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Distribution and interference of dandelion (*Taraxacum officinale*) in spring canola

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In both reduced-tillage and tilled fields, dandelion can be a problem, but the effect of dandelion on canola yield is unknown. This study was conducted to investigate the effect of dandelion infestation on spring canola yield and the influence of tillage on interference and in-field distribution of dandelion. Dandelion distribution was not associated with tillage regimen. Dandelion distribution showed some relationship to past cropping history, for example, the presence of alfalfa in the rotation. The strength of correlation between measures of dandelion infestation level and canola yield loss was associated with tillage regimen. For tilled fields, there was no correlation between reduction in canola yield and any measurements of dandelion infestation level. For reduced-tillage fields, the most reliable measures of dandelion interference level were dandelion ground cover prespray, total dandelion rosette diameter prespray, relative dandelion ground cover prespray, and total dandelion root diameter at crop harvest.

Nomenclature: Dandelion, *Taraxacum officinale* Weber in Wiggers TAROF; Argentine canola, *Brassica napus* L.; alfalfa, *Medicago sativa* L.

Key words: Distribution, interference, tillage, competition.

Dandelion has been recognized as a significant pest of lawns and forage crops (Moyer et al. 1990; Richardson 1985). There is evidence that as reduced-tillage production systems gain acceptance, dandelion populations will increase (Buhler et al. 1994; Triplett and Lytle 1972), and dandelion will become a more prevalent weed in annual crops. It has also been demonstrated that dandelion populations are much greater in annual crops in fields that have alfalfa in rotation relative to fields seeded to continuous cereal rotations (Ominski et al. 1999).

Canola is the second most commonly grown annual crop in western Canada (Martin et al. 2001), and dandelion infestation in canola has increased significantly in western Canada (Thomas et al. 1998).

The quantification of annual weed infestations has focused on density, leaf area, and dry biomass of weeds (Lotz et al. 1994, 1996; Lutman et al. 1996; Ngouajio et al. 1999). The quantification of interference using such measures has not been explored for dandelion in annual crops.

Weeds (especially perennial weeds) occur mainly in patches (Wiles et al. 1992). The distribution of a weed influences the yield loss due to interference, the design of optimal scouting plans, and the feasibility of patch spraying. The spatial distribution of a weed can also have a significant effect on economic thresholds (Thornton et al. 1990). For example, economic thresholds for a weed present in discrete patches are most valuable when spraying options are only considered on the portion of the field where the weed is present.

Little is known about the interference and distribution of dandelion in annual crops (Derksen et al. 1993). The objective of this project was to investigate dandelion's importance in canola. This included investigation of dandelion's distribution in fields, its ability to interfere with canola, and a determination of effective measures of dandelion interference.

Materials and Methods

Field Selection

In spring of 2000, sites across southern Manitoba that had a dandelion population were being seeded to canola were identified. Six fields (sites) ranging in size from 2.4 to 113.4 ha were found that met our criteria (Table 1). Sites selected were at Brandon, Carman, Dakota, Elie, New Bothwell, and Steinbach, MB. All sites were seeded to canola in 2000. Canola seeding rate for Brandon, Dakota, Elie, and New Bothwell was 5.6 kg ha^{-1}, whereas for Carman and Steinbach it was 6.2 kg ha^{-1}. Brandon and Carman were considered to be reduced-tillage sites because their tillage history for at least the past 3 yr included no more than one harrow pass per year in addition to seeding, and these sites were direct seeded (herbicide was used instead of tillage to control weeds before spring seeding). The other sites were classified as tilled sites because at each site at least one tillage was included before seeding in 2000, with a tillage implement providing more intensive tillage than a harrow (Table 2).

Determining Dandelion Density Across Each Site

Sites were surveyed with an all-terrain vehicle. Passes were made across sites at regular intervals (distance between passes was 25 m for Brandon and 50 m for all other sites). At regular points along passes, dandelion density (plants m^{-2}) was determined (distance between counts was 25 m for Brandon and 50 m for all other sites) and within a 1-m^2 quadrat (if densities were above 5 dandelion plants m^{-2}, a 0.2-m^2 quadrat was used). Surveys were conducted before crop seeding at four of the six sites. The Steinbach site was surveyed just after crop seeding, and no survey was performed at the Elie site because the canola was already in the two- to three-leaf stage when the site was added to the study.

