SHORT COMMUNICATION

Survey of yield losses due to weeds in central Alberta

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Harker, K. N. 2001. **Survey of yield losses due to weeds in central Alberta.** Can. J. Plant Sci. **81**: 339–342. Weedy and weed-free yields were determined in fields of barley, canola, and peas in Lacombe County, Alberta, Canada from 1995 to 1997. Yield losses were most frequent and severe in peas, and least frequent and less severe in barley. Yield losses due to weed competition were not detectable at 33, 60, and 73% of the pea, canola, and barley sites, respectively.

Key words: Competition, interference, barley, canola, peas

Harker, K. N. 2001. **Étude des diminutions de rendement attribuables aux adventices dans le centre de l'Alberta**. Can. J. Plant Sci. **81**: 339–342. L'auteur a identifié les champs d'orge, de canola et de pois avec et sans adventices dans le comté de Lacombe (Alberta, Canada), de 1995 à 1997. Les diminutions de rendement étaient les plus courantes et les plus importantes pour le pois, et les moins fréquentes et les moins graves pour l'orge. L'auteur n'a pu déceler de diminution du rendement attribuable à la concurrence des mauvaises herbes dans 33, 60 et 73 % des champs de pois, de canola et d'orge, respectivement.

Mots clés: Concurrence, interférence, orge, canola, pois

Weeds continue to reduce profits for crop producers. In 1998, herbicide sales in western Canada field crops were slightly below $1 billion (Crop Protection Institute of Canada 2000). However, even after "best management practices: crop losses due to weeds in western Canada field crops are estimated to exceed $500 million annually (Swanton et al. 1993). Future weed management techniques may help compensate for some of these losses, but yield losses are unlikely to decrease dramatically in the short term.

Some crops are said to have critical weed-free periods that vary with crop and variety, location, weed species and density, and year (Weaver 1984). Zimdahl (1988) concluded that "the critical period, if it can be defined, is a measure of the particular crop/weed environment interaction and not an inherent property of the crop". Therefore, the degree of crop loss due to weeds can vary widely from year to year depending on weed species and density, crop competitiveness, relative time of weed/crop emergence, and environmental conditions. Indeed, variable environmental conditions from year to year can preclude accurate predictions from generalized competition models (Wall et al. 1991). O'Donovan (1996) suggests that crop/weed competition models can be used to develop economic thresholds for weeds; however, he was skeptical that western Canadian farmers will shift from prophylactic herbicide application to applications based on thresholds. Are there cases where herbicide applications are not necessary for optimum yields? Do some crops require less yield protection than others? A study was conducted to determine the frequency and severity of yield loss in weedy barley, canola, and peas in central Alberta.

From 1995 to 1997, barley canola, and pea fields (four new fields per crop per year) were selected for study in Lacombe County. Field selection criteria were based on the willingness of growers to co-operate rather than on weed communities, weed densities or cropping practices. Some fields were direct-seeded, but most were in a conventional tillage regime. Fields with pre-plant incorporated or pre-emergence herbicides were not considered for the study. The experimental areas (0.2 to 0.4 ha) were marked and given sufficient borders to prevent spraying and harvest operations on the remainder of the fields from compromising the experiments. Shortly after crop emergence, paired plots (2 by 4 m) were marked in areas where crop density and weed populations were representative of the remainder of the field. Each crop site had four of these paired plots (replications). Half of the paired plot (2 by 2 m) was randomly assigned as hand-weeded and compared to the other half of the plot (non-weeded area) for data collection. Each site was arranged as a randomized complete block design.

Weeds were identified, counted, and removed (weed-free plots) within 3 wk of crops emergence. Crop stand counts were also determined in the same interval. Weed-free plots were hand-weeded throughout the growing season. At the end of the season, weed dry weights were determined in the weedy plots and crop seed weights were determined from the entire weedy and weed-free area (2 by 4 m). Treatment effects (weedy versus weed-free) were reported as P-values directly from the ANOVA. Pearson correlation coefficients were determined for yield relationships with crop stand counts, weed numbers, and seed weights.

