.1	1.0	4.7	0.9
HD3wpc	1.5	2.3	1.3	5.0	0.8	1.3	3.3	2.5	1.4	0.1	1.5	11.5	0.8
HHwfc	1.0	1.8	0.8	3.5	2.0	1.0	5.3	2.5	3.3	0.2	1.3	12.3	1.0
HHwpc	1.0	1.0	1.0	3.0	2.0	0.5	2.5	2.3	1.1	0.1	0.8	7.5	0.0
LDwfc	3.0	2.0	1.0	6.0	2.0	0.3	1.5	1.5	0.8	0.1	2.0	7.3	0.8
LDwpc	2.3	0.5	0.3	3.0	0.5	0.5	3.3	2.3	1.2	0.1	0.3	6.8	0.8
phx1wfc	1.8	1.0	0.0	2.8	2.3	0.0	2.5	2.0	1.3	0.1	1.5	6.5	0.8
phx2wfc	1.0	2.5	0.3	3.8	0.8	0.8	15.0	7.5	1.5	0.6	2.3	9.0	0.3
phx3wfc	1.5	0.8	0.8	3.0	0.8	0.8	5.0	4.5	1.3	0.2	1.3	11.0	1.0

¹ Alternaria pod spot ratings are recorded as the percent of pod area covered by lesions. The sum of the 25 plants is total of the percent ratings given for all 25 plants in the plot. The incidence value is the number of plants in each plot infected with Alternaria. The mean % / inf plants is expressed as the average rating for those plants that were infected. The mean % per 25 plants is the average percent pod area infected for the 25 plants examined.

² Insect Damage where Pod refers to the feeding damage on the surface tissue of the pod(s) and RM refers to root maggot damage.

³ Total refers to the number of plants with sclerotinia lesions (out of 25 plants).

Table 2. Yield and agronomic traits as impacted by pre seeding tillage in 2000										
Current Crop	Previous Crop	Disturbance level	Seed yield Kg/ha	Dry matter			Lodging g (1-9)	Height cm	Days to Mature	Seed wt G/1000 Kg/hl
				5 weeks after seeding	at flowering	at seed				
Canola	Flax	HD	1967	95.0	624.6	6.0	119	98	3.27	68
	Flax	HHLD	1775	135.7	592.9	5.4	130	97	3.39	68
	Flax	LD	1952	127.0	594.0	5.3	123	98	3.32	68
	Flax	PHX	2193	123.2	516.8	4.8	118	97	3.20	68
	Pea	HD	1821	103.2	697.1	6.2	115	98	3.36	68
	Pea	HHLD	1912	115.1	615.2	6.8	118	98	3.25	68
	Pea	LD	1759	145.8	602.5	6.9	120	97	3.33	68
Prob > F			0.590	0.070	0.680	0.005	0.002	0.002	0.650	0.143
Flax	Wheat	HD	1046	13.7	415.4	1.4	65	100	6.08	62
	Wheat	HHLD	1395	31.7	480.8	2.8	67	96	5.28	60
	Wheat	LD	1384	36.8	489.4	2.7	67	97	5.37	60
	Wheat	PHX	1460	37.7	466.3	1.4	67	98	5.92	62
	Prob > F		0.000	0.010	0.473	0.130	0.335	0.004	0.490	0.666
Pea	Wheat	HD	2815	65.3	531.9	9.0	69	97	170.72	81
	Wheat	HHLD	2696	73.0	550.8	8.6	77	96	160.32	81
	Wheat	LD	2916	58.4	457.6	8.0	77	97	175.17	81
	Prob > F		0.850	0.110	0.290	0.163	0.116	0.916	0.060	0.734
Wheat	Canola	HD	2561	55.8	624.4	1.5	103	96	29.02	72
	Canola	HHLD	2719	118.7	688.2	2.9	108	95	29.30	73
	Canola	LD	2745	106.9	741.1	2.5	106	95	29.05	71
	Canola	PHX	2331	59.1	609.4	1.6	104	95	29.13	72
	Prob > F		0.000	0.000	0.008	0.001	0.000	0.040	0.900	0.816