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TABLE 1. Field size, survey date, seeding date and canola (*Brassica napus* L.) cultivar for sites included in dandelion (*Taraxacum officinale* Weber in Wiggers) distribution survey and interference study in 2000.

Site	Field size	Survey date	Seeding date	Canola cultivar	Number of quadrats sampled[a]
	ha				
Brandon	2.4	May 2	May 17	'INV2573'[b]	23
Carman	48.6	May 3	May 15	'46A76'[c]	34
Dakota	113.4	May 22	April 28	'46A76'[c]	25
New Bothwell	16.2	May 3	May 15	'INV2273'[b]	29
Steinbach	30.4	May 18	May 3[d]	'LG3311'[e]	—[d]
Elie	97.1	—[f]	April 28	'LG3311'[e]	9

[a] Number of dandelion-infested quadrats sampled per field for interference study.
[b] Aventis Group, 295 Henderson Drive, Regina, SK S4N 6C2, Canada.
[c] Proven Seeds, TD Centre, 201 Portage Avenue, Winnipeg, MB R3C 3A7, Canada.
[d] Site not included in interference study.
[e] Limagrain Canada Seeds Inc., 4-411 Downey Road, Saskatoon, SK S7N 4L8, Canada.

Establishment of Quadrats for Interference Studies

For the reduced-tillage sites (Brandon and Carman), cooperators applied glyphosate before seeding (450 g ai ha^{-1} at Brandon and 900 g ai ha^{-1} at Carman). At each site, 1-m^2 quadrats were established on patches of varying dandelion infestation (based on visual estimation of percent ground cover), where the infestations appeared. Cooperators for both reduced-tillage sites used hoe drills for seeding, and these drills did not remove pin flags. Quadrats at these two sites were, therefore, established before seeding. For the tilled sites (Dakota, Elie, New Bothwell, and Steinbach), cooperators tilled before seeding and seeded using air seeders with cultivator sweeps. The preseeding tillage and the sweeps used at seeding cut off all dandelion plants at the surface and would have removed pin flags used to locate quadrats. At the tilled sites, quadrats were established 1 wk after seeding. Quadrats free of dandelions were established in close proximity to each dandelion-infested quadrat. All quadrats were hand weeded at the time they were established to remove other weed species. At the two- to four-leaf stage of canola, when flushes of small grass or broadleaf weeds appeared in the quadrats, all quadrats at each site were sprayed with sethoxydim (Poast Ultra[1]) at a rate of 378 g ai ha^{-1} and ethametsulfuron-methyl (Muster[2]) at a rate of

TABLE 2. Histories for sites included in interference study or field survey.

Site	Year	Crop	Tillage	Herbicide
Brandon	1999	Dry bean (*Phaseolus vulgaris* L.)	None	Ethafluralin, sethoxydim, imazethapyr
	1998	Oat (*Avena fatua* L.)	None	Glyphosate[a], dicamba, mecoprop
	1997	Canola (*Brassica napus* L.)	None	Glyphosate[a] 2×
	1996	Wheat (*Triticum aestivum* L.)	None	Glyphosate[a], dicamba
Carman	1999	Wheat	Rotary harrow[b]	Glyphosate[c], fenoxaprop, thifensulfuron
	1998	Oat	Rotary harrow	Glyphosate[c], bromoxynil, MCPA
	1997	Flax (*Linum usitatissimum* L.)	Rotary harrow	Glyphosate[c], bromoxynil, MCPA
	1996	Oat	Rotary harrow	Glyphosate[c], bromoxynil, MCPA
Dakota	1999	Wheat	Cultivator[d], harrow[e]	Fenoxaprop, clopyralid, MCPA
	1998	Canola	Cultivator, harrow	Sethoxydim, ethametsulfuron-methyl
	1997	Wheat	Cultivator, harrow	Bromoxynil, MCPA, thifensulfuron
	1996	Wheat	Cultivator, harrow	Dichlorprop, 2,4-D
Elie	1999	Flax	Cultivator[d]	Sethoxydim, bromoxynil MCPA
	1998	Wheat	Cultivator[d]	None
	1997	Alfalfa (*Medicago sativa* L.)	Plough[f], disk[g]	2,4-D
	1996	Alfalfa	None	None
New Bothwell	1999	Alfalfa	Plough[f], disk[g]	None
	1998	Alfalfa	None	None
	1997	Alfalfa	None	None
	1996	Alfalfa	None	None
Steinbach	1999	Oat	Cultivator[d], harrow[e]	None
	1998	Alfalfa	Disk[g], cultivator[d]	Glyphosate[c]
	1997	Alfalfa	None	None
	1996	Alfalfa	None	None

[a] Glyphosate applied at a rate of 450 g ai ha^{-1} preseeding in spring.
[b] Site was rotary harrowed once in fall.
[c] Glyphosate applied at a rate of 900 g ai ha^{-1} in fall before fall tillage.
[d] Site was cultivated twice in fall.
[e] Site was harrowed once in fall.
[f] Site was moldboard ploughed once in fall.