Dicot weeds were much more abundant than monocot weeds at most sites (Table 1). Common chickweed

Table 1. Most abundant weed species and density for each crop species[z]

	Most abundant weed			Next most abundant weed		
Crop	Species	Sites #	Mean density (# m^{-2})	Species	Sites #	Mean density (# m^{-2})
Barley	Common chickweed	3	417	Wild oat	3	46
	Spiny annual sowthistle	3	388	Stinkweed	2	12
	Stinkweed	3	28	False cleavers	1	98
	Common lambsquarters	1	598	Common chickweed	1	95
	Quackgrass	1	51	Green foxtail	1	38
				Cutleaf nightshade	1	33
				Canada thistle	1	7
				Volunteer canola	1	7
Canola	Common chickweed	3	141	Stinkweed	3	18
	Stinkweed	3	111	Common chickweed	1	114
	Spiny annual sowthistle	2	159	Shepherdspurse	1	34
	Volunteer barley	1	65	Quackgrass	1	14
	Common lambsquarters	1	7	Dandelion	1	13
				Hempnettle	1	7
				Volunteer barley	1	7
				Common lambsquarters	1	4
Peas	Common chickweed	3	237	Common chickweed	4	55
	Stinkweed	3	130	Stinkweed	3	120
	Spiny annual sowthistle	3	76	Volunteer barley	2	35
	Shepherdspurse	1	751	False cleavers	1	76
	Quackgrass	1	51	Dandelion	1	16
	Dandelion	1	14	Pineapple-weed	1	12

[z]Weed density data are averaged over sites and/or years when sites are greater than one.

(*Stellaria media*), stinkweed (*Thlaspi arvense*), and spiny annual sowthistle (*Sonchus asper*) were dominant weeds at some sites for all three crops. Although quackgrass (*Elytrigia repens*), dandelion (*Taraxcum officinale*), and Canada thistle (*Cirsium arvense*) were important weeds at a few sites, perennial weeds were usually found at relatively low densities. At most sites weed densities averaged well over 100 plants m^{-2}. Barley sites tended to have the highest weed density.

Yield differences between weedy and weed-free plots were most common in pea fields and least common in barley fields (Table 2). Yield losses were significant ($P < 0.05$) at 27, 40, and 67% of the sites for barley, canola, and peas, respectively. At sites with a significant yield loss, yield reductions averaged 29% for barley, 40% for canola, and 46% for peas (from Table 2). Therefore, yield losses were most severe in peas, somewhat less severe in canola, and least severe in barley. Barley appeared to be a better competitor with weeds than canola or peas. In a central Alberta study of intercropped barley and peas, Izaurralde et al. (1990) reported low intercrop pea yields, and barley yields that were often unaffected by pea competition. In addition, O'Donovan and Blackshaw (1997) suggested that volunteer barley was probably more competitive in peas than in canola. The latter studies confirm the order of competitiveness apparent in the current study.

In a survey of this nature, it is important to note that because all three crops were not randomly assigned to weedy and weed-free plots at a given site, no valid statistical comparisons among crops were possible. The "order of competitiveness" was simply derived from the number of sites where yield loss was detected. Nevertheless, assuming a lack of bias in site selection, and relatively consistent results from year to year, the frequency and severity of yield loss at different sites can still be instructive.

There were only two cases in peas and one in barley where weed-free plots had higher seed weights (1000 seeds) than weedy plots: all other comparisons were not statistically significant (data not shown). Therefore, yield differences between weed-free and weedy plots were probably related more to seed number than to seed size.

Crop yield associations with stand counts were weak or absent in most cases and varied greatly from year to year and from site to site (Table 3). Stand counts in canola were not significantly correlated with yield. Indeed, most canola yield correlations with crop stand, although not significant, tended to be negative. Perhaps the strong compensatory nature of canola negated yield associations with crop stand (McGregor 1987). In barley and peas, most yield associations with crop stand were positive; however, these were significant once in barley (1996, site 1) and once in peas (1999, site 4).

Weed numbers and weed weights sometimes had strong negative associations with crop yield, especially in peas (Table 3). In 1995, weed weight had a strong negative correlation with pea yield at three of four sites. Unfortunately, weed weights at harvest are of little predictive value for crop yields in the same year. At the remaining site (site 1), weed number had a strong negative correlation with pea yield.