Table 3. Impact of disturbance level and crop rotation on dry matter production and crop yields 2001

crop2001	tillage rotation	means				standard error			
		dry matter kg/ha		seed yield kg/ha	testwt kg/hl	dry matter kg/ha		seed yield kg/ha	testwt kg/hl
		5 weeks	flowering			5 weeks	flowering		
Canola	HD (yr-1) wfc	945	7273	1685	68.62	178.40	1508.51	107.08	0.08
Canola	HD (yr) wfc	939	6504	1814	68.57	104.96	484.04	118.73	0.03
Canola	HH_ wfc	1576	7509	1666	68.84	63.72	1038.96	99.89	0.12
Canola	LD_ wfc	1802	8668	1921	68.62	243.55	1217.86	19.59	0.24
Canola	phx (yr) wfc	1134	8000	1724	68.56	250.16	1615.19	73.39	0.17
Canola	phx(yr-1) wfc	1683	7336	1700	68.50	179.15	342.71	16.15	0.15
Canola	HD (yr-1) wpc	1412	7661	1665	68.32	160.13	724.27	96.46	0.10
Canola	HD (yr) wpc	984	5516	1645	68.47	181.60	1186.95	55.27	0.12
Canola	HH_ wpc	1438	6178	1709	68.66	119.16	439.63	67.57	0.14
Canola	LD_ wpc	1396	7556	1642	68.52	178.86	643.98	156.04	0.10
Prob > F		0.045	0.520	0.640	0.900				
Flax	HD (yr-1) cwf	485	4636	1192		124.24	933.72	47.35	
Flax	HD (yr) cwf	457	4942	1234		45.56	1050.24	106.18	
Flax	HH_ cwf	553	5401	1259		75.44	1196.54	52.88	
Flax	LD_ cwf	596	5714	1274		54.92	814.48	83.07	
Flax	phx(yr-1) cwf	567	2801	1204		68.49	907.53	73.59	
Flax	phx (yr) cwf	475	3317	1151		84.91	610.68	157.82	
Prob > F		0.010	0.150	0.835					
Pea	HD (yr-1) cwp	977	5158	1837	83.70	128.87	749.72	141.77	0.32
Pea	HD2 cwp	469	5096	1604	83.46	144.55	1448.04	157.52	0.31
Pea	HH_ cwp	921	6538	2088	83.68	69.84	1367.50	94.16	0.19
Pea	LD_ cwp	869	4913	2295	83.68	43.09	575.65	81.45	0.23
Prob > F		0.032	0.467	0.062	0.900				

Wheat	HD (yr-1)	fcw	2141	9479	1938	73.71	105.13	1779.63	128.30	0.49
Wheat	HD (yr)	fcw	1735	9066	2043	75.45	102.60	1306.37	132.48	0.84
Wheat	HH_	fcw	1507	9218	1991	74.43	305.83	1679.65	41.21	0.89
Wheat	LD_	fcw	1992	9467	1947	72.19	206.99	1586.40	104.52	2.69
Wheat	phx(yr-1)	fcw	1794	8987	2082	74.82	138.23	1533.40	117.55	0.87
Wheat	phx (yr)	fcw	1742	7327	1926	73.83	178.32	427.97	52.28	0.63
Wheat	HD (yr-1)	pcw	1908	6503	1913	72.68	113.05	749.18	178.39	0.65
Wheat	HD (yr)	pcw	1691	9095	2111	72.27	223.23	1053.35	56.04	1.01
Wheat	HH_	pcw	1641	7714	2042	73.39	204.19	633.17	130.90	0.75
Wheat	LD_	pcw	1976	8417	1898	74.05	150.97	1476.51	45.44	0.61
Prob >F			0.318	0.163	0.850	0.546				

HD (yr-1)= high disturbance in 2000; HD yr= high disturbance in 2001; HH= heavy harrow;
Phx (yr-1)= Phoenix harrows in 2000; phx (yr)= Phoenix harrows in 2001; LD= low disturbance;
w= wheat; f= flax; c= canola; p= pea;

Table 4: Summary of total weed counts (Pre-Spray) Strategic Tillage Trial 2001.