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14.8 g ai ha^{-1}. When cooperators sprayed their postemergence herbicides, all quadrats were covered with plastic to prevent herbicide injury to dandelion.

Field Sites Maintenance

Quadrats were checked routinely to ensure that unwanted weed species were removed. Because of above-average precipitation levels during and just after seeding in southern Manitoba in the summer of 2000, several of the sites had flooded areas. At Steinbach, many quadrats had to be abandoned because of flooding, and the site was excluded from the interference study.

Prespray Measures on Canola and Dandelion

At the two- to four-leaf stage of canola, just before the time of postemergence weed control application (prespray), several measurements were made of canola and dandelion. Canola and dandelion density and percent ground cover and dandelion rosette diameter (distance between leaf tips) were measured in each quadrat. Canola and dandelion ground cover were determined by taking overhead photographs of each quadrat 1.5 m above the ground. A transparency with a grid containing 100 random dots was placed over these photographs, and counts were made of the number of times these dots touched either dandelion or canola. This estimated the percent ground cover. Relative dandelion density was calculated by dividing dandelion density prespray by the sum of dandelion and canola density prespray. Relative dandelion cover was calculated by dividing dandelion ground cover prespray by the sum of dandelion and canola ground cover prespray.

Measurements on Dandelion at Canola Harvest

At the time of canola yield harvest, all dandelions were removed from each quadrat using forked dandelion pullers. The number of dandelion plants per quadrat was counted. All dandelion plants were cut even at the rosette base. The diameter of the dandelion root at the rosette base was measured in millimeters using calipers. Root diameters were summed for each quadrat. Leaves were removed from each dandelion plant, and leaf area was measured using a LiCor[4] 3100 leaf area meter. For each quadrat, all aboveground biomass was dried at 80 C for 48 h, weighed, and recorded.

Canola Harvest

When canola reached physiological maturity, plants were harvested from each quadrat. Canola plants were placed in burlap bags and were hung to dry for a period of 14 to 28 d. Once the canola had fully ripened, the contents of each bag were threshed using a Wintersteiger[3] NurseryMaster™ small-plot combine. Canola seed samples were placed in paper bags and left in a drying room for 5 d. Samples were then sieved to remove chaff, and the clean grain was weighed.

Data Analysis

Canola yield was expressed as a percentage of weed-free yield by dividing the canola yield for each dandelion-infested quadrat by the average weed-free canola yield for the site in which the quadrat was located. Using this calculation, few canola yield values were greater than 100% for conventional-tillage fields, and no values were greater than 100% for reduced-tillage fields.

To determine whether there were any correlations between the dependent variable (canola yield as a percentage of weed-free yield) and the independent variables (measures of dandelion infestation), we used a correlation procedure (PROC CORR) of SAS[5], initially combining all sites in the analysis. When plotting the relationships for all sites combined, there was a clear and consistent separation between tilled and reduced-tillage sites. The correlation analysis was conducted again separately for reduced-tillage (combined) and tilled sites (combined). There were only significant correlations for the reduced-tilled sites (combined). The correlation analysis was conducted again separately for each reduced-tillage site.

For the reduced-tillage sites, when significant correlations were found for relationships between measures of dandelion infestation level and canola yield as a percentage of weed-free yield, we modeled these relationships using a rectangular hyperbola model (Cousens 1985).

$$\%Y_{wf} = Y_{wf}\left[1 - \frac{ix}{100(1 + ix/a)}\right] \quad [1]$$

where $\%Y_{wf}$ = canola yield as a percentage of weed-free yield, Y_{wf} = estimated maximum yield, i = initial slope, a = maximum yield loss, and x = the measure of dandelion infestation. The model was fitted using a nonlinear regression procedure (PROC NLIN) of SAS[5]. The model fit (R^2) was determined by dividing the residual sum of squares by the corrected total sum of squares and subtracting from 1. When the rectangular hyperbola model could not be fitted to the data (lack of convergence), a simple linear model was fit using a linear regression (PROC REG) of SAS[5].

$$\%Y_{wf} = Y_{wf} + bx \quad [2]$$

where $\%Y_{wf}$ = canola yield as a percentage of weed-free yield, Y_{wf} = estimated maximum yield, b = slope, and x = the measure of dandelion infestation.