It would appear that yield in weedy barley, canola, and pea crops is more closely related to environmental conditions at a particular site for a particular year, than it is to

Table 2. Yields and *P*-values for weedy versus weed-free plots of barley, canola, and peas from 1995 to 1997

Crop	Site	1995 Weedy	1995 Weed-free	1995 *P*-value[z]	1996 Weedy	1996 Weed-free	1996 *P*-value	1997 Weedy	1997 Weed-free	1997 *P*-value
		g m^{-2}			g m^{-2}			g m^{-2}		
Barley	1	655	719		585	685		230	285	
	2	543	727	**	351	629		170	282	**
	3	769	774		531	557		335	427	***
	4	–	–		445	432		165	209	
Canola	1	221	209		172	218		275	300	
	2	116	168	***	131	202	**	123	167	
	3	83	194	***	187	194		158	134	
	4	–	–		–	–		81	126	**
Peas	1	349	657	***	403	597	**	288	365	**
	2	323	582	**	472	541		322	311	
	3	224	624	***	389	660	*	339	328	
	4	304	648	***	255	618	**	168	333	***

[z]*P* values of significant ANOVA comparisons between weedy and weed-free < 0.10, < 0.05, and < 0.01, are represented by *, **, and ***, respectively.

Table 3. Pearson correlation coefficients for yield relationships in weedy plots with crop stand counts, weed numbers, and weed weight in barley, canola, and peas from 1995 to 1997[z]

Crop	Site	1995 Crop count	1995 Weed no.	1995 Weed wt.	1996 Crop count	1996 Weed no.	1996 Weed wt.	1997 Crop count	1997 Weed no.	1997 Weed wt.
Barley	1	0.14	0.23	–0.11	0.92*	–0.66	–0.94*	0.15	–0.95**	–0.59
	2	0.74	–0.22	0.85	0.05	0.09	0.76	0.18	–0.68	–0.23
	3	–0.45	–0.38	–0.07	–0.71	–0.05	–0.66	0.16	–0.05	0.45
	4	–	–		–	–	–	–0.11	0.94*	–0.73
Canola	1	–0.13	–0.99**	–0.79	–0.25	0.41	0.04	–0.67	–0.83	–0.57
	2	0.86	0.30	–0.92*	0.51	–0.71	0.04	0.59	0.07	0.53
	3	–0.22	0.01	0.24	–0.71	0.39	0.26	0.46	0.78	0.28
	4	–	–		–	–		–0.19	0.03	–0.28
Peas	1	0.71	–0.96**	0.62	0.70	–0.49	–0.67	0.89	0.89	0.72
	2	–0.78	0.25	–0.93*	0.37	–0.88	–0.95**	0.49	–0.65	0.68
	3	0.15	–0.63	–0.94*	0.19	0.70	0.28	0.25	–0.56	–0.71
	4	0.90*	–0.88	–0.96**	–0.36	–0.00	–0.43	0.83	–0.96**	–0.75

[z]*P* values of significant correlations < 0.10, < 0.05, and < 0.01, are followed by *, **, and ***, respectively.

crop stand, weed numbers, or weed weight. For economic threshold models to be effective, weed numbers should have a strong association with yields. More replications at each site would probably increase the number of significant correlations, but many of the correlations tended to go in the opposite direction to what predictive models would suggest. The latter suggests that under some conditions, models that predict the outcome of specific weed/crop interactions will not be successful.

In conclusion, yield losses were most frequent and severe in peas and least frequent and less severe in barley. In peas, weed numbers and weights were more strongly associated with pea yield than was crop stand. Significant yield losses due to weed competition were not detected at 60% of the canola and 73% of the barley sites. In contrast, pea yield loss due to weed competition was not detected at only 33% of the pea sites. Marginal herbicide rates and/or decisions to forgo herbicide application will probably be more successful in canola or barley than in peas.

The author acknowledges Murray McLelland, Phil Thomas, and Neil Miller for assistance with site selection. Daryl Friesen and Bob Pocock provided technical assistance. Funding support was provided by the Alberta Agriculture Research Institute (#95M769).

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