Treatment	Canola		Wheat		Flax		Pea		Mean
	w-f-c	w-p-c	f-c-w	p-c-w	c-w-f	c-w-p	c-w-p		
HD1 (Y-1)	69.3 ± 8.1	44.5 ± 8.2	38.2 ± 5.1	67.2 ± 13.8	34.5 ± 8.3	41.1 ± 6.7	49.1 ± 4.3		
HD2 (Y)	148.2 ± 14.8	137.5 ± 18.7	85.2 ± 8.9	49.9 ± 4.5	75.4 ± 18.3	62.6 ± 14.7	93.1 ± 9.3		
HH	137.8 ± 12.6	88.8 ± 6.8	96.5 ± 10.1	78.9 ± 14.4	55.1 ± 8.7	43.6 ± 6.4	83.5 ± 7.4		
PH1 (Y-1)	115.8 ± 10.4	-	52.7 ± 9.2	-	84.5 ± 15.0	-	84.3 ± 9.9		
PH2 (Y)	96.6 ± 11.4	-	74.2 ± 20.7	-	62.0 ± 14.2	-	77.6 ± 9.4		
LD	99.9 ± 7.0	85.7 ± 15.0	49.2 ± 9.5	65.8 ± 10.5	67.0 ± 7.3	26.2 ± 6.0	65.6 ± 6.1		

HD1= high disturbance in 2000; HD2= high disturbance in 2001; HH= heavy harrow;
PH1= Phoenix harrows in 2000; PH2= Phoenix harrows in 2001; LD= low disturbance;
w= wheat; f= flax; c= canola; p= pea;

Table 5: Summary of Wild Oat counts (Pre-Spray) Strategic Tillage Trial 2001.

Treatment	Canola		Wheat		Flax		Pea		Mean
	w-f-c	w-p-c	f-c-w	p-c-w	c-w-f	c-w-p	c-w-p		
HD1 (Y-1)	1.5 ± 0.4	3.2 ± 1.6	4.6 ± 2.8	6.4 ± 2.5	7.3 ± 2.6	8.2 ± 3.1	5.2 ± 1.0		
HD2 (Y)	19.2 ± 9.7	27.3 ± 5.6	20.8 ± 12.1	8.4 ± 4.5	41.4 ± 18.3	36.3 ± 18.4	25.6 ± 5.1		
HH	22.5 ± 9.0	12.5 ± 6.3	6.4 ± 3.8	6.8 ± 3.0	19.1 ± 10.4	13.2 ± 5.1	13.4 ± 2.7		
PH1 (Y-1)	5.1 ± 0.6	-	7.4 ± 3.9	-	29.3 ± 12.9	-	13.9 ± 5.2		
PH2 (Y)	17.6 ± 7.3	-	2.2 ± 0.9	-	22.7 ± 8.8	-	14.2 ± 4.3		
LD	16.1 ± 10.3	14.8 ± 7.7	5.2 ± 2.7	5.3 ± 3.9	33.8 ± 13.2	6.8 ± 3.8	13.7 ± 3.5		

HD1= high disturbance in 2000; HD2= high disturbance in 2001; HH= heavy harrow;
PH1= Phoenix harrows in 2000; PH2= Phoenix harrows in 2001; LD= low disturbance;
w= wheat; f= flax; c= canola; p= pea;

Table 6: Summary of Wild Buckwheat counts (Pre-Spray) Strategic Tillage Trial 2001.