If a given relationship between a measure of dandelion infestation level and canola yield was described using the same model for more than one site, F-tests were performed according to Seefeldt et al. (1995) to determine whether models were significantly different between sites.

Results and Discussion

Dandelion Distribution in Fields

Dandelion distribution was not generally associated with tillage regimen. Dandelion distribution in the reduced-tillage fields was patchy at Carman and uniform at Brandon (Figure 1). At Brandon, dandelion was present in 93% of the quadrats, whereas at Carman, it was present in only 18% of the quadrats. Average density at the Brandon site was 8.8 ($\pm$ 1.09) dandelion plants m^{-2}, whereas at Carman, it was 0.6 ($\pm$ 0.14) plants m^{-2}. Dandelion distribution at the tilled sites was patchy at Steinbach and Dakota and uniform at New Bothwell (Figure 1). Dandelion was present in 10% of the quadrats at the Dakota site, 12% at the Steinbach site,

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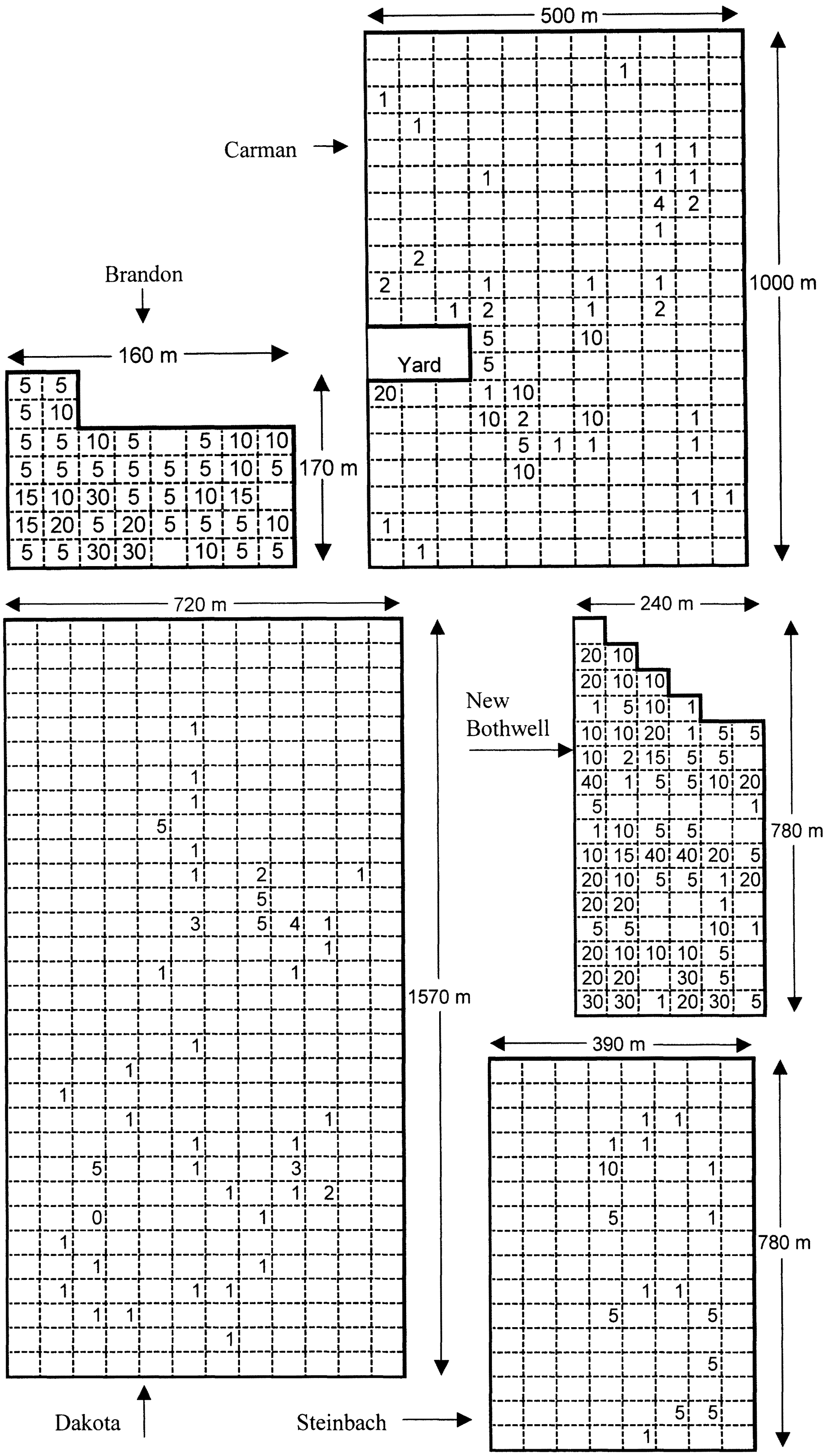