Treatment	Canola		Wheat		Flax	Pea	Mean
	w-f-c	w-p-c	f-c-w	p-c-w	c-w-f	c-w-p	
HD1 (Y-1)	13.6 ± 2.7	12.6 ± 3.9	10.3 ± 2.8	28.1 ± 13.6	5.1 ± 1.1	9.0 ± 3.6	13.1 ± 2.7
HD2 (Y)	79.9 ± 22.0	50.0 ± 21.1	11.2 ± 4.0	6.9 ± 2.0	12.5 ± 2.0	3.9 ± 1.0	27.4 ± 7.4
HH	82.3 ± 16.9	27.7 ± 7.5	18.4 ± 6.6	29.6 ± 12.4	16.4 ± 3.5	21.4 ± 8.0	32.6 ± 6.0
PH1 (Y-1)	73.5 ± 11.6	-	10.3 ± 2.5	-	10.6 ± 4.6	-	31.5 ± 9.7
PH2 (Y)	39.0 ± 10.1	-	20.2 ± 6.8	-	14.2 ± 5.7	-	24.5 ± 5.1
LD	45.7 ± 5.1	28.4 ± 11.3	7.5 ± 1.6	26.7 ± 10.8	9.4 ± 4.3	6.0 ± 1.5	20.6 ± 3.9

HD1= high disturbance in 2000; HD2= high disturbance in 2001; HH= heavy harrow;
 PH1= Phoenix harrows in 2000; PH2= Phoenix harrows in 2001; LD= low disturbance;
 w= wheat; f= flax; c= canola; p= pea;

Table 7: Summary of Sow Thistle species counts (Pre-Spray) Strategic Tillage Trial 2001.

Treatment	Canola		Wheat		Flax	Pea	Mean
	w-f-c	w-p-c	f-c-w	p-c-w	c-w-f	c-w-p	
HD1 (Y-1)	12.6 ± 3.9	14.2 ± 7.0	0.3 ± 0.2	2.0 ± 0.6	4.3 ± 0.6	2.2 ± 1.4	5.9 ± 1.7
HD2 (Y)	4.5 ± 2.4	39.0 ± 30.4	1.6 ± 1.1	1.2 ± 0.7	0.3 ± 0.3	2.3 ± 0.8	8.2 ± 5.3
HH	2.0 ± 0.7	8.0 ± 3.7	2.4 ± 1.6	1.4 ± 1.0	1.3 ± 0.7	0.4 ± 0.2	2.6 ± 0.8
PH1 (Y-1)	5.0 ± 2.4	-	1.4 ± 0.9	-	14.5 ± 13.2	-	7.0 ± 4.4
PH2 (Y)	9.4 ± 3.1	-	2.0 ± 0.7	-	2.9 ± 1.9	-	4.8 ± 1.5
LD	4.1 ± 1.7	16.5 ± 13.4	0.6 ± 0.5	0.4 ± 0.4	3.5 ± 2.7	1.9 ± 1.3	4.5 ± 2.3

HD1= high disturbance in 2000; HD2= high disturbance in 2001; HH= heavy harrow;
 PH1= Phoenix harrows in 2000; PH2= Phoenix harrows in 2001; LD= low disturbance;
 w= wheat; f= flax; c= canola; p= pea;

Table 8: Summary of Canada Thistle species counts (Pre-Spray) Strategic Tillage Trial 2001.

Treatment	Canola		Wheat		Flax		Pea		Mean
	w-f-c	w-p-c	f-c-w	p-c-w	c-w-f	c-w-p	c-w-p	c-w-p	
HD1 (Y-1)	6.7 ± 1.9	5.9 ± 4.3	1.0 ± 0.5	2.4 ± 1.9	0.6 ± 0.2	3.6 ± 1.3	3.4 ± 0.9		
HD2 (Y)	3.2 ± 1.8	3.8 ± 2.1	2.4 ± 1.6	0.8 ± 0.3	0.5 ± 0.3	1.3 ± 0.7	2.0 ± 0.5		
HH	2.6 ± 1.1	4.1 ± 1.6	1.9 ± 0.8	2.4 ± 1.1	0.8 ± 0.5	0.7 ± 0.3	2.1 ± 0.4		
PH1 (Y-1)	4.5 ± 2.5	-	0.8 ± 0.5	-	1.5 ± 1.0	-	2.3 ± 1.0		
PH2 (Y)	2.5 ± 1.6	-	1.2 ± 0.3	-	4.5 ± 2.9	-	2.7 ± 1.1		
LD	3.4 ± 0.8	5.8 ± 1.6	0.8 ± 0.5	0.6 ± 0.4	0.9 ± 0.3	0.4 ± 0.2	2.0 ± 0.5		

HD1= high disturbance in 2000; HD2= high disturbance in 2001; HH= heavy harrow;
 PH1= Phoenix harrows in 2000; PH2= Phoenix harrows in 2001; LD= low disturbance;
 w= wheat; f= flax; c= canola; p= pea;

Table 9: Summary of Dandelion counts (Pre-Spray) Strategic Tillage Trial 2001.

Treatment	Canola		Wheat		Flax		Pea		Mean
	w-f-c	w-p-c	f-c-w	p-c-w	c-w-f	c-w-p	c-w-p	c-w-p	
HD1 (Y-1)	4.6 ± 1.9	0.9 ± 0.8	0.2 ± 0.2	1.0 ± 0.6	0.4 ± 0.3	2.5 ± 1.4	1.6 ± 0.5		
HD2 (Y)	0.1 ± 0.1	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.2 ± 0.2	0.0 ± 0.0	0.05 ± 0.04		
HH	0.5 ± 0.3	2.0 ± 1.7	0.2 ± 0.2	0.4 ± 0.3	0.7 ± 0.2	0.0 ± 0.0	0.6 ± 0.3		
PH1 (Y-1)	1.9 ± 0.9	-	0.8 ± 0.3	-	0.5 ± 0.3	-	1.1 ± 0.4		
PH2 (Y)	0.7 ± 0.4	-	0.3 ± 0.3	-	1.6 ± 1.2	-	0.9 ± 0.4		
LD	1.9 ± 0.9	0.9 ± 0.8	0.1 ± 0.1	0.1 ± 0.1	1.0 ± 0.7	0.3 ± 0.2	0.7 ± 0.2		

HD1= high disturbance in 2000; HD2= high disturbance in 2001; HH= heavy harrow;
 PH1= Phoenix harrows in 2000; PH2= Phoenix harrows in 2001; LD= low disturbance;
 w= wheat; f= flax; c= canola; p= pea;

Table 10: Summary of total weed counts (Residual) Strategic Tillage Trial 2001.

Treatment	Canola		Wheat		Flax		Pea		Mean
	w-f-c	w-p-c	f-c-w	p-c-w	c-w-f	c-w-p	c-w-p	c-w-p	
HD1 (Y-1)	75.2 ± 18.7	37.7 ± 10.6	10.5 ± 2.0	17.1 ± 7.7	52.1 ± 5.8	49.4 ± 19.8	40.3 ± 6.4		
HD2 (Y)	42.0 ± 8.9	68.2 ± 13.6	34.7 ± 5.4	18.2 ± 5.5	54.6 ± 5.3	40.3 ± 8.3	43.0 ± 4.4		
HH	26.4 ± 3.7	35.4 ± 4.1	15.7 ± 2.9	8.9 ± 0.8	54.4 ± 10.8	29.9 ± 2.7	28.5 ± 3.6		
PH1 (Y-1)	35.7 ± 6.2	-	22.0 ± 9.9	-	67.4 ± 12.5	-	41.7 ± 7.7		
PH2 (Y)	30.8 ± 8.0	-	17.2 ± 5.2	-	79.8 ± 19.0	-	42.6 ± 10.3		
LD	36.5 ± 8.8	51.2 ± 14.0	8.7 ± 1.0	6.7 ± 3.2	64.0 ± 10.4	34.6 ± 11.7	33.6 ± 5.5		

HD1= high disturbance in 2000; HD2= high disturbance in 2001; HH= heavy harrow;
 PH1= Phoenix harrows in 2000; PH2= Phoenix harrows in 2001; LD= low disturbance;
 w= wheat; f= flax; c= canola; p= pea;

Table 11: Summary of Wild Oat counts (Residual) Strategic Tillage Trial 2001.