FIGURE 1. Dandelion (*Taraxacum officinale* Weber in Wiggers) distribution in reduced-tillage and tilled sites. Each square represents 625 m^2 at Brandon site and 2,500 m^2 for all other sites. Values in boxes represent dandelion density within the square (plants m^{-2}).

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TABLE 3. Correlation of canola (*Brassica napus* L.) yield as a percentage of weed-free yield with measures of dandelion (*Taraxacum officinale* Weber in Wiggers) infestation level for reduced-tillage and tilled sites included in the dandelion interference study.

Timing	Measurement	Correlation (r)	P[a]
Tilled sites combined (n = 63)			
Prespray	Dandelion cover	− 0.05	0.673
	Relative cover	− 0.10	0.414
	Dandelion density	− 0.09	0.445
	Relative density	− 0.11	0.361
	Total dandelion rosette diameter	− 0.07	0.595
At crop harvest	Total dandelion leaf area	− 0.20	0.106
	Total dandelion root diameter	− 0.17	0.174
	Total dandelion biomass	− 0.16	0.205
	Dandelion density	− 0.10	0.417
Reduced-tillage sites combined (n = 57)			
Prespray	Dandelion cover	− 0.70	0.0001
	Relative cover	− 0.74	0.0001
	Dandelion density	− 0.48	0.0002
	Relative density	− 0.48	0.0002
	Total dandelion rosette diameter	− 0.54	0.0001
At crop harvest	Total dandelion leaf area	− 0.32	0.0154
	Total dandelion root diameter	− 0.55	0.0001
	Total dandelion biomass	− 0.32	0.0153
	Dandelion density	− 0.45	0.0004

[a] Probability of significance.

and 80% at the New Bothwell site. The average density of dandelion was 0.2 (± 0.03), 0.4 (± 0.12), and 9.7 (± 1.13) plants m^{-2} at the Dakota, Steinbach, and New Bothwell sites, respectively.

Uniform distribution of a simple perennial (perennial that regenerates from seed or rootstock but is spread by seed alone) such as dandelion across large fields is dependent on sustained opportunities for successful seedling establishment (Solbrig and Simpson 1974). Uniform dandelion distribution in a given field may reflect a long past history of unimpeded weed invasion and proliferation opportunities (Cousens and Mortimer 1995). Among the tilled sites, New Bothwell was most uniformly infested with dandelion. It was also the site that had most recently been in alfalfa (Table 2), and it had been in alfalfa and untilled for a long time (8 yr). Alfalfa stands are known to weaken over time, and open areas in these fields become infested with dandelion (Moyer et al. 1994; Ominski et al. 1999; Spandl et al. 1999). Dandelion infestations at the Steinbach and Dakota sites were more heterogeneous than the infestation at the New Bothwell site. The Steinbach site had been cropped with annuals a year longer than the New Bothwell site, and the Dakota site had not been in alfalfa at all between 1996 and 2000. Tillage and herbicide applications during annual cropping can significantly reduce dandelion infestation (Froese 2001; Leeson et al. 2000; Ominski et al. 1999). Even a single year of tillage can greatly reduce dandelion infestation (Froese 2001). The farmer managing the Dakota site noted that in 1994 the dandelion infestation flourished at this site because it was seeded to an uncompetitive crop of lentils (*Lens culinaris* Medic.), and there were no herbicides registered for use in lentils that would control dandelion seedlings.