Treatment	Canola		Wheat		Flax		Pea		Mean
	w-f-c	w-p-c	f-c-w	p-c-w	c-w-f	c-w-p	c-w-p	c-w-p	
HD1 (Y-1)	2.2 ± 0.5	2.4 ± 1.3	0.9 ± 0.6	0.0 ± 0.0	3.7 ± 1.4	5.9 ± 1.3	2.5 ± 0.5		
HD2 (Y)	6.5 ± 2.6	8.4 ± 3.5	6.1 ± 5.6	0.8 ± 0.3	1.2 ± 0.6	19.0 ± 11.6	7.0 ± 2.4		
HH	6.3 ± 2.3	8.7 ± 2.6	3.7 ± 1.9	0.7 ± 0.7	4.7 ± 4.3	5.2 ± 2.3	4.9 ± 1.1		
PH1 (Y-1)	4.1 ± 1.5	-	1.2 ± 1.2	-	5.9 ± 2.1	-	3.7 ± 1.0		
PH2 (Y)	9.4 ± 4.2	-	0.2 ± 0.2	-	4.1 ± 3.4	-	4.6 ± 2.0		
LD	6.0 ± 3.7	8.7 ± 3.6	0.6 ± 0.3	0.8 ± 0.5	8.7 ± 0.8	13.0 ± 9.7	6.3 ± 1.9		

HD1= high disturbance in 2000; HD2= high disturbance in 2001; HH= heavy harrow;
 PH1= Phoenix harrows in 2000; PH2= Phoenix harrows in 2001; LD= low disturbance;
 w= wheat; f= flax; c= canola; p= pea;

Table 12: Summary of Wild Buckwheat counts (Residual) Strategic Tillage Trial 2001.

Treatment	Canola		Wheat		Flax		Pea		Mean
	w-f-c	w-p-c	f-c-w	p-c-w	c-w-f	c-w-p	c-w-p	c-w-p	
HD1 (Y-1)	5.6 ± 3.1	4.2 ± 1.8	2.9 ± 1.5	2.6 ± 0.4	7.0 ± 1.6	5.2 ± 1.5	4.6 ± 0.7		
HD2 (Y)	10.1 ± 6.2	9.4 ± 4.0	10.6 ± 3.7	5.6 ± 1.0	13.4 ± 2.4	5.0 ± 2.4	9.0 ± 1.5		
HH	1.5 ± 0.8	3.8 ± 1.7	2.3 ± 0.9	1.9 ± 1.2	10.6 ± 1.2	8.4 ± 2.9	4.8 ± 0.9		
PH1 (Y-1)	6.2 ± 3.2	-	8.5 ± 4.4	-	15.7 ± 4.5	-	10.1 ± 2.5		
PH2 (Y)	2.9 ± 1.3	-	2.5 ± 0.6	-	7.8 ± 3.3	-	4.4 ± 1.3		
LD	3.2 ± 1.5	10.1 ± 2.6	1.6 ± 0.4	0.4 ± 0.2	10.9 ± 3.4	9.2 ± 1.8	5.9 ± 1.1		

HD1= high disturbance in 2000; HD2= high disturbance in 2001; HH= heavy harrow;
 PH1= Phoenix harrows in 2000; PH2= Phoenix harrows in 2001; LD= low disturbance;
 w= wheat; f= flax; c= canola; p= pea;

Table 13: Summary of Sow Thistle species counts (Residual) Strategic Tillage Trial 2001.

Treatment	Canola		Wheat		Flax		Pea		Mean
	w-f-c	w-p-c	f-c-w	p-c-w	c-w-f	c-w-p	c-w-p	c-w-p	
HD1 (Y-1)	10.7 ± 3.1	3.9 ± 2.1	0.3 ± 0.2	0.9 ± 0.4	4.1 ± 0.9	3.4 ± 2.4	3.9 ± 1.0		
HD2 (Y)	1.6 ± 0.4	14.5 ± 12.3	0.0 ± 0.0	0.3 ± 0.2	1.2 ± 0.6	1.5 ± 0.5	3.2 ± 2.1		
HH	0.6 ± 0.3	0.9 ± 0.6	0.3 ± 0.2	0.2 ± 0.2	1.9 ± 1.0	0.7 ± 0.4	0.8 ± 0.2		
PH1 (Y-1)	4.1 ± 1.2	-	1.0 ± 0.7	-	11.2 ± 9.2	-	5.4 ± 3.1		
PH2 (Y)	1.4 ± 0.6	-	0.6 ± 0.5	-	4.0 ± 3.2	-	2.0 ± 1.1		
LD	1.1 ± 0.7	6.3 ± 3.8	0.3 ± 0.3	0.3 ± 0.2	2.4 ± 1.9	0.4 ± 0.2	1.8 ± 0.8		