Between the reduced-tillage sites, the difference in dandelion distribution may reflect minor differences in crop rotation and tillage. Effective weed control can reduce weed patch size and increase weed infestation heterogeneity in a field (Cousens and Mortimer 1995). Between 1996 and 1999, the Brandon site had been seeded to broadleaf crops twice, whereas the Carman site had been seeded to broadleaf crops only once. A greater frequency of broadleaf crops, such as pea (*Pisum sativum* L.), flax (*Linum usitatissimum* L.), canola, dry bean (*Phaseolus vulgaris* L.), and sunflower (*Helianthus annuus* L.) in rotation, has been associated with increased populations of dandelion (Stevenson and Johnston 1999). These crops may be generally less competitive against weeds than are cereal crops, and there are no postemergence herbicides registered for use in these crops, which provide high levels of efficacy on dandelion (Anonymous 2001). Longer cropping histories of these sites were not known.

Canola Yield as Affected by Dandelion Interference

The strength of relationship between measures of dandelion infestation level and canola yield loss was associated with tillage regimen. For tilled sites (combined), not a single measure of dandelion infestation level was significantly correlated with canola yield as a percentage of weed-free yield (Table 3). This was also true for each tilled site individually (results not shown). For the tilled sites, leaf area, ground cover, relative leaf area, and relative ground cover, which are generally more predictive of an annual weed infestation's ability to cause crop yield loss than density (Kropff and Spitters 1991; Lotz et al. 1996), were not reliable measures of canola yield loss as affected by dandelion interference (Table 3).

For the reduced-tillage sites (combined), all measures of dandelion infestation level were significantly correlated with canola yield as a percentage of weed-free yield (Table 3). Only dandelion cover prespray, relative cover prespray, total rosette diameter prespray, total dandelion root diameter at harvest, and density at harvest were significantly correlated with canola yield loss at the Brandon site (Table 4). Dan-

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TABLE 4. Correlation of canola (*Brassica napus* L.) yield as a percentage of weed-free canola yield with measures of dandelion (*Taraxacum officinale* Weber in Wiggers) infestation for individual reduced-tillage sites included in the dandelion interference study.

Timing	Measurement	Correlation (r)	P[a]
Brandon site (n = 23)			
Prespray	Dandelion cover	− 0.62	0.002
	Relative cover	− 0.58	0.003
	Dandelion density	− 0.34	0.108
	Relative density	− 0.28	0.185
	Total dandelion rosette diameter	− 0.46	0.028
At crop harvest	Total dandelion leaf area	− 0.26	0.237
	Total dandelion root diameter	− 0.47	0.025
	Total dandelion biomass	− 0.16	0.471
	Dandelion density	− 0.41	0.055
Carman site (n = 34)			
Prespray	Dandelion cover	− 0.82	0.0001
	Relative cover	− 0.85	0.0001
	Dandelion density	− 0.60	0.0001
	Relative density	− 0.63	0.0001
	Total dandelion rosette diameter	− 0.66	0.0001
At crop harvest	Total dandelion leaf area	− 0.53	0.0012
	Total dandelion root diameter	− 0.82	0.0001
	Total dandelion biomass	− 0.66	0.0001
	Dandelion density	− 0.66	0.0001

[a] Probability of significance.

delion ground cover and relative ground cover were most strongly correlated with canola yield loss for both reduced-tillage sites. The common weed infestation measurement of dandelion density prespray was significantly correlated with canola yield loss for only one of the five sites in this study.

The strength of the relationship between measures of dandelion infestation and canola yield loss may be related to the diversity in age and biotype within a given infestation of dandelion. Different infestations of simple perennials such as dandelion can have different age structures (Silversides 1938), and individual dandelion infestations often comprise a range of unique biotypes because dandelion reproduction is primarily asexual (Solbrig and Simpson 1974). Dandelion biotypes have been shown to differ in competitive ability, and these differences are related both to the disturbance level in which the biotype has evolved and the unique response of biotypes to plant competition in their environment (Ford 1981). For example, older dandelion plants and dandelions growing in undisturbed habitats have been shown to be more competitive (Bunce 1980; Moyer et al. 1990; Solbrig and Simpson 1974). If a dandelion infestation has a greater age or biotype range distribution within an infestation, there may be a weaker relationship between measures of that infestation and its interference ability, particularly if the measure of the infestation does not reflect dandelion age or biotype specificity. The stronger correlation between measures of dandelion infestation level and canola yield loss in reduced-tillage vs. tilled sites may mean that the age or biotype structure of the dandelion infestations was broader in the tilled vs. the reduced-tillage fields. Tillage before spring seeding may promote a more diverse age and biotype structure within a dandelion infestation. Légère and Samson (1999) reported that in long-term rotation studies, dandelion could behave more as an annual than as a perennial in some years, producing large flushes of spring seedlings. They offered no explanation for the variation in this phenomenon from year to year. Distribution of dandelion within a field seemed to reflect past history of disturbance or lack thereof (for example, a history of alfalfa). However, current interference ability of a given dandelion infestation may reflect dandelion age structure, which may be a reflection of very recent disturbance (for example, presence or absence of tillage before seeding).

TABLE 5. Summary of dandelion (*Taraxacum officinale* Weber in Wiggers) root diameter statistics for each site included in the canola (*Brassica napus* L.) interference study.

Site	Mean root diameter	Range of root diameters
	mm	mm
Brandon	11.36 (0.390)	2 to 41
Carman	8.05 (0.256)	1 to 40
Dakota	9.09 (0.391)	1 to 112
New Bothwell	5.43 (0.143)	1 to 19
Elie	6.77 (0.305)	1 to 30

We thought that for a perennial species, root diameter may reflect plant age and competitiveness; however, total dandelion root diameter was significantly correlated with canola yield loss for the reduced-tillage sites only (Table 3). Silversides (1938) found that root shrinkage could occur depending on soil moisture conditions during the season, and he found that root diameter did not necessarily reliably reflect root biomass. Solbrig and Simpson (1974) found that dandelion competitiveness was not merely a function of age. The distribution of dandelion root diameters was not obviously different among sites regardless of tillage regimen at a given site (Table 5), suggesting that dandelion root diameter may not be a generally reliable measure of dandelion age or relative competitiveness.

The models relating dandelion ground cover prespray, relative ground cover prespray, total root diameter at canola

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Table 6. Parameter estimates for models representing relationships between canola (*Brassica napus* L.) yield as a percentage of weed-free yield and measures of dandelion (*Taraxacum officinale* Weber in Wiggers) infestation level. Values in parentheses are standard errors of parameter estimates.

Dandelion measure	Site	Model	Parameter estimates					
			Y_{wf}	i	a	Y_{wf}	b	R^2
Dandelion cover[a]	Brandon	Linear				71.0 (12.7)	− 0.7 (0.19)	0.39
	Carman	Linear				121.4 (10.9)	− 1.2 (0.15)	0.67
Relative cover[a]	Brandon	Linear				90.4 (19.5)	− 80.9 (24.5)	0.34
	Carman	Linear				146.7 (12.3)	− 139.4 (15.1)	0.73
Root diameter[b]	Brandon	Rect.hyp.[c]	213.4 (451.0)	2.6 (7.5)	105.4 (21.7)			0.47
	Carman	Rect.hyp.	94.5 (14.7)	0.1 (0.06)	207.7 (104)			0.79
Rosette diameter[a]	Brandon	Linear				47.0 (9.4)	− 0.1 (0.05)	0.21
	Carman	Rect.hyp.	109.8 (45.0)	0.7 (0.6)	151.1 (91.4)			0.47
Density[b]	Carman	Rect.hyp.	83.8 (14.3)	1.5 (0.73)	136.8 (37.1)			0.59
Biomass[b]	Carman	Rect.hyp.	111.0 (38.6)	0.8 (0.6)	162.5 (102)			0.46
Relative density[a]	Carman	Linear				65.4 (7.4)	− 68.2 (14.8)	0.40
Density[a]	Carman	Rect.hyp.	104.9 (51.4)	24.7 (27.0)	143.7 (91.3)			0.40
Leaf area[b]	Carman	Linear				66.3 (9.5)	− 0.003 (0.00)	0.28

[a] Measured prespray (at the two- to four-leaf stage of canola).
[b] Measure at harvest (at physiological maturity of canola).
[c] Rectangular hyperbola model (see Equation 1).

harvest, and total rosette diameter prespray to reduction in canola yield differed significantly between Brandon and Carman (Table 6). In studies with annual weeds, it is common for models to differ significantly between sites and years (Lotz et al. 1996). The competitiveness of canola can be greatly affected by site and environmental conditions (Lemerle et al. 1995; Lutman et al. 1994; Martin et al. 2001). The effect of dandelion on yield loss has been documented for forage crops (Moyer et al. 1990) but not for prominent annual crops. Our results show that dandelion does have the ability to cause great yield loss in canola. A dandelion infestation with 50% ground cover caused 64 and 39% canola yield loss at Brandon and Carman, respectively (Figure 2). However, the inconsistency in the strength of the relationship between measures of dandelion infestation level and canola yield loss demonstrated in this study suggests that it is difficult to generalize on the effect of dandelion interference on canola yield.