HD1= high disturbance in 2000; HD2= high disturbance in 2001; HH= heavy harrow;
 PH1= Phoenix harrows in 2000; PH2= Phoenix harrows in 2001; LD= low disturbance;
 w= wheat; f= flax; c= canola; p= pea;

Table 14: Summary of Canada Thistle species counts (Residual) Strategic Tillage Trial 2001.

Treatment	Canola		Wheat		Flax		Pea		Mean
	w-f-c	w-p-c	f-c-w	p-c-w	c-w-f	c-w-p	c-w-p		
HD1 (Y-1)	11.9 ± 5.1	10.0 ± 2.9	0.8 ± 0.3	3.4 ± 1.4	3.9 ± 1.9	6.8 ± 3.4	6.1 ± 1.3		
HD2 (Y)	3.3 ± 1.5	9.5 ± 5.7	4.3 ± 2.9	2.5 ± 1.6	1.9 ± 1.1	0.6 ± 0.3	3.7 ± 1.2		
HH	2.4 ± 0.6	3.6 ± 0.8	1.5 ± 0.4	2.5 ± 1.1	5.7 ± 2.1	2.0 ± 0.8	3.0 ± 0.5		
PH1 (Y-1)	4.2 ± 1.1	-	1.3 ± 1.3	-	5.5 ± 4.3	-	3.7 ± 1.5		
PH2 (Y)	3.2 ± 0.8	-	2.1 ± 1.6	-	5.8 ± 3.6	-	3.7 ± 1.3		
LD	5.1 ± 1.1	7.7 ± 2.7	1.1 ± 0.4	1.0 ± 0.5	3.2 ± 1.4	4.1 ± 1.5	3.7 ± 0.7		

HD1= high disturbance in 2000; HD2= high disturbance in 2001; HH= heavy harrow;
 PH1= Phoenix harrows in 2000; PH2= Phoenix harrows in 2001; LD= low disturbance;
 w= wheat; f= flax; c= canola; p= pea;

Table 15: Summary of Dandelion counts (Residual) Strategic Tillage Trial 2001.

Treatment	Canola		Wheat		Flax		Pea		Mean
	w-f-c	w-p-c	f-c-w	p-c-w	c-w-f	c-w-p	c-w-p		
HD1 (Y-1)	30.7 ± 13.2	5.6 ± 3.1	2.0 ± 0.6	6.6 ± 5.3	12.4 ± 5.4	10.0 ± 6.3	11.2 ± 3.1		
HD2 (Y)	5.1 ± 2.7	9.7 ± 2.2	4.1 ± 2.4	2.4 ± 0.8	1.5 ± 0.7	2.0 ± 1.0	4.1 ± 0.9		
HH	2.4 ± 1.3	4.1 ± 3.1	4.1 ± 1.9	1.5 ± 0.5	5.1 ± 3.4	2.0 ± 0.8	3.2 ± 0.8		
PH1 (Y-1)	7.7 ± 2.4	-	4.2 ± 1.2	-	9.6 ± 6.5	-	7.2 ± 2.2		
PH2 (Y)	2.7 ± 1.7	-	8.6 ± 6.1	-	9.7 ± 5.8	-	7.0 ± 2.7		
LD	7.7 ± 4.6	6.6 ± 4.1	1.6 ± 0.4	3.2 ± 2.1	12.4 ± 8.9	1.9 ± 0.7	5.6 ± 1.8		

HD1= high disturbance in 2000; HD2= high disturbance in 2001; HH= heavy harrow;
 PH1= Phoenix harrows in 2000; PH2= Phoenix harrows in 2001; LD= low disturbance;
 w= wheat; f= flax; c= canola