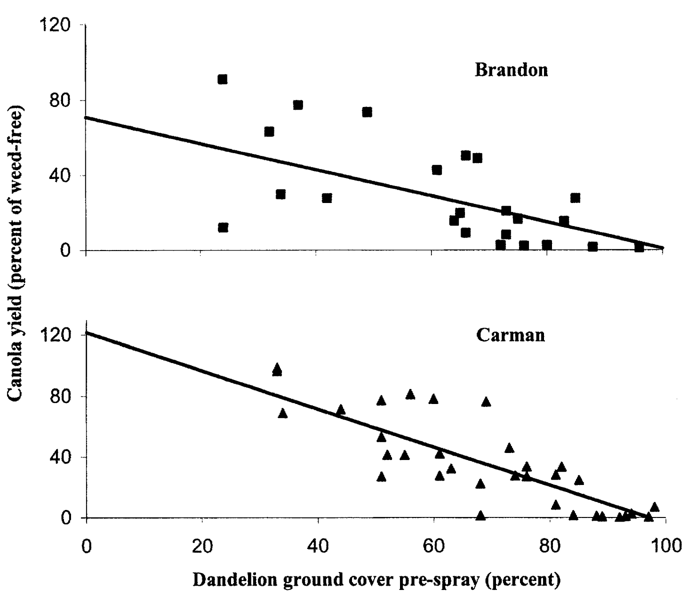

Figure 2. Reduction in canola (*Brassica napus* L.) yield as influenced by dandelion (*Taraxacum officinale* Weber in Wiggers) ground cover measured prespray (two- to four-leaf stage of canola) at Brandon and Carman. Markers represent data points, and lines represent fitted models. For model parameter values, see Table 6.

Conclusions

Dandelion distribution in canola fields can be either uniform or heterogeneous. The distribution of dandelion infestations in a particular field is not driven by tillage alone. Past cropping history, for example, the presence of crops in rotation for which there are no options for control of dandelion (e.g., alfalfa and lentils), can lead to more uniform infestations of this weed within a field (Derksen et al. 1993; Ominski et al. 1999). This study confirms that dandelion can uniformly infest both tilled and reduced-tillage sites.

On a whole-field basis, dandelion has the potential to dramatically reduce canola yield. For example, at Carman, even though dandelion was present in only 18% of quadrats, if dandelion cover averaged only 50% where dandelion was present, yield would be reduced by 7% for the entire field. Producers can scout fields to determine whether dandelion affects the small areas of a field or the entire field. With the difficulty in predicting level of competitiveness of dandelion infestations, producers may default to the position that if dandelion is present to a noticeable extent in canola fields, control is warranted.

Studies in the literature show that dandelion plants can vary significantly in their competitiveness and that this may not necessarily be reflected in any simple measure of the dandelion plant. We confirm these findings in a field crop setting. Unfortunately, our confirmation of these findings mean that it is not a simple matter to predict yield loss due to dandelion interference. Dandelion cover prespray, relative cover prespray, total rosette diameter prespray, and total root diameter at harvest provided the most reliable measures of dandelion interference. Dandelion density prespray was not significantly related to canola yield loss at four of the five sites. Improving our ability to predict the competitiveness of a dandelion infestation in a field crop such as canola will

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require a better understanding of the interaction between the cropping practices (i.e., crop rotation and tillage) and the competitiveness of dandelion infestations. This will require a more extensive characterization of the influence of cropping practices on the competitiveness of dandelion infestations, an investigation of whether the latter is related to the competitive diversity of dandelion plants within an infestation, and study of how one simply and reliably measures competitive diversity within dandelion infestations in field crops.

Sources of Materials

[1] Poast Ultra, BASF Canada Inc., 345 Carlingview Drive, Toronto, ON M9W 6N9, Canada.

[2] Muster, Dupont Canada Inc., Box 2200, Streetsville, Mississauga, ON L5M 2H3, Canada.

[3] Wintersteiger NurseryMaster, Wintersteiger Inc., 217 Wright Brothers Drive, Salt Lake City, UT 84116.

[4] LiCor 3100 leaf area meter, Li-Cor Inc., 4421 Superior Street, Lincoln, NE 68504.

[5] SAS Institute Inc., 100 SAS Campus Drive, Cary, NC 27513-2414.

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